Bone and Arthrosurgery Science, 2026, Volume 4, Issue 4
https://www.bbwpublisher.com/journal/BAS
Online ISSN: 2981-8222
Print ISSN: 3083-4856

Comparison of Clinical Efficacy Between Exercise Therapy and Percutaneous Radiofrequency Ablation for Chronic Discogenic Low Back Pain: A Randomized Controlled Trial

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Abstract: *Objective*: To compare the clinical efficacy of exercise therapy and percutaneous radiofrequency ablation in the treatment of chronic discogenic low back pain in patients. *Methods*: Sixty-eight patients with chronic discogenic back pain who were hospitalized at the 923rd Hospital of the Joint Logistics Support Force and the Armed Police Guangxi Autonomous Region General Hospital from March 2023 to February 2025 were included in the study. They were randomly divided into two groups, with 34 patients in each group. The ablation group received percutaneous radiofrequency ablation treatment, while the exercise therapy group received core muscle strength training treatment. Comparative analysis of intragroup and intergroup differences was conducted on evaluation indicators such as visual analogue scale, Japanese Orthopaedic Association score, and lumbar Oswestry disability index of patients before treatment, 1 week after treatment, 1 month after treatment, 6 months after treatment, and at the last follow-up. *Results*: All patients were followed up for an average of 20.74 ± 6.70 (11–35) months. The lumbar pain VAS, JOA, and ODI scores in the ablation group showed significant differences compared to pre-treatment levels at 1 week post-treatment ($P < 0.05$). At 1 month, 6 months, and the final follow-up, both groups exhibited significant differences in lumbar pain VAS, JOA, and ODI scores compared to pre-treatment levels ($P < 0.05$). The VAS, JOA, and ODI scores at 1 week post-treatment differed significantly between the two groups ($P < 0.05$). At the final follow-up, the ODI scores also showed significant differences between the two groups ($P < 0.05$). *Conclusion*: Both exercise therapy and percutaneous radiofrequency ablation can achieve good short-term efficacy in treating patients with discogenic low back pain. The percutaneous radiofrequency ablation group has a faster onset of action, while the exercise therapy group has a more significant long-term efficacy.

Keywords: Low back pain; Discogenic low back pain; Radiofrequency ablation; Exercise therapy

Online publication: August 31, 2026

1. Introduction

Discogenic low back pain (DLBP) arises from pathological changes within the intervertebral disc, such as tears or degeneration of the annulus fibrosus and/or nucleus pulposus, leading to inflammation and reduced local stability. These mechanical and chemical factors stimulate pain nerve endings in the posterior longitudinal ligament and annulus fibrosus, resulting in pain [1]. While acute DLBP often resolves rapidly with bed rest and anti-inflammatory medication, recurrences are common, leading to a chronic condition. Treatment modalities for chronic DLBP include pharmacotherapy, physical therapy, exercise, and surgery [2–4]. With advances in minimally invasive techniques, percutaneous radiofrequency ablation (PRFA) has been widely used and shown favorable outcomes [5,6]. Exercise therapy (ET), a non-invasive and accessible approach, is also recognized as a first-line treatment for chronic low back pain [7]. However, no consensus exists regarding the comparative efficacy of these two interventions. This prospective randomized study aimed to compare the clinical outcomes of ET versus PRFA for chronic DLBP.

2. Materials and methods

2.1. Study design and participants

From March 2023 to February 2025, 68 patients with chronic discogenic low back pain who were hospitalized in the 923rd Hospital of the Joint Logistics Support Force and the Guangxi Armed Police Corps Hospital were selected as the research subjects, and they were randomly divided into the exercise therapy group and the ablation group, with 34 patients in each group. The average age of the exercise therapy group was 26.21 ± 3.88 (21–36) years old. The average course of the disease was 27.02 ± 36.24 (3–109) months, the average age of the ablation group was 24.53 ± 3.65 (20–36) years, and the average course of the disease was 26.28 ± 35.47 (3–120) months. The exercise therapy group was trained with suspension exercise therapy and McKenzie therapy, while the ablation group was treated with percutaneous radiofrequency ablation. This study was approved by the Hospital Clinical Research Ethics Committee, and all patients signed the informed consent form.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) All patients were diagnosed with discogenic low back pain, with chronic low back pain lasting for more than 3 months, no radiating pain in the lower limbs, and no clear compression of the nerve root or dural sac on imaging examination; (2) VAS score ≥4; (3) Aged between 18 and 40 years. Exclusion criteria: (1) Significant neurological impairment or radiculopathy; (2) Severe cardiopulmonary function, coagulation dysfunction, or mental and psychological disorders; (3) Infection, malignancy; (4) Other sources of low back pain; (5) Allergy to local anesthetic drugs; (6) Incomplete data, loss to follow-up, etc.

2.3. Interventions

2.3.1. Exercise therapy group

A professional physiotherapist instructed them to carry out whole-body muscle strength training, mainly suspension exercise therapy and McKenzie the rapy (**Figure 1**).

Suspension exercise therapy training method: including 4 action steps.

(1) Suspension static core stabilization (basic level)

Key points: Hold the bar with both hands, tighten your body as much as possible, keep your spine naturally neutral, slightly contract your shoulder blades, maintain continuous core strength, and slowly relax after maintaining this position for 3–4 breaths.

Training method: Initially, maintain 10–20 seconds per group, with 3–4 groups, gradually extending to 40–60 seconds.

(2) Suspension segmented stretching and grip strength training

Key points: Start at a comfortable height and practice different grips for holding the barbell (pronation, supination, and staggered grip).

Training method: Each set consists of 8–12 grips or small pulls, with the focus on the coordination of "micro-contraction + stability" of the muscles. Rest for 30–60 seconds between sets.

(3) Simplified version of the hanging push-pull combination

Key points: Starting from a stable suspension position, perform a slight pull-up (such as moving the chest slightly upward towards the bar), and then slowly lower back to the suspension position.

Training method: Perform 6–8 reps per set, maintain control of the movement, and avoid excessive leverage. You can use your feet to press against the ground for assistance, gradually reducing the assistance as you progress.

(4) Suspended knee lift (core strengthening)

Key points: Keep your legs together, lift your knees towards your chest, maintain stability of your shoulder blades, and control the rhythm when lowering to avoid using inertia.

Training method: Each set consists of 6–10 repetitions, synchronized with breathing rhythm. During training, the number of repetitions can be gradually increased to 15–20 or the dwell time can be extended.

McKenzie therapy training method: It mainly involves prone stretching exercises: lie on your stomach with your elbows supporting your upper body, keeping your hips off the bed, and maintain this position for 30 seconds. When the pain subsides, switch to using your palms for support to achieve greater stretching of the lumbar spine.

Train once a day, with 2–3 sets for each exercise, and each session lasting 20–30 minutes. The total treatment duration is at least 11 months or more.

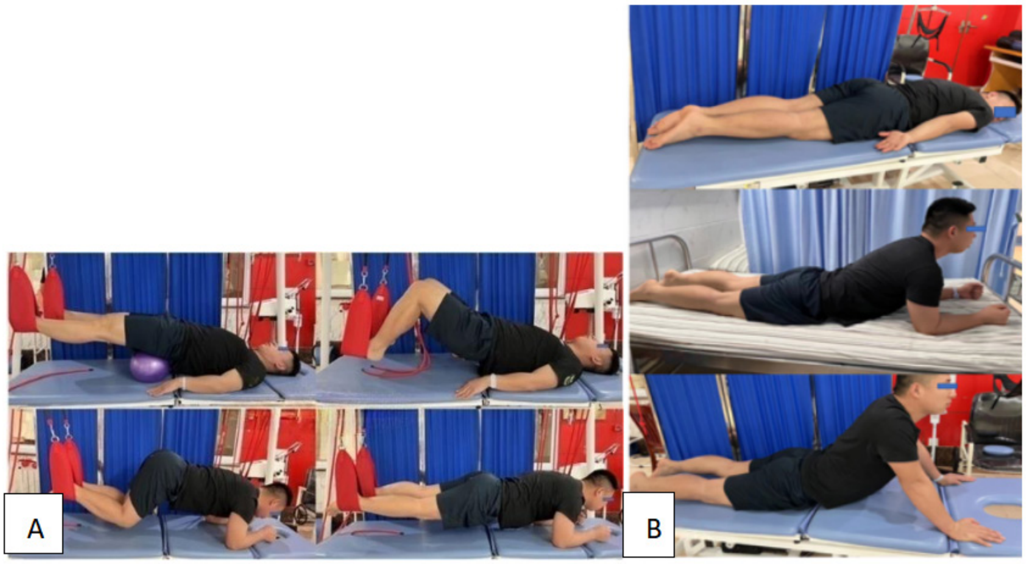

Figure 1. Exercise therapy training methods. A. Suspension exercise therapy; B. McKenzie therapy

2.3.2. Ablation group

The patient is placed in a prone position with the abdomen suspended in the air. Routine iodophor disinfection is performed, and sterile drapes are applied. Using 1% lidocaine hydrochloride injection, a skin pimple is made at the puncture site, which is located 8–10 cm lateral to the affected lumbar disc corresponding to the level of the spinous process (6–8 cm lateral to L5–S1, and 1–1.5 cm lateral for patients with high iliac spines), and punctured through the posterior side of the intervertebral space. Local infiltration anesthesia is performed from shallow to deep. The needle is inserted at a forward and medial angle of about 30–40° at this puncture point, with a depth of about 10–11 cm. After a distinct sensation of emptiness, the puncture needle tip is seen to reach the posterior edge of the affected lumbar disc space under C-arm X-ray fluoroscopy. The puncture needle core is removed, and the radiofrequency ablation working electrode is inserted into the target point through the puncture needle. After an impedance test is normal, neuroelectrophysiological sensory and motor nerve function tests are performed. The sensory test frequency is 50 Hz and the voltage is 0.3 to 0.5 V. The patient reports abnormal sensations such as numbness and distension in the preoperative pain area. During the motor test, when the frequency is 2 Hz and the voltage is 0.6 to 0.8 V, muscle contraction and jumping occur in the lumbosacral region. When the voltage is above 1.0 V, no motor nerve stimulation-induced muscle contraction or distal radiating pain in the lower extremities occurs, indicating successful testing. The temperature is set to 60°C, 70°C, and 80°C, respectively, for thermal coagulation ablation, each lasting for 1 minute. Then, the temperature is adjusted to 95°C, and thermal coagulation ablation lasts for 4 minutes, for a total of two cycles (**Figure 2**). After the treatment, the puncture needle is removed, the puncture site is disinfected, and a band-aid is applied to cover the puncture site.

All patients in the ablation group and exercise therapy group both received anti-inflammation, dehydration for one week, and lumbar brace use for one month. Avoid bending over and sitting for long periods within 1 month, and avoid weight-bearing within 3 months. No other co-interventions were permitted during the study period in either group.

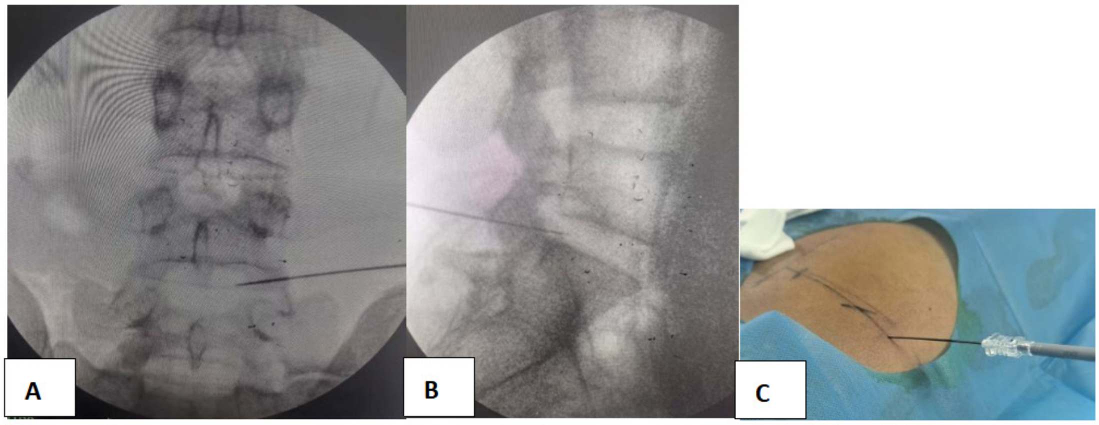

Figure 2. Radiofrequency ablation case. A. anteroposterior image; B. lateral fluoroscopic image; C. radiofrequency ablation

2.4. Outcome measures

(1) VAS score was used for pain assessment, and the VAS scores of all patients before treatment, 1 week, 1 month, 6 months after treatment, and the last follow-up were recorded.

(2) Oswestry Dysfunction Index (ODI score) and JOA score were used for functional assessment, and the ODI and JOA scores before treatment, 1 week, 1 month, 6 months after treatment, and the last follow-up were recorded.

2.5. Statistical analysis

The data were statistically analyzed using SPSS 17.0 statistical software. The measurement data were expressed as mean ± standard deviation (SD); an independent-samples *t*-test was used. Count data were analyzed using a chi-square test, and the measurement data within the group were analyzed by one-way ANOVA. $P < 0.05$ is statistically significant.

3. Results

3.1. General data

Both patient groups were composed of males. There were no statistically significant differences in general data such as age, disease duration, affected disc level, BMI, and follow-up time, indicating comparability. See **Table 1**. No adverse events or complications were observed in either group.

Table 1. Comparison of general data between the two groups (mean ± SD)

Group	Age year	Disease duration month	Follow-up time month	BMI	Affected disc level (*n*)	
					L4/5	L5S1
Exercise therapy group (n = 34)	26.21 ± 3.88	27.02 ± 36.24	21.91 ± 7.39	20.74 ± 1.33	18	16
Radio frequency ablation group (n = 34)	24.53 ± 3.65	26.28 ± 35.47	19.56 ± 6.48	20.76 ± 1.21	19	15
t	1.834	0.086	1.396	0.095	$\chi^2 = 0.059$	
P	0.071	0.932	0.167	0.924	0.808	

3.2. Intragroup comparison of therapeutic effects between the two groups after treatment

All patients were followed up for an average of 20.74 ± 6.70 months (11–35 months). Compared with before treatment, the scores of VAS, JOA, and ODI of low back pain in the exercise therapy group were not significantly different from those before treatment ($P > 0.05$), and the VAS of low back pain in the two groups was 1 month after treatment, 6 months after treatment, at the last follow-up, and 1 week after treatment. See **Table 1** for specific data.

3.3. Comparison of curative effect between two groups after treatment

Compared with the ablation group, there were significant differences in VAS, JOA, and ODI scores of low back pain between the two groups one week after treatment ($P < 0.05$). One month and six months after treatment, there was no significant difference in the scores of VAS, JOA, and ODI between the two groups ($P > 0.05$). At the last follow-up, there was no significant difference in VAS score and JOA score between the two groups ($P > 0.05$), but there was a significant difference in ODI score between the two groups ($P < 0.05$). See **Table 2** for specific data.

Table 2. Longitudinal comparison of VAS, JOA, and ODI scores between groups

	Exercise therapy group (*n* = 34)	**Radiofrequency ablation group (*n* = 34)**
VAS score (points)		
Preoperative	5.94 ± 0.65	5.94 ± 0.65
1 week postoperatively	5.74 ± 0.57	2.44 ± 0.61 ①②
1 month postoperatively	2.68 ± 0.64 ①③	2.44 ± 0.66 ①③
6 months postoperatively	1.68 ± 0.59 ①③④	1.74 ± 0.67 ①③④
Last follow-up	1.03 ± 0.30 ①③④⑤	1.03 ± 0.30 ①③④⑤
JOA score (points)		
Preoperative	19.74 ± 2.06	19.32 ± 4.27
1 week postoperatively	19.85 ± 1.73	21.38 ± 3.63 ①②
1 month postoperatively	22.82 ± 1.49 ①③	22.97 ± 1.49 ①③
6 months postoperatively	27.26 ± 0.79 ①③④	27.74 ± 1.21 ①③④
Last follow-up	28.12 ± 0.69 ①③④⑤	28.35 ± 0.85 ①③④⑤
ODI (%)		
Preoperative	36.94 ± 1.15	34.38 ± 6.80
1 week postoperatively	36.41 ± 1.33	26.91 ± 4.37 ①②
1 month postoperatively	15.41 ± 2.31 ①③	14.50 ± 2.22 ①③
6 months postoperatively	17.97 ± 1.68 ①③④	18.00 ± 1.79 ①③④
Last follow-up	12.71 ± 1.43 ①③④⑤	13.79 ± 2.21 ①②③④⑤

Note: ① $P < 0.05$ compared with preoperative value; ② $P < 0.05$ compared with exercise therapy group; ③ $P < 0.05$ compared with 1 week postoperatively; ④ $P < 0.05$ compared with 1 month postoperatively; ⑤ $P < 0.05$ compared with 6 months postoperatively.

4. Discussion

Low back pain is a common disease in orthopedics, and its pain mechanism is very complicated. Intervertebral disc, facet joint, psoas fascia, and sacroiliac joint can cause low back pain [8]. In recent years, with the deepening research on low back pain, it has been found that the low back pain caused by the posterior branch of the lumbar nerve (that is, the syndrome of posterior branch of lumbar nerve) accounts for about 80% of the low back pain. There are two main reasons for the pain, one is the radiation pain in the distal distribution area caused by the mechanical traction stimulation of the trunk or branch of the posterior branch of spinal nerve, and the other is the reflex low back pain or lower limb pain caused by various stimuli in the posterior sinus of intervertebral disc [1], that is, the low back pain caused by intervertebral disc. There are many treatments for chronic discogenic low back pain, among which conservative treatment is the first choice. Intervertebral fusion is considered to be an effective surgical treatment for discogenic low back pain, but it has great trauma and many complications, so strict indications are needed, and it is only suitable for patients with severe symptoms, long course of disease, and intervertebral instability [9,10]. In recent years, with the development of minimally invasive surgery technology, radiofrequency ablation has been widely used in the treatment of discogenic low back pain and achieved good results. Because of its small trauma, quick response, and simple operation, it is widely used in clinical practice [5,6,11]. Liu *et al.* [12] conducted a retrospective study of the clinical efficacy of Sinuvertebral nerve block for discogenic low back pain; the research findings indicate that Sinuvertebral nerve block (SVNB), as a rapid and cost-effective minimally invasive treatment, provided some assistance for the short-term pain relief and physical functional improvement of DLBP. SVNB could be a good choice for the treatment of DLBP. However, due to the limited damage to nerve endings by radiofrequency ablation, nerve endings may still regenerate after a period of time, resulting in uncertain long-term results. Although percutaneous radiofrequency ablation is considered a low-risk operation, it is still an invasive interventional operation, so there are also serious complications, such as nerve or visceral injury caused by puncture error, nerve thermal injury caused by the RF working electrode being too close to the nerve, and local hematoma formation during puncture. In addition, percutaneous radiofrequency ablation requires a specially designed puncture needle for puncture and radiofrequency operation, so the cost is relatively high.

Exercise therapy has been recognized as an important non-surgical treatment for chronic low back pain, which can promote the recovery of various functions of the body by exercising limbs and contracting muscles, enhance the strength and endurance of patients' core muscles, improve the range of motion of intervertebral joints, and strengthen the stability of lumbar vertebrae, thus restoring or improving dysfunction [13–16]. At present, the commonly used exercise therapies mainly include suspension exercise, McKenzie therapy, Pilates, Tai Ji Chuan, and yoga, which are the first-line treatment methods in some national guidelines. Moreover, exercise therapy is a non-invasive treatment, and patients can exercise and treat themselves, with low cost and strong maneuverability. However, because learning methods take time and energy, the effect is relatively slow, and the clinical utilization rate is low, doctors and patients prefer to use instrument therapy. Kühn *et al.* [17] found that although exercise therapy is effective for low back pain, it must be accompanied by appropriate supervision and effective implementation for patients; otherwise, the therapeutic effect will be greatly reduced.

The results of this study show that the patients with chronic discogenic low back pain in the percutaneous radiofrequency ablation group and the exercise therapy group can significantly improve the VAS score, JOA score, and ODI score of patients with low back pain ($P < 0.05$) at one month after treatment, six months after treatment, and at the last follow-up, and both groups have obvious short-term effects. Compared with the two groups, the VAS score, JOA score, and ODI score of low back pain in the percutaneous radiofrequency ablation group were significantly improved one week after treatment ($P < 0.05$).

However, one week after treatment, the VAS score, JOA score and ODI score of low back pain in the exercise therapy group were not significantly improved ($P > 0.05$), and there was a significant difference between the two groups ($P > 0.05$), indicating that the percutaneous radiofrequency ablation group took effect faster; One month after treatment, six months after treatment and the last follow-up, there was no significant difference in the VAS score of low back pain between the two groups ($P > 0.05$). One month and six months after treatment, there was no significant difference in JOA score and ODI score between the two groups ($P > 0.05$). At the last follow-up, there was no significant difference in VAS score and JOA score between the two groups ($P > 0.05$). One month and six months after treatment, there was no significant difference in ODI scores between the two groups ($P > 0.05$). At the last follow-up, there was a significant difference in ODI scores between the two groups ($P < 0.05$). VAS score and JOA score are mainly used to evaluate clinical symptoms, while ODI focuses on the evaluation of functional status. The results suggest that radiofrequency ablation and exercise therapy have obvious effects on chronic discogenic low back pain in the short term, while the long-term effect of exercise therapy is better than radiofrequency ablation, and the curative effect lasts longer.

Although exercise therapy takes effect slowly, it is effective and lasts for a long time, which can basically solve the problem of patients' low back pain, so it also greatly reduces the chance of recurrence of low back pain. With the continuous in-depth research on exercise therapy, the research field of exercise therapy is also constantly expanding. The treatment methods of exercise therapy are becoming more and more diversified, and the effects are becoming more and more positive. Amstel *et al.* [18] conducted a randomized controlled trial to compare the effectiveness of the 4xT method and exercise therapy-only in patients with chronic low back pain. The 4xT method consists of four components: Test (functional diagnostic test), Trigger (fascia tissue manipulations), Tape (elastic taping), and Train (exercise). Interaction effects were noted in all outcomes. The 4xT group showed significant improvements over time for trunk flexion and extension mobility, trunk flexion and extension mobility-dependent pain, and quality of life ($P < 0.05$), with no significant relapse post-therapy (except for extension mobility). The exercise group exhibited significant within-time changes in the quality of life, as measured with the VAS ($P < 0.05$). The results of this study demonstrate that the 4xT method stands out as a promising and impactful treatment option for individuals with chronic low back pain, as it demonstrated significant reductions in mobility-dependent pain, increased trunk mobility, and improved quality of life compared to exercise-only treatments. Sun et al.[19] compared the clinical effect between head acupuncture combined with exercise therapy and conventional acupuncture for low back pain. The results showed that head acupuncture combined with exercise therapy could relieve pain, improve dysfunction, and increase the local temperature of the pain area in patients with low back pain, and its curative effect is better than conventional acupuncture.

5. Conclusion

These research findings indicate that the combined application of exercise therapy and other methods may be an ideal treatment for low back pain. Exercise therapy in this group mainly uses suspension exercise and McKenzie therapy to train and treat the core muscle strength of the spine. Some of them need special instruments, and some training methods are complicated, which are relatively difficult to operate and slow to take effect. Therefore, many patients are easily discouraged from treatment and find it difficult to persist. Developing a simple exercise therapy that is relatively simple, easy to operate, and train may be more easily accepted by patients, so as to play a more lasting role, which is also our future research direction.

Funding

This study was supported by the Hospital Project of the 923rd Hospital of the Joint Logistics Support Force (Grant No. 2023YNKT-JS-01).

Disclosure statement

The authors declare no conflict of interest.

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