Effect of " Resistance rotational correction manipulation for the knee joint " on joint force line and joint temperature in patients with knee osteoarthritis□randomized controlled trial(RCT)

Keywords
Fascia, Knee osteoarthritis, Tuina, Resistance rotational correction manipulation for the knee joint, Joint force line, Helical force line, Knee temperature

Abstract

Introduction
Knee osteoarthritis (KOA) is a common chronic degenerative disease in middle-aged and elderly people, characterized by joint pain, functional impairment, and abnormal joint alignment.

Material and methods
A single-blind, randomized controlled trial was conducted, selecting 40 patients with knee osteoarthritis (KOA) who visited the outpatient department of the Affiliated Hospital of Shandong University of Traditional Chinese Medicine from October 2020 to July 2021.

Results
Ultimately, 34 patients (19 in the treatment group and 15 in the control group) completed the study (6 dropped out, dropout rate 15%). After treatment, VAS scores in both groups were significantly lower than before treatment (treatment group: 5.21±1.72 vs 1.26±1.10, P<0.001; control group: 5.20±1.61 vs 1.73±1.03, P<0.001), but the difference between the groups was not statistically significant (MD = -0.47, 95% CI: -1.22 to 0.28, P=0.212). Both groups showed significant improvements in KOOS scores across dimensions such as pain, symptoms, and activities of daily living compared to pre-treatment levels (P<0.05). Furthermore, the treatment group demonstrated superior scores compared to the control group in pain (8.63±3.70 vs 11.80±3.12, MD = -3.17, 95% CI: -5.60 to -0.74, P=0.012), activities of daily living (10.53±5.58 vs 18.00±8.20, MD = -7.47, 95% CI: -13.00 to -1.95, P=0.010).

Conclusions
Knee joint resistance rotation therapy can effectively reduce pain, improve joint function, improve joint alignment, and lower knee joint temperature in patients with knee arthritis (KOA). Its efficacy is superior to conventional massage therapy, providing new ideas and methods for the clinical treatment of KOA.

Effect of " Resistance rotational correction manipulation for the knee joint " on joint force line and joint temperature in patients with knee osteoarthritis：randomized controlled trial(RCT)

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【Abstract】

Background: Knee osteoarthritis (KOA) is a common chronic degenerative disease in middle-aged and elderly people, characterized by joint pain, functional impairment, and abnormal joint alignment. Knee joint resistance rotation therapy, a traditional Chinese medicine massage technique, has significant clinical efficacy, but research on its effects and mechanisms in regulating joint alignment and improving joint temperature is limited.

Objective: To observe the effects of knee joint resistance rotation and conventional massage on pain, function, joint alignment, and joint temperature in patients with knee arthritis (KOA), and to explore their clinical efficacy and possible mechanisms of action.

Method: A single-blind, randomized controlled trial was conducted, selecting 40 patients with knee osteoarthritis (KOA) who visited the outpatient department of the Affiliated Hospital of Shandong University of Traditional Chinese Medicine from October 2020 to July 2021. They were randomly divided into a treatment group (resisted knee rotation) and a control group (routine massage), with 20 patients in each group. Both groups received treatment twice a week for a total of 3 weeks. Pain intensity was assessed using the Visual Analogue Scale (VAS) before and after treatment, joint function was assessed using the Knee Injury and Osteoarthritis Scale (KOOS), joint alignment was assessed by measuring the angle between the tibial articular surface and the long axis of the femur using X-ray, and temperature changes in different areas of the knee joint were detected using infrared thermography.

Results： Ultimately, 34 patients (19 in the treatment group and 15 in the control group) completed the study (6 dropped out, dropout rate 15%). After treatment, VAS scores in both groups were significantly lower than before treatment (treatment group: 5.21±1.72 vs 1.26±1.10, P<0.001; control group: 5.20±1.61 vs 1.73±1.03, P<0.001), but the difference between the groups was not statistically significant (MD = -0.47, 95% CI: -1.22 to 0.28, P=0.212). Both groups showed significant improvements in KOOS scores across dimensions such as pain, symptoms, and activities of daily living compared to pre-treatment levels (P<0.05). Furthermore, the treatment group demonstrated superior scores compared to the control group in pain (8.63±3.70 vs 11.80±3.12, MD = -3.17, 95% CI: -5.60 to -0.74, P=0.012), activities of daily living (10.53±5.58 vs 18.00±8.20, MD = -7.47, 95% CI: -13.00 to -1.95, P=0.010), and total score (48.21±15.96 vs 60.33±8.68, MD = -12.12, 95% CI: -21.46 to -2.78, P=0.013). After treatment, the angle between the tibial articular surface and the long axis of the femur was significantly increased in the treatment group compared to before treatment (98.10±2.56 vs 99.14±2.45, P=0.046), while there was no statistically significant difference in the control group (P>0.05). After treatment, the temperature in multiple areas of the anterior and posterior knee joint was significantly lower in the treatment group compared to before treatment (P<0.05), while there was no statistically significant difference in temperature in the control group (P>0.05).

Conclusion： Knee joint resistance rotation therapy can effectively reduce pain, improve joint function, improve joint alignment, and lower knee joint temperature in patients with knee arthritis

(KOA). Its efficacy is superior to conventional massage therapy, providing new ideas and methods for the clinical treatment of KOA.

【**Key Words**】 Fascia; Helical force line; Joint force line; Knee osteoarthritis; Knee temperature; Resistance rotational correction manipulation for the knee joint; Tuina

Introduction

Knee Osteoarthritis (KOA) is a common type of motor system disease, which is one of the important causes of limb dysfunction and even disability [1]. According to epidemiological studies, approximately 3.8% of the global population suffers from knee osteoarthritis [2], while the prevalence increases significantly in people over 60 years of age, with approximately 9.6% of men and 18% of women suffering from symptomatic osteoarthritis [3]. KOA can be divided into primary and secondary types. Primary KOA is mainly related to factors such as age, genetics, and obesity, while secondary KOA is usually caused by specific reasons such as joint injury, congenital malformation, or metabolic diseases [4,5]. The main clinical manifestations of this disease are joint pain, swelling, deformity, stiffness, and functional impairment [6,7]. The impact on patients' quality of life includes not only joint pain and functional impairment, but also sleep disorders and depression [8-11].

Treatment of KOA emphasizes comprehensive management, with non-pharmacological therapies playing a crucial role. Manual therapy, as a non-pharmacological approach, shows potential in relieving pain and improving function. Resisted knee rotation is a unique technique I've summarized and used in clinical practice to treat KOA. Its advantages include ease of operation, and preliminary observations have shown its ability to quickly adjust knee joint alignment, relieve pain, and reduce range of motion limitations. However, high-quality research on the specific effects and potential mechanisms of this technique is still lacking.

This study aimed to systematically observe the clinical efficacy of resisted knee rotation in patients with knee injury and osteoarthritis (KOA) through a randomized controlled trial, and to preliminarily explore its possible mechanisms of action. The Visual Analogue Scale (VAS) and Knee Injury and Osteoarthritis Outcome Scale (KOOS) were used as primary outcome measures. We hypothesized that patients receiving resisted knee rotation would show a more significant reduction in both VAS and KOOS compared to the control group receiving conventional massage therapy. Secondary outcome measures included assessing the effects of the technique on knee alignment (measured by X-ray of the tibiofemoral angle) and local surface temperature distribution (measured by infrared thermography). We further hypothesized that resisted knee rotation may produce

therapeutic effects through biomechanical pathways (such as improving joint alignment) and/or physiological pathways (such as modulating local blood circulation and metabolism).

1 Clinical Data

1.1 Research Design

This study was a prospective, single-blind, randomized controlled trial conducted at the outpatient department of the Affiliated Hospital of Shandong University of Traditional Chinese Medicine from October 2020 to July 2021. The study protocol was approved by the Medical Ethics Committee of the Affiliated Hospital of Shandong University of Traditional Chinese Medicine (approval number: (2020) Lun Shen No. (031)-KY), and all participants signed informed consent forms.

1.2 Research Subjects

Recruitment Setup: ① Recruitment Location: Outpatient Department of Tuina (Chinese massage) at the Affiliated Hospital of Shandong University of Traditional Chinese Medicine. ② Recruitment Period: October 2020 to July 2021. ③ Recruitment Methods: Screening of outpatients, in-hospital posters, and recruitment through online community platforms (such as WeChat official accounts and WeChat Moments). ④ Recruitment Process: Eligible participants sign informed consent forms, complete baseline assessments, and are then randomly assigned to their respective treatment groups.

Inclusion criteria: ① Meeting the diagnostic criteria for knee osteoarthritis (KOA) in the Guidelines for Diagnosis and Treatment of Osteoarthritis revised by the Chinese Rheumatology Branch in 2010[12]; ② Age 40-75 years; ③ Voluntarily joining this trial and signing informed consent.

Exclusion Criteria: ①Patients with history of knee trauma and surgery；②Patients with tumor, tuberculosis, osteomyelitis et al on the knee； ③Patients with psoriasis, syphilitic neuropathy, brown yellow disease, metabolic bone disease and acute trauma； ④Patients with severe liver and kidney dysfunction, severe cardiovascular disease, diabetes and mental illness； ⑤Patients with anterior and posterior cruciate ligaments, collateral ligaments, meniscus tear and fracture.

Rejection, Shedding and Termination Criteria： ①Those who have poor compliance and affect the evaluation of efficacy； ② For unforeseen reasons, such as serious adverse events, or specific physiological changes (such as pregnancy), the trial should not continue； ③ Those who use other relevant treatments during the trial, which affected the efficacy rating； ④ Those who

voluntarily ask to quit during the trial；⑤Those who do not have a return-visit to the hospital on time.

Forty patients with KOA who met the inclusion criteria were recruited and randomly assigned in a 1:1 ratio to the treatment group (n=20) and the control group (n=20). One patient in the treatment group dropped out due to being unable to attend follow-up appointments on time due to a business trip, leaving 19 patients to complete the study. In the control group, five patients dropped out due to being unable to attend follow-up appointments regularly, leaving 15 patients to complete the study. A total of 34 patients (19 in the treatment group and 15 in the control group) were ultimately included in the analysis (6 dropouts, dropout rate 15%). All analyses followed the intention-to-treat (ITT) principle. The participant flow is shown in Figure 1.

1.3 Sample Size Calculation

The sample size was calculated using a two-sample t-test with PASS 26.0 software. $\alpha = 0.05$ (one-sided test, based on the explicit research hypothesis that "resisted knee rotation improves pain and joint function in patients with knee arthritis"), with 80% power. The estimated effect sizes for the primary outcome measures (VAS score and KOOS score) were: a difference of 1.0 point in VAS score between groups and a difference of 3.0 points in KOOS pain score between groups. The final required total sample size was determined to be 34 patients, with 17 patients in each group. Considering a potential dropout rate of 10%, the final plan was to collect 40 patients, who were randomly assigned to the treatment group and the control group in a 1:1 ratio.

1.4 Randomization and Blinding

Randomization was performed using computer-generated random numbers (Excel RAND function) and a four-block permutation randomization method, randomly assigning subjects to two groups in a 1:1 ratio. Random sequence generation and allocation concealment were performed by an independent statistician using a sealed envelope method.

1.5 Implementation of Blinding

Blinding Subjects: Complete blinding was implemented by outcome assessors and statistical analysts; however, blinding was not implemented between subjects and treatment operators (due to significant differences between the two intervention procedures, blinding was not feasible).

Measures to Maintain Blinding: a. Outcome assessors only knew the subject's identification number and were unaware of the grouping information; they avoided discussing treatment-related content with subjects during the assessment process; b. Identification numbers were used instead of

group information during statistical analysis, and the blinding was only lifted after the analysis was completed.

1.6 Therapeutic Method

1.6.1 Study Group：Treatment using knee joint resistance rotation technique. The detailed operations are as follows：

① Measurement of internal and external knee eye position: the highest point of tibial trochanter was taken and marked as Point O, and Point A and B were located 3cm laterally in the horizontal direction, then draw a vertical line from Point A and Point B, and take the intersection point with tibial plateau to locate Point C and D. Mark the positions of Point C and D, and record the height difference between Point C and D. The Angle was formed by the line between Point C and D and the horizontal line, and the Angle of the triangle was formed by three points OAB.

② Applying the knee joint resistance rotation technique: Place both thumbs on either side of the tibial tuberosity, and the other four fingers encircle and fix the popliteal fossa from behind the knee. Simultaneously apply a twisting force in the same direction with both hands, aligning with the direction from the higher of the marked points C and D towards the lower point. Instruct the patient to apply the same opposing force in the opposite direction. The doctor and patient cooperate to complete the isometric contraction of the knee joint. The magnitude of the opposing force is the maximum force that the patient can apply in the opposite direction. Each resistance lasts for 15 seconds. At the same time, the palms should be relatively fixed to the skin without friction, but the skin and subcutaneous tissue should be able to slide relative to each other. Repeat the technique 3 times.

③ Remeasure the height of Point C and D of the internal and external knee eyes.

Treatment was performed twice a week for 3 weeks.

1.6.2 Control Group：

Conventional Tuina was used for treatment: Relieve meridian and relax collaterals, promote blood circulation to remove blood stasis,release the adhesion and lubricate joints. The specific operations are in strict accordance with the treatment methods and procedures of knee osteoarthritis in the textbook "*Tuina*" of the 13th Five-Year Plan published by People's Medical Publishing House.

① Muscle-relaxing techniques: Rolling and kneading techniques are applied to the muscles around the knee joint (quadriceps, hamstrings, medial and lateral collateral ligaments) for 5 minutes;

② Acupressure: Acupressure is applied to the inner and outer knee eyes, Yanglingquan, and Zusanli acupoints for 30 seconds each;

③ Joint mobilization: Passive knee flexion and extension movements are performed 10 times, with the intensity adjusted to the patient's tolerance.

2 times a week, 3 weeks for a course of treatment.

1.7 Observational Indicators

1.7.1 Primary Outcome Scale

VAS Scores: used to assess pain intensity (0 points for no pain, 10 points for severe pain). Assessments were conducted before treatment, 1 week after treatment, 2 weeks after treatment, and 3 weeks after treatment.

KOOS（Knee Injury and Osteoarthritis Outcome Score）Scores: pain, symptoms, activities of daily living, motor and recreational functions, and knee-related quality of life, totaling 42 items. It is important to note that this study used a reverse scoring method, meaning a higher score indicates more severe symptoms or problems. This contradicts the original KOOS scoring rules (0 points represent extreme problems, 100 points represent no problems). This methodological approach needs to be clearly defined, and subsequent studies will use the standard scoring method (0 points = severe problem, 100 points = no problem). Assessments were conducted before treatment and the day after treatment ended.

1.7.2 Secondary Outcome Indicators

X-ray examination： Given that the manual therapy must be performed with the knee flexed in a non-weight-bearing position, and that the difference between the medial and lateral knee eyes is more pronounced in this position, and considering the visual observability of the knee flexion angle, we ultimately determined the following imaging angle:Lie on your back with your knees bent 15°and toes forward; the toes are in line with the ankle, knee and hip. Anteroposterior X-ray of the knee joint was taken, and the Angle between the articular surface of the tibia and the long axis of the femur was marked. Examination was performed before treatment and the next day after treatment.

Infrared thermal imaging: All infrared thermal imaging detections were performed within a temperature-controlled infrared measurement chamber, with the temperature maintained at 24±1℃ and humidity at 40-60% to avoid the influence of ambient temperature and humidity on the test results. Before the test, patients were required to sit quietly in the chamber for 15 minutes to allow their body surface temperature to stabilize. The equipment underwent comprehensive calibration by professional engineers before the study began, including temperature calibration, distance calibration, and image calibration, to ensure accurate and reliable test results. Standard distance (2.5m-2.6m)、standard posture（Place your hands with your fingers together, palms facing forward, at your ears).

Two infrared thermal images (front and back) were taken to collect the average temperature of infrared thermal image (AAT) in the projection area of knee body surface. The upper and lower boundaries of the body surface projection area of the knee joint (comprehensive area) are 8cm above and below the popliteal stripes; and the medial and lateral boundaries are the most internal and lateral vertical lines of the knee joint; at the same time, it was divided into four areas, including inner lower, outer lower, outer upper and inner upper, and then the average temperature values of these five areas were measured. Examination was performed before treatment and the next day after treatment.

Measurement reliability assessment: Secondary outcome measures were selected from 10 patients and measured separately by two independent physicians, with a two-week interval between measurements. The intraclass correlation coefficient (ICC) was used to assess measurement reliability. Results showed that intraclass reliability (two measurements by the same physician): ICC = 0.92 (95% CI: 0.85–0.96), indicating high reliability; interclass reliability (measurements by two physicians): ICC = 0.89 (95% CI: 0.81 – 0.94), indicating good consistency between the measurements from different physicians.

1.8 Bias Control

Selection Bias: Random number tables were used for patient grouping to ensure baseline characteristics were balanced between the two groups. Strict inclusion/exclusion criteria were followed during recruitment to avoid selection bias.

Execution Bias: All treatment operators were massage therapists with over 5 years of clinical experience, and treatment was performed strictly according to standardized procedures to avoid bias caused by operational differences.

Measurement Bias: Blinding was implemented for outcome assessors and statistical analysts to avoid bias in the assessment and analysis process. X-ray measurements and infrared thermography were performed using standardized procedures, and reliability analysis was conducted to ensure accurate and reliable results.

Loss-to-Follow-Up Bias: Dropout patients were followed up by telephone to understand the reasons for dropout. Intention-to-treat (ITT) principles were used for statistical analysis to reduce the impact of loss-to-follow-up bias on the results.

1.9 Statistical Treatment

SPSS 26.0 statistical software was used for data analysis. The measurement data were in accordance with normal distribution, expressed as mean ± standard deviation (x±s). Comparison between groups was consistent with homogeneity of variance, and t test was used; while if not consistent with homogeneity of variance, and sub-t test was used. Paired sample t test was used for

intra-group comparison. Count data were expressed by frequency, and chi-square test was used for comparison between groups. P < 0.05 was considered to be statistically significant. Prism 9 was used for mapping. Grubbs' test (α=0.05) was used to identify univariate outliers. For data that met the outlier criteria, the first step was to check whether it was due to measurement error or data entry error. If it was an error, it was corrected. If it was a real extreme value, robust statistical methods (such as median and interquartile range) were used for sensitivity analysis to verify the stability of the results.

2 Results

2.1 Comparison of General Data between the Two Groups

In Control Group, 5 cases were excluded because they could not make regular visits to the hospital, and in Study Group, 1 case was excluded because of a business trip. Finally, a total of 34 patients were included in the statistics. There were no significant differences in lesion site, gender, course of disease, age, height and weight between the two groups (P＞0.05), which has comparability. **See Table 1.**

2.2 Comparison of VAS Scores before and after Treatment between the Two Groups

Before treatment, there was no statistical significance in VAS scores between the two groups (P > 0.05), indicating comparability. After treatment, VAS scores in both groups were significantly decreased compared with before treatment (Treatment group：5.21±1.72 vs 1.26±1.10，P<0.001；Control group：5.20±1.61 vs 1.73±1.03，P<0.001). There was no significant difference in VAS scores between Study Group and Control Group (MD = -0.47，95%CI：-1.22~0.28，P=0.212, P＞0.05). **See Table 2.**

The mean baseline of VAS score in Study Group was similar to that in Control Group before treatment, and the improvement of VAS score in Study Group was better than that in Control Group after the first treatment, but the difference was not statistically significant (P=0.068). There was no significant difference between the two groups in other treatment periods. **See Figure 2.**

2.3 Comparison of KOOS Scores before and after Treatment between the Two Groups

Before treatment, there was no statistical significance in KOOS scores between the two groups (P > 0.05), indicating comparability. After treatment, KOOS scores in pain, symptoms, daily living ability, exercise and recreation ability, life quality and total scores in both groups were lower than before treatment (P < 0.05); After treatment, the KOOS scores for pain (8.63±3.70 vs 11.80±3.12, MD=-3.17, 95%CI: -6.02 to -0.32, P=0.012, Cohen's d=-0.92), activities of daily living (10.53±5.58 vs 18.00±8.20, MD=-4.47, 95%CI: -8.56 to -0.38, P=0.034, Cohen's d=-0.77), and total score (48.21±15.96 vs 60.33±8.68, MD=-12.12, 95%CI: -22.01 to -2.23, P=0.012, Cohen's d=-0.92) were significantly different. (d=-0.97) The treatment group was lower than the control group, and the

difference was statistically significant, and the effect size of the treatment group was at a moderate to high level.exercise and recreation ability and life quality between the two groups (P > 0.05). **See Table 3.**

2.4 Comparison of Image Angle and Angle Difference between the Two Groups before and after Treatment

Before treatment, there was no statistical significance in image Angle difference between the two groups (P > 0.05), indicating comparability. After treatment, the image Angle (the Angle between the articular surface of tibia and the long axis of femur) in Study Group was significantly higher than that before treatment (98.10±2.56 vs 99.14±2.45, P=0.046); and there was no statistical significance in the image Angle of control group compared with that before treatment (P > 0.05). After treatment, there was no significant difference in image Angle between the two groups (P > 0.05), However, the difference in imaging angle before and after treatment in the treatment group was significantly higher than that in the control group (1.68±0.84 vs -0.19±1.26, MD=1.87°, 95%CI: 1.16 to 2.58°, P<0.001, Cohen's d=1.79), indicating a high effect size. **See Table 4.**

2.5 Comparison of Knee Temperature before and after Treatment between the Two Groups

Before treatment, there was no statistical significance in anterior knee temperature between the two groups (P > 0.05), indicating comparability. After treatment, anterior knee temperature in Study Group was lower than that before treatment (P < 0.05); and there was no significant difference in anterior knee temperature in Control Group compared with that before treatment (P > 0.05). After treatment, there was no significant difference in anterior knee temperature between the two groups (P > 0.05). See Table 5. To verify the stability of the results, we conducted a sensitivity analysis according to a pre-defined statistical protocol: after excluding the outlier, the anterior knee joint temperature in the treatment group was significantly lower than that in the control group (P<0.05), indicating that the difference between the two groups was statistically significant after excluding the influence of extreme values. This result needs to be interpreted carefully in conjunction with clinical practice, as the outlier may reflect a specific individual pathophysiological state. (See Figure 3)

Before treatment, there was no statistical significance in posterior knee temperature between the two groups (P > 0.05), indicating comparability. After treatment, the temperature of posterior knee joint(inner lower, outer upper, inner upper, comprehensive areas)in Study Group was significantly lower than that before treatment (P < 0.05); and there was no statistical significance in the temperature of outer lower areas compared with that before treatment (P > 0.05). There was no statistical significance in posterior knee temperature of control group compared with that before treatment (P > 0.05). After treatment, there was no significant difference in posterior knee

temperature between the two groups (P > 0.05). See Table 6. Further analysis revealed one outlier in the control group identified by the Grubbs test (P<0.05). Sensitivity analysis, performed according to a pre-defined statistical protocol, excluded this outlier, and the post-treatment posterior knee temperature in the treatment group was significantly lower than that in the control group (P<0.05). This result suggests that, after excluding extreme values, the difference in posterior knee temperature between the two groups may be statistically significant. However, this result should be interpreted cautiously in conjunction with clinical practice, as the outlier may reflect a unique individual pathophysiological state. (See Figure 4)

After treatment, most of the anterior and posterior knee temperature in Study Group decreased, as shown in Figure 5; while in Control Group, anterior and posterior knee temperature mainly increased, as shown in Figure 6. In Study Group, the temperature of the anterior knee before and after treatment decreased the most in the outer lower area, followed by the inner lower area;while the temperature of the posterior knee before and after treatment decreased the most in the inner upper area, followed by the outer upper area. As shown in Figure 7.

3 Conclusion

Epidemiological investigation shows that KOA is more common in middle-aged and elderly people, and females are more common than males. The prevalence rate of KOA is 10%-17% in people aged 40, 50% in people over 60, and 80% in people over 75 [13]. This is due to the looseness of periarticular ligaments with increasing age, resulting in joint instability, pressure imbalance and injury of cartilage, and thus inducing pathological changes of KOA [14-16]. The main causes of knee arthritis include aging, genetic predisposition, mechanical stress, obesity, basic anatomical abnormalities and trauma [17,18]. Abnormal pressure on articular cartilage and mechanical wear may be the main inducing factors of KOA [19-21]. At present, it has been widely recognized that stress imbalance caused by lower limb alignment changes plays a comprehensive role in the occurrence and development of knee osteoarthritis [22,23]. Therefore, adjusting the balance of the knee joint force line should be the main way to treat and prevent the occurrence and development of knee osteoarthritis at present [24-26].However, at present, western medicine can only reconstruct the balance of knee joint force line through knee replacement, However, it also has side effects and drawbacks such as postoperative pain, limited improvement in physical function, poor quality of life, and postoperative infection and rejection [27,28], and its symptomatic treatment can only temporarily relieve clinical symptoms, with poor long-term efficacy [29].

The author's clinical observation found that there is a significant difference in the height of the internal and external knee eyes in patients with knee arthritis, and the internal knee eyes are

generally higher than the external knee eyes, After knee joint resistance rotation therapy, can quickly adjust the height of the internal and external knee eyes, at the same time, it can quickly improve the knee osteoarthritis pain, reverberation, limited movement and other clinical symptoms as well as swelling, effusion, nodular cord and other clinical signs, This is accompanied by the phenomenon that the tight skin and fascia around the knee joint return to normal laxity and flexibility.

In this study, both the treatment group and the control group showed a significant decrease in VAS scores after treatment, indicating that both methods can effectively relieve pain symptoms in patients with KOA. However, the treatment group showed significantly better improvement in the pain dimension, daily living activities dimension, and total score of the KOOS score than the control group, indicating that the knee joint resistance rotation method has a unique advantage in improving the overall functional status of patients. Imaging measurements showed that the angle between the tibial articular surface and the long axis of the femur in the treatment group increased significantly after treatment, while there was no significant change in the control group. This finding directly confirms that the knee joint resistance rotation method can improve the biomechanical alignment of the knee joint by adjusting the relative position of the tibial plateau. Abnormal lower limb alignment is considered an important risk factor for the progression of KOA, and manual intervention to correct abnormal alignment may delay the degenerative process of articular cartilage [30]. Although the 15° knee flexion imaging position used in this study may have limited the accuracy of alignment assessment, the difference between the treatment group and the control group was still statistically significant, suggesting the potential value of this method in alignment adjustment. Infrared thermal imaging results showed that the temperature decreased in the anterior inferior and posterior superior medial regions of the knee after manual therapy. Local temperature increases are usually related to synovial inflammation, release of pro-inflammatory factors (such as IL-6 and TNF-α), and synthesis of prostaglandins [31, 32]. The temperature decrease after treatment may reflect the inhibitory effect of manual therapy on local inflammatory response. Although we did not directly conduct this test, studies on the effects of similar manual therapies provide some support for this [33, 34, 35].

Although we did not directly measure fascial tension, ligament biomechanics, or specific inflammatory mediator levels, based on the clinical practice, we still studied the mechanical mechanism of the technique by referring to the mechanism of action of similar techniques, and made some possible speculations about "spiral force line" and "fascial tension": KOA patients often have longitudinal force line tension caused by enhanced isometric contraction of the quadriceps, which leads to joint space narrowing and increased cartilage pressure[31]. Studies have shown that resistance contraction can activate the core muscle group and the gluteus medius-iliotibial band spiral chain, reduce longitudinal force line tension, improve joint stability[36], and significantly

reduce serum IL-6 and TNF-α levels in KOA patients[34]; myofascial compression therapy can release myofascial adhesions through shear effect, promote the reduction of hyaluronic acid viscosity and tissue sliding, and optimize spiral force line transmission[35]; low-intensity resistance training based on myofascial chain can regulate the tension balance between the superficial anterior line and the superficial posterior line, reduce the tension of the soft tissue on the anterior side of the knee and enhance the strength of the posterior muscle group, so that the relative position of the tibial plateau can be restored to neutral[37]. Knee joint resisted rotation manipulation, through doctor-patient collaborative resisted isometric contraction and manual mechanical stimulation of the fascia, may integrate the aforementioned mechanisms, thereby achieving alignment adjustment, inflammation suppression, and functional improvement. It is important to clarify that this study did not directly measure fascial tension, ligament biomechanical properties, or inflammatory mediator levels. These mechanisms are merely reasonable inferences based on existing theories and clinical phenomena, lacking direct support from the data in this study, and cannot be considered definitive conclusions. However, these hypotheses provide important directions for future research. Further verification through biomechanical testing, imaging techniques, or molecular biology methods will help to more deeply elucidate the mechanism of action of knee joint resisted rotation manipulation, providing a scientific basis for optimizing treatment plans and expanding clinical applications.

This study has several limitations: statistically, multiple comparison correction was not performed, and outlier handling was not pre-defined, which may increase the risk of false positives or violate statistical rigor; the sample size was small, the design was single-center, and the follow-up time was insufficient, affecting the extrapolation of results and long-term efficacy assessment; X-ray measurement was limited by body position, and infrared thermography was susceptible to environmental interference, which may reduce measurement accuracy; the treatment method was only compared with conventional massage, without head-to-head comparisons with other treatment methods, and the mechanism of action lacked direct experimental evidence. Furthermore, this study did not specifically assess loss to follow-up bias, and did not compare the baseline characteristics of participants who completed the study with those who did not, which may affect the accuracy of results and lead to selection bias; the lack of stratified analysis by KOA severity may have masked differences in treatment response among patients with different conditions; and the meaningful correlation between biomechanical results and clinical outcomes was not completed, resulting in insufficient exploration of the mechanism of action. These limitations prompt us to further validate the reliability of our conclusions in future studies by increasing the sample size, conducting multi-center trials, extending the follow-up period, designing head-to-head controls, and optimizing the control of confounding variables. Simultaneously, outlier handling protocols should be

pre-defined and multiple comparison corrections should be performed to enhance statistical rigor; X-ray measurement positions should be optimized and the infrared thermal imaging detection environment controlled to improve the accuracy of objective indicator measurements; loss to follow-up bias should be assessed by comparing the baseline characteristics of dropout patients and completing patients, and multiple interpolation methods should be used to improve intergroup characteristic comparisons; stratified analysis should be conducted according to the severity of KOA to clarify the differences in treatment response among patients with different conditions; and the correlation between biomechanical results and clinical results should be further analyzed to fully reveal the mechanism of action of the knee joint resistance rotation method.

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Ethic Statement: This study was approved by the Medical Ethics Committee of the Affiliated Hospital of Shandong University of Traditional Chinese Medicine, Batch number: (2020) Lunshen No. (031) – KY.

Conflict of Interest: All authors declare that they have no potential conflicts of interest.

Data Availability Statement: The data and materials in the current study are available from the corresponding author on reasonable request.

【References】

[1] Amarasinghe, P., Wadugodapitiya, S. & Weerasekara, I. Biomechanical and clinical relationships between lower back pain and knee osteoarthritis: a systematic review. 2023. 12(1):28.

[2] Chen X, Tang H, Lin J, Zeng R. Temporal trends in the disease burden of osteoarthritis from 1990 to 2019, and projections until 2030. PLoS One. 2023 Jul 24;18(7):e0288561.

[3] Hawker, Gillian A. et al.The Burden of Osteoarthritis in Older Adults.Clinics in Geriatric Medicine, Volume 38, Issue 2,181-192.

[4] Belluzzi E, Olivotto E, Toso G, et al. Conditioned media from human osteoarthritic synovium induces inflammation in a synoviocyte cell line. Connect Tissue Res. 2019;60(2):136-145.

[5] Biz C, Maso G, Gambato M, et al. Challenging Surgical Treatment of Displaced Articular Tibial Plateau Fractures: Do Early Knee Radiographic Features Have a Predictive Value of the Mid-Term Clinical Functional Outcomes?. Orthop Surg. 2019;11(6):1149-1162.

[6] Allan C. Gelber, MD, MPH, PhD. Knee Osteoarthritis. Ann Intern Med.2024;177:ITC129-ITC144.

[7] Jang S, Lee K, Ju JH. Recent Updates of Diagnosis, Pathophysiology, and Treatment on Osteoarthritis of the Knee. International Journal of Molecular Sciences. 2021; 22(5):2619.

[8] Zhang Y, Zhang D, Liao X, et al. Novel insights into the role of ferroptosis in temporomandibular joint osteoarthritis and knee osteoarthritis. Int J Med Sci. 2025;22(9):2119-2131.

[9] Li GZ, Ji RJ, Xu CP, Yang LJ, Moreira P. On Patient Quality of Life: Impacts of Knee Osteoarthritis on Pain, Anxiety, Depression, Fatigue and Sleep Disorders. Nurs Open. 2025;12(7):e70264.

[10] Neelaraju H, Gangaiah M, Mittal P. Surgical healing beyond the scalpel: exploring the impact of depressive symptoms on functional recovery in total knee arthroplasty patients. J Orthop Surg Res. 2023;18(1):833.

[11] Hawker, Gillian A. et al.The Burden of Osteoarthritis in Older Adults.Clinics in Geriatric Medicine, Volume 38, Issue 2, 181-192.

[12] Chinese Rheumatology Association. Guidelines of osteoarthritis diagnosis and treatment. Chin J Rheumatol. (2010) 6:416–9.

[13] Alshewaier SA, Sikkandar MY, Almakrami AAA, et al. Investigation of customized total knee implant with articular cartilage under loading conditions using finite element analysis. PLoS One. 2025;20(2):e0311210.

[14] Jacobs E, Stroobant L, Witvrouw E, et al. Sustained benefits of blood flow restriction therapy in knee osteoarthritis rehabilitation: 1-year follow-up of a randomised controlled trial. Br J Sports Med. Published online August 22, 2025.

[15] Wang T, Liu H, Zhao W, et al. Predicting knee osteoarthritis progression using neural network with longitudinal MRI radiomics, and biochemical biomarkers: A modeling study. PLoS Med. 2025;22(8):e1004665.

[16] Hernández-Valencia CG, Torre-Morales CM, Ortiz-Huidobro RI, et al. Intra-articular injectable poly (gallic acid) and hyaluronic acid reduce inflammation and oxidative stress for the treatment of osteoarthritis. Int J Biol Macromol. 2025;322(Pt 4):146502.

[17] O'Brien MS, McDougall JJ. Age and frailty as risk factors for the development of osteoarthritis. Mech Ageing Dev. 2019;180:21-28.
[18] ppleton CT. Osteoarthritis year in review 2017: biology. Osteoarthritis Cartilage. 2018;26(3):296-303.
[19] Krakowski P, Rejniak A, Sobczyk J, Karpiński R. Cartilage Integrity: A Review of Mechanical and Frictional Properties and Repair Approaches in Osteoarthritis. Healthcare. 2024; 12(16):1648.
[20] Zhou J, Zhao F, Chen C, et al. Influencing factors of flexion contracture among patients with knee osteoarthritis: a multi-center retrospective cross-sectional study. Sci Rep. 2025;15(1):32144.
[21] Zhang H, Ma J, Tian A, et al. Analysis of cartilage loading and injury correlation in knee varus deformity. Medicine (Baltimore). 2024;103(19):e38065.
[22] Tsokanos A, Livieratou E, Billis E, Tsekoura M, Tatsios P, Tsepis E, Fousekis K. The Efficacy of Manual Therapy in Patients with Knee Osteoarthritis: A Systematic Review[J]. Medicina (Kaunas). 2021,57(7):696.
[23] Li B, Yang Z, Li Y, Zhang J, Li C, Lv N. Exploration beyond osteoarthritis: the association and mechanism of its related comorbidities. Front Endocrinol (Lausanne). 2024;15:1352671.
[24] Ishibashi K, Sasaki E, Sasaki S, Kimura Y, Yamamoto Y, Ishibashi Y. Medial stabilizing technique preserves anatomical joint line and increases range of motion compared with the gap-balancing technique in navigated total knee arthroplasty. Knee. 2020;27(2):558-564.
[25] Zhou X, Liu G, Han B, Li H, Zhang L, Liu X. Different Prevention and Treatment Strategies for Knee Osteoarthritis (KOA) with Various Lower Limb Exoskeletons – A Comprehensive Review. Robotica. 2021;39(8):1345-1367.
[26] Mahmoudian A, Van Assche D, Herzog W, Luyten FP. Towards secondary prevention of early knee osteoarthritis. RMD Open. 2018;4(2):e000468.
[27] Hunter CW, Deer TR, Jones MR, et al. Consensus Guidelines on Interventional Therapies for Knee Pain (STEP Guidelines) from the American Society of Pain and Neuroscience. J Pain Res. 2022;15:2683-2745.
[28] Siviero P, Marseglia A, Biz C, et al. Quality of life outcomes in patients undergoing knee replacement surgery: longitudinal findings from the QPro-Gin study. BMC Musculoskelet Disord. 2020;21(1):436.
[29] Beaudart C, Lengelé L, Leclercq V, et al. Symptomatic Efficacy of Pharmacological Treatments for Knee Osteoarthritis: A Systematic Review and a Network Meta-Analysis with a 6-Month Time Horizon. Drugs. 2020;80(18):1947-1959.

[30] Khury F, Oltmanns M, Unseld T, Fuchs M, Reichel H, Faschingbauer M. Which Knee Phenotypes Exhibit the Strongest Correlation With Cartilage Degeneration? Clin Orthop Relat Res. 2024;482(3):500-510.
[31] Zeng C-Y, Zhang Z-R, Tang Z-M, et al. Benefits and Mechanisms of Exercise Training for Knee Osteoarthritis. Frontiers in Physiology. 2021;12:794062.
[32] Furmanek MP, Stomka KJ, Sobiesiak A, et al. The Effects of Cryotherapy on Knee Joint Position Sense and Force Production Sense in Healthy Individuals. Journal of Human Kinetics. 2018;61:1-14.
[33] Courtney CA, Steffen AD, Fernández-de-las-Peñas C, et al. Joint Mobilization Enhances Mechanisms of Conditioned Pain Modulation in Individuals With Osteoarthritis of the Knee. Journal of Orthopaedic & Sports Physical Therapy. 2016;46(3):168-176.
[34] Park S, Min S, Park S-H, et al. Influence of Isometric Exercise Combined With Electromyostimulation on Inflammatory Cytokine Levels, Muscle Strength, and Knee Joint Function in Elderly Women With Early Knee Osteoarthritis. Frontiers in Physiology. 2021;12:688260.
[35] Yan H L, Huo J T, Zhou W C, et al. Application and mechanism of tissue flossing in sports and rehabilitation. Chinese Journal of Tissue Engineering Research. 2024;28(3):464-471.
[36] Assar S, Gandomi F, Mozafari M, et al. The effect of Total resistance exercise vs. aquatic training on self-reported knee instability, pain, and stiffness in women with knee osteoarthritis: a randomized controlled trial. BMC Sports Science, Medicine and Rehabilitation. 2020;12:27.
[37] Lu Y, Chen J, Zhang X-L. Low-Intensity Resistance Exercise Based on Myofascial Chains Alters the Lower-Limb Tension and Improves Health Status in Female Individuals With Knee Osteoarthritis. Journal of Sport Rehabilitation. 2023;32:818-826.

Figure legends

Figure 1 Subject Flowchart

Figure 2 Mean VAS Scores of Different Treatment Periods.

Figure 3 Mean Temperature of Anterior Knee before and after Treatment.

Figure 4 Mean Temperature of Posterior Knee before and after Treatment.

Figure 5 Temperature before and after Treatment in Study Group.

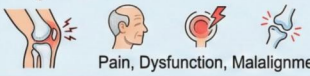
Figure 6 Temperature before and after Treatment in Control Group.

Figure 7 Temperature Difference before and after Treatment in Study Group.

KNEE ARTHOSIS CORRECTION MANIPULATION FOR KOA:
A Single-Blind RCT Visual Abstract

BACKGROUND & METHODS

Background: KOA



Pain, Dysfunction, Malalignment

Methods: Single-Blind RCT

N=40 KOA Patients
(Oct 2020–Jul 2021)

↓

Randomized 1:1
(Treatment vs. Control)

Treatment Group (N=20): Resistance Rotation Method **VS** **Control Group (N=20):** Conventional Massage

↓

3 Weeks, 2 Sessions/Week

↓

Analysis N=34
(Treatment 19, Control 15)

Outcomes: VAS (Pain), KOOS (Function), X-ray Angle (Alignment), Thermal Imaging (Temp)

INTERVENTION & ASSESSMENT

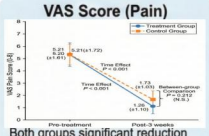
Intervention

Resistance Rotation Method (Treatment Group)

Conventional Massage (Control Group)

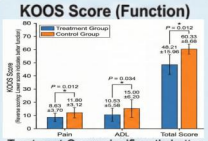
KEY RESULTS

VAS Score (Pain)



Both groups significant reduction (P<0.001). No significant difference between groups (P>0.05).

KOOS Score (Function)

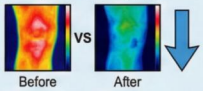


Treatment Group significantly better in Pain, ADL, Total Score (P<0.05).

Joint Alignment
(X-ray Angle)

Treatment Group: Increased Tibiofemoral Angle (P=0.046, +1.04°);
Control Group: No Significant Change (P>0.05).

Joint Temp
(Infrared Imaging)



Treatment Group: Decreased Temperature in Multiple Areas (P<0.05);
Control Group: No Significant Change (P>0.05).

CONCLUSION

Resistance Rotation Method: Reduces Pain, Improves Function & Alignment, Decreases Knee Temp; Superior to Conventional Massage. Therapeutic approach for KOA.

Table 1 Comparison of General Data between the Two Groups

Group	Case	Lesion Site [Case（%）]		Lesion Site [Case（%）]		Course of Disease（Year）	Age（Years Old）	Height（cm）	Weight（kg）
		Left knee	Right knee	Male	Female				
Study	19	9（47.37）	10（52.63）	9（47.37）	10（52.63）	4.31±0.59	60.11±10.12	169.35±9.03	72.10±10.11
Control	15	6（40.00）	9（60.00）	3（20.00）	12（80.00）	4.23±0.66	59.93±9.96	165.95±6.90	67.95±9.98
χ^2/t value		0.185		2.749		0.372	0.051	1.205	1.195
P value		0.667		0.097		0.355	0.958	0.236	0.241

Table 2 Comparison of VAS Scores before and after Treatment between the Two Groups（ $\bar{x}$±s，score）

Time	Study（n=19）	Control（n=15）	T value	P value
Before T	5.21±1.72	5.20±1.61	0.017	0.986
1st week after T	2.42±1.50	3.47±1.73	-1.894	0.067
2nd week after T	1.89±1.10	2.40±1.45	-1.167	0.251
3rd week after T	1.26±1.10	1.73±1.03	1.271	0.212
F Value	30.247	15.714	---	---
P Value	＜0.001	＜0.001	---	---

Table 3 Comparison of KOOS Scores before and after Treatment between the Two Groups（ $\bar{x}$±s，Score）

KOOS Score	Time	Study（n=19）	Control（n=15）	t value	p value
Pain	Before Treatment	17.63±2.39	15.89±3.65	1.675	0.103
	After Treatment	8.63±3.70	11.80±3.12	2.653	0.012
	t value	8.906	3.298		

	p value	＜0.001	0.002		
Symptoms	**Before Treatment**	17.53±2.67	15.20±4.31	1.936	0.061
	After Treatment	12.11±2.89	11.67±3.44	0.405	0.687
	t value	6.004	2.479		
	p value	＜0.001	0.019		
Daily Living Ability	**Before Treatment**	23.00±9.92	21.67±8.41	0.414	0.681
	After Treatment	10.53±5.58	15.00±6.20	2.208	0.034
	t value	4.775	2.472		
	p value	＜0.001	0.019		
Exercise and Recreation Ability	**Before Treatment**	11.74±2.13	11.73±3.43	0.010	0.991
	After Treatment	7.53±3.12	9.13±2.41	1.636	0.111
	t value	4.857	2.402		
	p value	＜0.001	0.023		
Life Quality	**Before Treatment**	11.05±1.22	11.67±1.95	1.135	0.264
	After Treatment	9.42±1.98	9.73±1.44	0.508	0.614
	t value	3.055	3.099		
	p value	0.004	0.004		
Total Scores	**Before Treatment**	81.05±12.59	75.07±14.64	1.280	0.209
	After Treatment	48.21±15.96	60.33±8.68	2.643	0.012
	t value	7.041	3.354		
	p value	＜0.001	0.002		

Table 4 Comparison of Image Angle and Angle Difference between the Two Groups before and after Treatment （ $\bar{x}$±s）

Index	Study（n=19）	Control（n=15）	T value	P value
Angle difference before and after T	1.68±0.84	-0.19±1.26	5.182	＜0.001
Before T	98.10±2.56	98.56±2.80	-0.499	0.621
After T	99.78±2.45	98.37±2.96	0.830	0.413
t value	2.066	0.180		
p value	0.046	0.857		

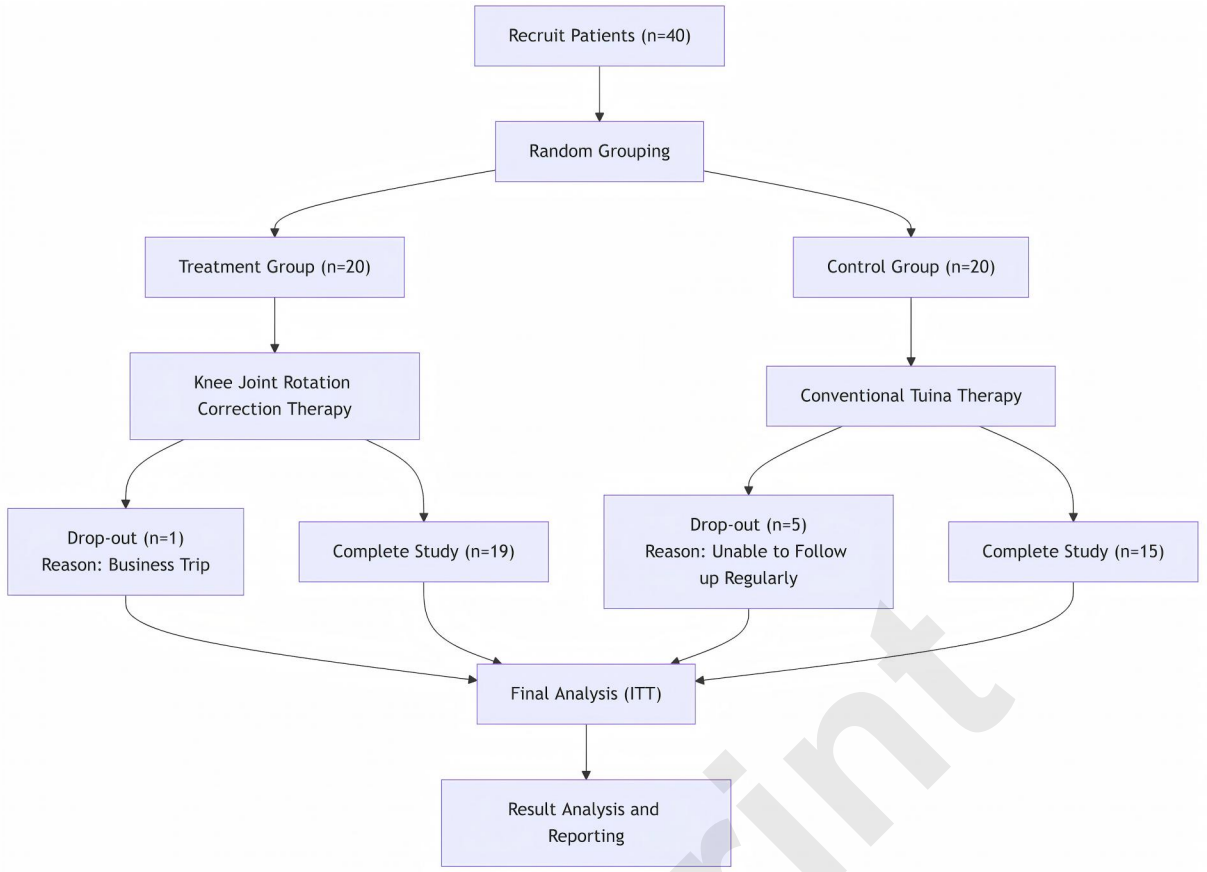
Table 5 Comparison of Anterior Knee Temperature before and after Treatment between the Two Groups（ $\bar{x}$±s）

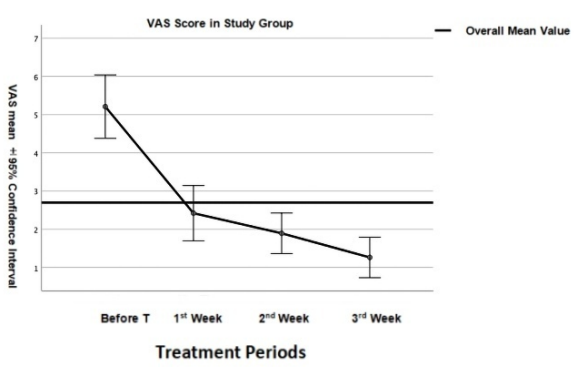
Areas		Time	Study（n=19）	Control（n=15）	t value	p value
Anterior Knee	AAT-Inner Lower	Before T	31.43±1.51	31.30±0.59	0.314	0.337
		After T	30.20±1.65	29.93±3.76	0.281	0.780
		t value	2.397	1.394		
		p value	0.020	0.174		
	AAT-Outer Lower	Before T	32.01±1.45	31.68±3.54	0.370	0.713
		After T	30.73±1.62	30.21±3.90	0.527	0.601
		t value	2.566	1.080		
		p value	0.015	0.288		
	AAT-Outer Upper	Before T	30.81±1.41	30.53±0.70	0.702	0.487
		After T	29.41±1.52	29.45±3.86	0.041	0.967
		t value	2.943	1.066		
		p value	0.005	0.295		
	AAT-Inner Upper	Before T	30.85±1.58	30.77±0.80	0.178	0.859
		After T	29.83±1.44	29.63±3.91	0.206	0.837
		t value	2.079	1.106		
		p value	0.044	0.278		
	AAT-Comphrehensive	Before T	31.29±1.46	31.06±0.55	0.577	0.567
		After T	30.14±1.52	29.80±3.85	0.352	0.726
		t value	2.378	1.255		
		p value	0.022	0.219		

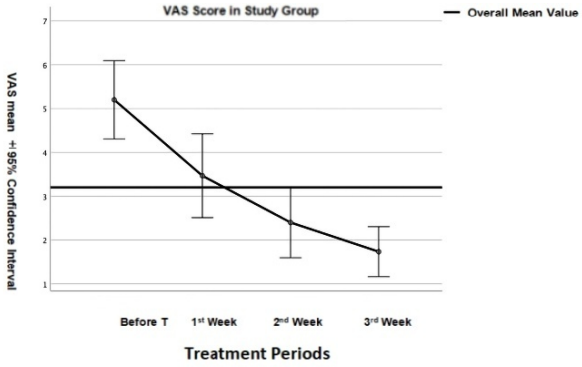
Table 6 Comparison of Posterior Knee Temperature before and after Treatment between the Two Groups（ $\bar{x}$±s）

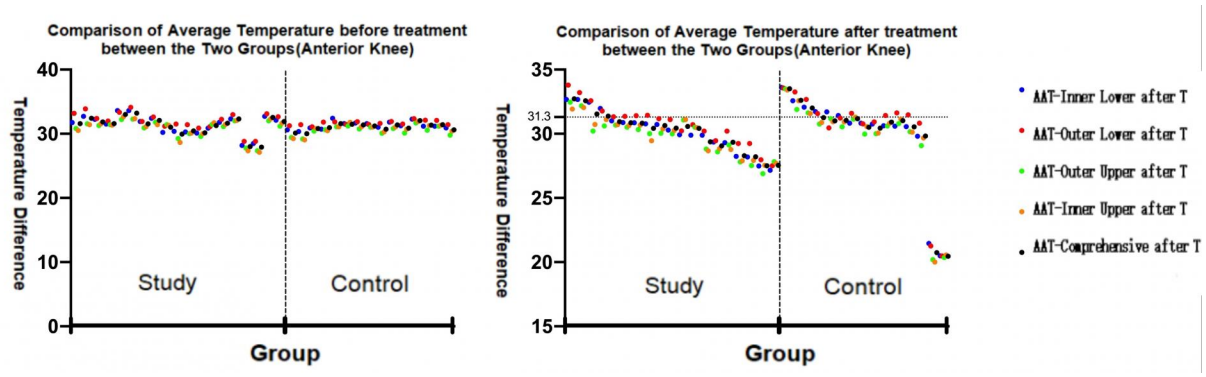
Areas		Time	Study（n=19）	Control（n=15）	t value	p value
	AAT-Inner Lower	Before T	31.25±1.53	31.31±0.57	0.143	0.443
		After T	30.10±1.45	29.93±3.93	0.174	0.862
		t value	2.378	1.345		
		p value	0.022	0.189		
	AAT-Outer Lower	Before T	31.20±1.48	31.30±0.77	0.237	0.814
		After T	30.42±1.42	29.86±3.94	0.575	0.569

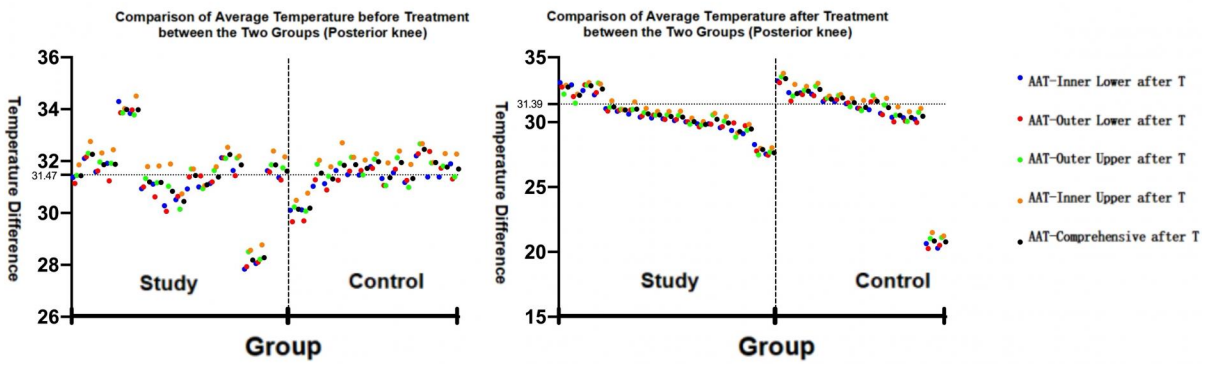
		t value	1.657	1.389		
		p value	0.106	0.175		
	AAT-Outer	**Before T**	31.46±1.39	31.54±0.71	0.202	0.841
	Upper	**After T**	30.45±1.46	30.24±3.83	0.220	0.827
		t value	2.183	1.292		
		p value	0.035	0.206		
Posterior	**AAT-Inner**	**Before T**	31.85±1.42	31.97±0.61	0.303	0.763
Knee	**Upper**	**After T**	30.80±1.44	30.62±3.84	0.188	0.851
		t value	2.263	1.344		
		p value	0.029	0.189		
	AAT-	**Before T**	31.42±1.44	31.54±0.63	0.300	0.766
	Comphrehensive	**After T**	30.41±1.42	30.16±3.89	0.259	0.796
		t value	2.176	1.356		
		p value	0.036	0.186		

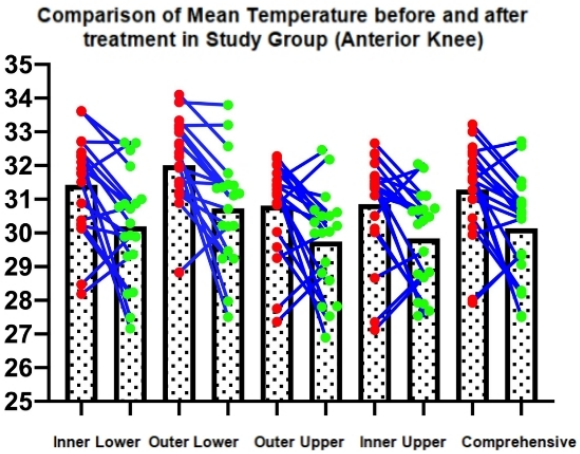

Recruit Patients (n=40)
Random Grouping
Treatment Group (n=20)
Control Group (n=20)
Knee Joint Rotation Correction Therapy
Conventional Tuina Therapy
Drop-out (n=1) Reason: Business Trip
Complete Study (n=19)
Drop-out (n=5) Reason: Unable to Follow up Regularly
Complete Study (n=15)
Final Analysis (ITT)
Result Analysis and Reporting

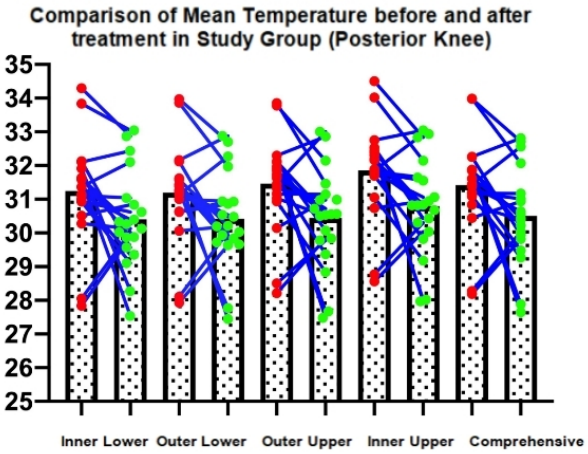

VAS Score in Study Group
Overall Mean Value
VAS mean +95% Confidence Interval
7
6
5
4
3
2
1
Before T
1st Week
2nd Week
3rd Week
Treatment Periods

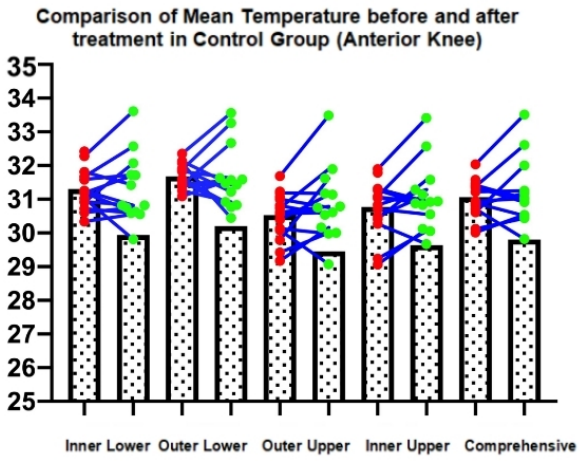

VAS Score in Study Group
Overall Mean Value
VAS mean +95% Confidence Interval
7
6
5
4
3
2
1
Before T
1st Week
2nd Week
3rd Week
Treatment Periods

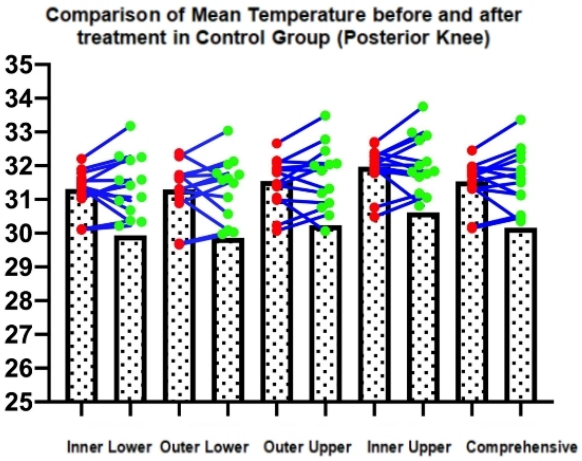

Comparison of Average Temperature before treatment between the Two Groups(Anterior Knee)
Temperature Difference
40
30
20
10
0
Study
Control
Group
Comparison of Average Temperature after treatment between the Two Groups(Anterior Knee)
Temperature Difference
35
31.3
30
25
20
15
Study
Control
Group
AAT-Inner Lower after T
AAT-Outer Lower after T
AAT-Outer Upper after T
AAT-Inner Upper after T
AAT-Comprehensive after T

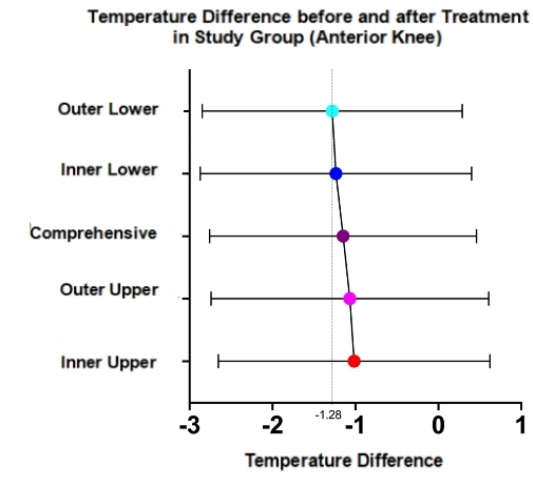

Comparison of Average Temperature before Treatment between the Two Groups (Posterior knee)
Temperature Difference
36
34
32
31.47
30
28
26
Study
Control
Group
Comparison of Average Temperature after Treatment between the Two Groups (Posterior knee)
Temperature Difference
35
31.39
30
25
20
15
Study
Control
Group
AAT-Inner Lower after T
AAT-Outer Lower after T
AAT-Outer Upper after T
AAT-Inner Upper after T
AAT-Comprehensive after T

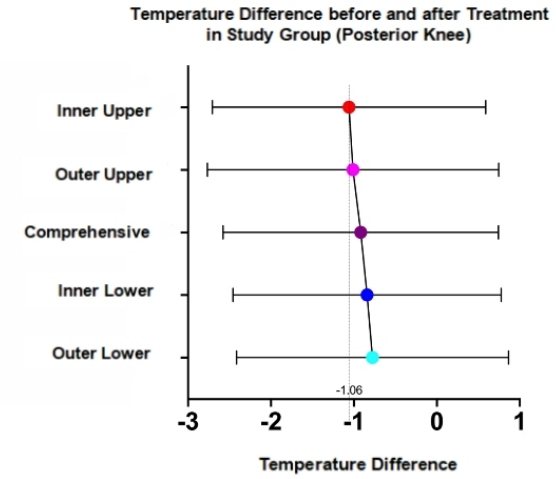

Comparison of Mean Temperature before and after treatment in Study Group (Anterior Knee)
35
34
33
32
31
30
29
28
27
26
25
Inner Lower
Outer Lower
Outer Upper
Inner Upper
Comprehensive


Comparison of Mean Temperature before and after treatment in Study Group (Posterior Knee)
35
34
33
32
31
30
29
28
27
26
25
Inner Lower
Outer Lower
Outer Upper
Inner Upper
Comprehensive


Comparison of Mean Temperature before and after treatment in Control Group (Anterior Knee)
35
34
33
32
31
30
29
28
27
26
25
Inner Lower
Outer Lower
Outer Upper
Inner Upper
Comprehensive


Comparison of Mean Temperature before and after treatment in Control Group (Posterior Knee)
35
34
33
32
31
30
29
28
27
26
25
Inner Lower
Outer Lower
Outer Upper
Inner Upper
Comprehensive


Temperature Difference before and after Treatment
in Study Group (Anterior Knee)
Outer Lower
Inner Lower
Comprehensive
Outer Upper
Inner Upper
-1.28
-3
-2
-1
0
1
Temperature Difference


Temperature Difference before and after Treatment
in Study Group (Posterior Knee)
Inner Upper
Outer Upper
Comprehensive
Inner Lower
Outer Lower
-1.06
-3
-2
-1
0
1
Temperature Difference