Effectiveness of the Rehabilitation Training Combined with Maitland Mobilization for the Treatment of Chronic Ankle Instability: A Randomized Controlled Trial.

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Effectiveness of the Rehabilitation Training Combined with Maitland Mobilization for the Treatment of Chronic Ankle Instability: A Randomized Controlled Trial

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The study aims to determine whether routine rehabilitation training combined with the Maitland mobilization is more effective than routine rehabilitation training alone in patients with chronic ankle instability, intending to provide a novel rehabilitation strategy for chronic ankle instability. A total of 48 subjects were divided into three groups: EG (Maitland mobilization and routine rehabilitation), CG (routine rehabilitation), and SG (sham mobilization and routine rehabilitation). The intervention was performed three times each week for 4 weeks, for a total of 12 sessions. Before and after the intervention, the muscle strength, star excursion balance test (SEBT), weight-bearing dorsiflexion range of motion (WB-DFROM), ankle range of movement, Cumberland ankle instability tool (CAIT), self-comfort visual analog scale (SCS-VAS), and self-induced stability scale (SISS-VAS) were assessed. The results showed that the improvement of SEBT, WB-DFROM, and active ankle range of movement without the pain in EG was more obvious than CG and SG, but the improvement of the self-report of ankle severity and muscle strength was not. Compared with routine rehabilitation training alone, routine rehabilitation training combined with Maitland mobilization for patients with chronic ankle instability may provide more benefit in terms of balance and ankle range of movement than routine rehabilitation alone, but the improvement in muscle strength was not evident enough.

Maitland mobilization

chronic ankle instability

joint range of movement

national key R&D; project

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An ankle sprain is one of the most common sports injuries and the recurrence rate of an ankle sprain is the highest in lower limbs sports injuries [

Currently, muscle strength training, physical factor treatments, and Kinesio taping combined with external stabilization measures, such as protective gear, taping, and orthoses, are the primary therapeutic approaches for CAI [

Therefore, routine rehabilitation training can reduce the degree of swelling and pain after the ankle sprain and enhance muscle strength [

The main characteristic of ankle instability following an ankle sprain, as well as one of the factors contributing to the risk of re-injury, is the restricted range of movement in the ankle, proprioceptive impairment, and decreased neuromuscular control ability [

Manual therapy improves and recovers joint physiological and accessory movements through passive activities. Moreover, it can stretch the ligaments and joint capsule around a joint, reduce soft tissue adhesion, realign joints, and recover ligament extensibility [

To reduce the impact of confounding factors and improve the quality of manual therapy research, researchers have previously conducted comparative studies of real manual therapy and sham manual therapy [

2. Materials and Methods

The study was a single-blind randomized controlled trial for the intervention method for subjects. The CONSORT 2010 statement [

Subjects were recruited at Guangxi Normal University through questionnaires and posters. All the subjects signed a consent form before participating in the study.

Inclusion and exclusion criteria conformed to the 2019 consensus statement and recommendations made by the International Ankle Consortium [

Subjects had at least one history of ankle sprain in the past 12 months, causing pain and swelling, and the time to lose normal function within 1 day or more;

The affected ankle of subjects felt “soft leg”, and/or repeatedly sprains and/or “unstable”;

The Cumberland ankle instability tool (CAIT) scores for the subjects were less than or equal to 27.

Subjects had undergone surgery on any lower limb musculoskeletal structure in the past (i.e., bone, joint structure, nerve);

In the past three months, the subject suffered an acute injury (such as a sprain, or fracture) to the musculoskeletal structure of other joints of the lower limb, resulting in at least one day of required physical activity interruption;

Subjects had diseases such as the nervous system and vestibular system;

Subjects had other nerve injuries that could affect balance and muscle strength;

Subjects had accepted any other type of treatment during the trial.

Subjects who were incorrectly included because they did not fulfill the inclusion criteria, those who met the inclusion criterion but did not cooperate with treatment after inclusion, and those who could not participate on time were included in the rejection and abscission criteria.

The sample size was calculated by the mixed model analysis software (G*power 3.1, Düsseldorf, Germany) through repeated measurement ANOVA. The effect size was estimated to be 0.3 with 0.8 power and an α value of 0.05. According to the sample size calculation, at least 39 subjects had to be recruited. A total of 48 subjects (16 per group), taking subject loss into account, had to be recruited.

2.4.1. Star Excursion Balance Test (SEBT)

SEBT is a standard measurement method for dynamic balance, which also can be conducted to evaluate the dynamic postural control disorder induced by musculoskeletal injuries (such as chronic ankle instability) and assess the risk of injury of lower limbs [

SEBT (A, PM, PL)% = ((M1 + M2 + M3)/3)/L × 100%);

SEBTC% = (SEBT-A% + SEBT-PM% + SEBT-PL%)/3).

2.4.2. Weight-Bearing Dorsiflexion Range of Motion (WB-DFROM)

WB-DFROM was conducted to evaluate the ankle dorsiflexion motion angle of subjects. WB-DFROM was used to simulate the function position of ankle dorsiflexion in daily physical activity [

2.4.3. Muscle Strength

The muscle around the ankle of CAI patients would be wasting and weak, increasing the risk of reinjury [

2.4.4. Range of Movement (ROM)

A sufficient ankle range of movement is necessary for daily physical activity such as walking and running, but the ankle range of movement of patients with CAI was variably limited. Therefore, the primary physical treatment goal was to improve the ankle range of movement [

Measurement of the ankle dorsiflexion and plantar flexion range of movement: The subject was in the prone position, and the ankle was in the neutral position. The axis was located about 2.5 cm below the midpoint of the ankle. The fixed leg was parallel to the long axis of the fibula and the moving leg was parallel to the fifth metatarsal bone.

Measurement of the ankle varus and eversion range of movement: The subject was in the prone position, and the ankle was in the neutral position. The axis was located near the outer side of the calcaneus. The fixed leg was parallel to the long axis of the tibia and the moving leg was parallel to the plantar surface of the heel.

Since the included angle between the fixed leg and the moving leg was 90° when measuring the starting position, it was necessary to deduct 90° after the measurement to obtain the right range of movement.

2.4.5. Visual Analog Scale (VAS)

The self-comfort visual analog scale (SCS-VAS) and the self-induced stability scale (SISS-VAS) for the ankle of the subjects were measured. The VAS was conducted by a 10 cm long linear visual analog scale with numbers ranging from 0 to 10. 0 represented the highest degree of comfort or stability, while 10 represented the lowest degree of either. From 0 to 10, comfort or stability decreased in turn [

2.4.6. Cumberland Ankle Instability Tool (CAIT)

CAIT, which consists of 9 questions and involves the self-perception of ankle stability in daily life [

Subjects were randomly divided into the experimental group (EG), the control group (CG), and the sham group (SG) by using a simple random assignment sequence generated by Stata 12.0 software (

2.5.1. Balance Training

Subjects were conducted stable plane and unstable plane balance training, respectively. The stable plane training was carried out on flat ground, and the unstable plane training was carried out on the balance pad. The training was divided into two types, one was single-leg standing with eyes open and the other one was single-leg standing with eyes closed [

Training with eyes open: Subjects were required to keep their bodies upright, abduct their upper limbs 90 degrees, lift the healthy lower limbs to the knee of the affected side, keep the inner side of the healthy ankle at the same level as the healthy knee, and keep their bodies stable by looking straight ahead for one minute.

Training with eyes closed: Subjects were required to keep their body balance in advance, then close their eyes. The rest of the training was the same as training with eyes open.

Subjects were required to repeat each training 3 times with a 10-s break in between each repetition.

2.5.2. Muscle Strength Rehabilitation Training

Use an elastic band to conduct plantar flexion, dorsiflexion, varus, and eversion resistance training in the neutral position of the ankle, varus and eversion resistance training in the plantar flexion position of the ankle, and varus and eversion resistance training in the dorsiflexion position of ankle. Subjects were required to reach the maximum painless joint range of movement while conducting the training. Repeat 8 times per group in each direction, rest for 3 min during the repetition and repeat 3 groups per training [

2.5.3. Manual Therapy

The physiotherapist conducted Maitland mobilization for manual therapy [

Talocrural joint longitudinal traction: Subjects lay in the supine position with the heel at the treatment bedside. The physiotherapist conducted the calcaneus's level III traction action relative to the distal leg's long axis.

Subtalar joint forward/backward sliding: Subjects lay in the supine position with the heel at the treatment bedside. The physiotherapist placed one hand on the instep and conducted the level I traction. Moreover, the other hand was placed on the posterior distal calcaneus. Then the physiotherapist conducted the level III forward/backward sliding motion of the calcaneus relative to the talus.

Subtalar joint Inside/outside sliding: Subjects lay in the prone position or the lateral decubitus position with the ankle propped up by towel rolls at the treatment bedside. The physiotherapist stabilized the talus of the subject with one hand, then placed the other hand's palm on the medial calcaneus then conducted level III outside sliding. Or the physiotherapist placed the other hand's palm on the lateral calcaneus and then conducted level III inside sliding.

Each group received 30 s of manual therapy, with 1 min rest between groups. There were 3 groups in total.

2.5.4. Sham Manual Therapy

The sham manual therapy was conducted in the same position as the manual therapy. The only difference between them was that sham manual therapy did not involve any type of exercise, but the physiotherapist maintained hand contact with the skin for a period of ten minutes.

2.6. Statistical Analysis

The Shapiro–Wilk test was used to evaluate the normality of variables. The mean and standard deviation (SD) were reported for the descriptive analysis of the quantitative variables. For the categorical variable, chi-square tests were reported. The paired sample T-test was used for intragroup statistical analysis. After the intervention, one-way repeated measures ANOVA was applied to evaluate whether the muscle strength around the ankle, ankle range of movement, and lower limb balance ability were statistically significant. Moreover, the post hoc multiple comparisons were conducted through Bonferroni. The effect size was calculated through the partial Eta square (η

All the analyses were conducted with SPSS v.22 software (SPSS Inc., Chicago, IL, USA),

A total of 52 subjects were recruited. A total of 4 subjects were excluded, 2 of whom had bilateral ankle instability and the other 2 had a history of ankle surgery. Finally, 48 subjects (35 males and 13 females) were selected. During the research, 2 subjects dropped out at the follow-up and 1 subject dropped out due to an ankle sprain. 45 subjects completed the study, of which 16 were allocated to the EG group, 15 to the CG group, and 14 to the SG group. A flow diagram of subjects is presented in

3.1. General Information of Subjects

The general information of subjects: age = 20.33 ± 1.08 (y), height = 1.73 ± 0.08 (m), weight = 67.05 ± 10.75 (kg), BMI = 22.23 ± 2.77 (kg/m

3.2. CAIT, SIS-VAS, SCS-VAS, and WB-DFROM (cm)

The study showed that there was no statistically significant difference among the indexes of each group before intervention (

In terms of SEBT, after 4 weeks of intervention, there was a statistically significant difference among the three groups: SEBT-A (

3.4. Range of Movement

After 4 weeks of intervention, the ankle range of movement in the three groups was improved compared with that before (

The results indicated that the muscle strength of all groups had an enhancement compared with that before the four weeks intervention (

According to statistics, about 71,200 people have ankle sprains every day [

After 4 weeks of intervention, SEBT-A, SEBT-PM, SEBT-PL, and SEBT-C of EG, CG, and SG were significantly improved, and there was a statistical difference among the three groups. In terms of the improvement of SEBT-A, SEBT-PM, SEBT-PL, and SEBT-C, there was a statistically significant difference between EG and SG. This may be due to the Maitland mobilization improving the ankle range of movement. After routine rehabilitation, the balance of the ankle was also improved. In the comparison of EG and CG, there was a statistically significant difference in terms of SEBT-A and SEBT-PM. Muscle strength training can improve the proprioceptive acuity and balance of the ankle [

The restricted ankle dorsiflexion range of movement is a common dysfunction of patients with CAI. The symptom is caused by forwarding displacement of the talus or forward displacement of the distal fibula relative to the tibia [

For the patient with CAI, both the reaction and activation times of the long and short fibular muscles in the affected lower limb are significantly prolonged [

Regular self-report of ankle severity for CAI patients is conducive to the implementation and improvement of rehabilitation strategies [

Three of the subjects withdrew from the study, and the number of men and women was imbalanced, which may affect the statistical efficacy. Moreover, the study only used a single-blind design for the participants rather than conducting a double-blind study. Moreover, better comparative analysis cannot be achieved due to the lack of a control group with simple manual therapy. Additionally, the hand-held dynamometer used for the muscle strength tests may have introduced human error into the process, skewing the results. Therefore, in future research, objective instruments such as electromyograms and isokinetic dynamometers are supposed to be used in the muscle strength test to improve experimental rigor. Moreover, it is suggested that force plates and stereophotogrammetry are supposed to be conducted in the tests for balance and joint range of movement.

In summary, the results suggest that the balance, ankle range of movement, and muscle strength of patients with CAI were improved after three types of intervention methods. Compared with routine rehabilitation training alone, routine rehabilitation training combined with Maitland mobilization seems to improve the balance ability and ankle range of movement of patients with CAI, but it is not obvious enough to promote the improvement of muscle strength. It is necessary to increase the mid-term and long-term follow-up survey to clarify the effectiveness of Maitland mobilization in CAI in future research.

Conceptualization, Y.Y. and J.W.; methodology, Y.Y.; formal analysis, Y.Y. and J.W.; data curation, J.W.; writing—original draft preparation, Y.Y. and Z.Y.; writing—review and editing, Y.Y., J.W., Z.Y. and J.S.; visualization, Y.Y.; supervision, J.S. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

This study conforms to the Declaration of Helsinki and has been approved by the ethics review of Chengdu University of Physical Education (no. 2022-43).

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

Data Availability Statement

The data are not publicly available for privacy or ethical reasons.

Conflicts of Interest

The authors declare no conflict of interest.

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