OBJECTIVE EVALUATION OF CHRONIC ANKLE INSTABILITY AND BALANCE EXERCISE TREATMENT

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INTRODUCTION

Lateral ankle inversion sprains occur frequently in sports and recreational activities. Although the majority of patients recover completely after their first moderate/severe ankle sprain, disabling symptoms of pain and swelling, feelings of instability, and recurrent sprains continue to affect 15% - 60% of people despite treatments [1]. There are conflicting results in literature regarding the role of suggested etiological factors of Chronic Ankle Instability (CAI) including ankle joint laxity, proprioceptive deficiencies, peroneal muscle weakness, and the elongated muscle response time. In spite of the disagreement regarding CAI etiological factors, balance training is widely used in rehabilitation clinics for patients with CAI [2]. Past studies have reported the effect of balance training on CAI, but strong evidence with a definitive result is still missing. Furthermore, the mechanism that explains the effect of balance training on CAI is still unclear [2]. Therefore, the objective of this research was to determine the effect of balance training intervention on the ankle joint laxity, peroneal muscle weakness, and ankle proprioception in patients with CAI using quantitative biomechanical and neuromuscular measurements.

METHODS

We tested two groups of patients with unilateral CAI before and after a 4-week balance training program in the Neuromuscular Research Laboratory at The University of Kansas Medical Center. Subjects were randomly assigned to either experimental or control group with 4 subjects (2 males, 2 females; age, 35.2±6.3 years, height, 175.2±6.5 cm; weight, 87.88±21.1 kg) in the experimental group and 6 subjects (2 males, 4 females; age, 36.3±8.6 years, height, 168.9±11.8 cm; weight, 80.43±18.6 kg) in the control group. Subjects in the experimental group participated in a balance training program prescribed over a 4-week time period (3 times per week) whereas subjects in the control group didn’t receive balance training. The balance training program consisted of single limb standing, using both static and dynamic balance components. Ankle joint laxity, peroneal muscle strength, and ankle proprioception were measured using the Biodex dynamometer in the seated position for both the affected and unaffected legs pre- and post- training in both groups.

Ankle laxity testing was done at 20° of ankle plantar flexion. The Biodex machine performed full inversion/eversion ranges of motions while the movement angle and joint resistance were recorded (torque-angle curve). The ankle peroneal muscle isometric strength was determined at 15° of ankle inversion (peak torque). Additionally, isokinetic testing of the ankle peroneal muscles was also performed at a rotational velocity of 120°/s for concentric contractions to determine peroneal muscle strength (peak torque). The ankle proprioception positioning-repositioning test was done passively at 15° and 30° of ankle inversion with the subjects blinded. The error in degrees between the reference angle and the repositioned angle was recorded.

The recorded data was processed using lab-made Matlab programs (Mathworks Inc.). The outcome measures for the affected and unaffected leg at the baseline, and pre-post intervention in both the groups were examined using a one-sided independent t-test and one-sided t-test within the groups, respectively.
RESULTS

The affected leg showed increased laxity, decreased peroneal muscle strength, and decreased ankle proprioception as compared to the unaffected leg at the baseline. The ankle joint laxity, peroneal muscle strength, and ankle proprioception in the affected leg were found to be improved by balance training intervention as compared to the control group.

The ankle stiffness improved for both eversion and inversion motions following balance training in the experimental group (pre-test: eversion slope, -0.072±0.05 and inversion slope, -0.050±0.05; post-training: eversion slope, -0.115±0.11 and inversion slope, -0.063±0.02), but it did not reach significance (eversion, p=0.166; inversion, p=0.461). In the control group, the ankle stiffness decreased for both eversion and inversion motions (pre-test: eversion slope, -0.104±0.05 and inversion slope, -0.067±0.02; post-test: eversion slope, -0.097±0.06 and inversion slope, -0.044±0.01), but were not found to be significant.

The isometric peroneal muscle strength following balance training improved significantly as compared to isokinetic peroneal muscle strength for patients in the experimental group. The peak torque produced during isometric strength test increased significantly following balance training (pre-test: 11.69±3.05 Nm; post-training: 16.18±4.57 Nm; p=.05). However, the control group showed a decrease in peak torque produced during isometric strength test, but it was not found to be significant. The isokinetic strength test showed the similar trend as isometric strength test for both experimental and control group but the peak torques observed pre-and post-testing showed no significant difference.

The ankle joint proprioception for the experimental group patients improved significantly in 30° of ankle inversion (p=.002) but not for 15° ankle inversion (p=0.07). In contrast, the control group patients were less accurate in matching the target position post-testing in both 15° and 30° ankle inversion tests and error magnitudes were found to be significant in 30° ankle inversion (p=0.007).

DISCUSSION

The findings of the present study confirm that a proprioceptive and strength deficit exists in patients with CAI: specifically, the perception of ankle inversion movement and isometric peroneal strength is impaired. CAI has long been thought to occur in part because the initial sprain causes deficit in proprioception. The articular de-afferentation may lead to high risk of re-injury at the ankle joint in challenging positions which may further lead to chronic ankle instability. Similarly, lesion to either the afferent or efferent nerves during repeated injuries may also lead to impaired neuromuscular control of the ankle joint, in turn affecting the peroneal muscle strength. Balance training—long known to help some patients decrease the level of pain—may help retrain the nervous system to re-establish more normal neural connections and help re-establish the neuromuscular control around the ankle joint. There was no significant difference in the ankle stiffness, isokinetic peroneal muscle strength, or proprioception at 15° ankle inversion in the study, but that may be due to the small subject sample size. A similar argument can be made for positive findings in our study but we hope to establish a clear pattern as we enroll more subjects into our ongoing study. Classification of individuals with CAI based on impairments or treatment response may lead to more efficient conservative management. The results of the proposed study will help researchers and clinicians to develop more focused and effective diagnostic tools and treatment approaches for CAI in the future.

REFERENCES