

# Effectiveness of Foot Intensive Exercise Training for Subjects with Chronic Ankle Sprain: Experimental Study

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## Abstract

**Background:** This study was developed to determine the effectiveness of Foot Intensive Exercise Training among subjects with Chronic Ankle Sprain.

**Purpose:** To determine the effect of Foot Intensive Exercise Training and Proprioception Exercise Training in subjects with Chronic Ankle Sprain.

**Materials and Methods:** Thirty subjects with Chronic Ankle Sprain were divided randomly into two equal groups. "Foot Intensive Exercise Group" received plyometric exercises while the Control Group received proprioception exercises on alternate days for 6 weeks. Cumberland Ankle Instability Tool (CAIT) and Y-Balance Test were used to evaluate subjects at two intervals (Pre-Treatment and Post-Treatment). The entire process was performed from November 2022 to March 2023.

**Result:** Statistical analysis of Cumberland Ankle Instability Tool and Y-Balance Test post values revealed constantly significant differences, with the p value of <0.0001.

**Conclusion:** Foot Intensive Exercise is effective and increases functional ankle stability and decreases episodes of giving away in subjects with chronic ankle sprain.

**Key Words:** CAIT, plyometric training, ankle stability, proprioception, balance.

## Introduction

The ankle joint brings about the lower limb and the foot close together. The varying degrees of motion occurs between 50° dorsiflexion and 90° plantarflexion. Talus bone gives maximal postural control in dorsiflexion and minimal postural control in plantar flexion.<sup>1</sup> The most habitual injuries seen in orthopedics among dancers and sports players, is ankle sprain.<sup>2</sup> Of all the athletic injuries the

involvement of ankle takes up to 40% in average.<sup>3</sup> Habitually injury by persons who take part in court, ground and indoor sports would be the acute ankle sprain (lateral), which may lead to CAI (Chronic Ankle Sprain) in the longer run.<sup>4</sup> Depending upon the anatomical position, the ligament around the joint may be put into 3 groups: lateral, medial ligaments (deltoid ligament), and the ligament in the tibiofibular junction of tibia and fibula at the junction

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of distal epiphysis. In plantar flexed and inversed force, the largest impact is on the ATL (anterior talofibular ligament). In this mechanism and position the ligament develops increased vulnerability to injury and strain. With more applied force, the calcaneofibular ligament, and the posterior ligament is prone to be injured.<sup>5</sup>

Injuries like abrasions, lacerations and fractures are unavoidable due to aggressive play, but the rest may be prevented with proper intervention methods.<sup>6</sup> Internal rotation is one of the causes at the ankle joint of inversion ankle sprain, involving a slight inversion in the joint during touchdown. To prevent this, players should touch down with the ankle in neutral position, while performing sideward cutting motions.<sup>7</sup> It has been reported that previous injuries, balance deficit, ankle dorsiflexion loss are strong predictors of recurrent sprain in ankle in persons with FAI.<sup>8</sup> Most of the injuries occurring to players are sprains which puts them in a long-term risk of instability, prolonged symptoms and also includes reinjury.<sup>9</sup> The most commonly and effectively used measure of dynamic stability and risk of injury is the Star Excursion Balance test (SEBT). Another most frequently used modified version of measure is the Y Balance test which is also often used.<sup>10</sup> The Y balance test is seen to have a strong association with hip abduction strength.<sup>11</sup> The Cumberland Ankle Instability Tool (CAIT) is a reliable 30-point 9-item scale, widely used to measure the degree and severity of Functional Ankle Instability. CAIT's supremacy is that it does not require much of the subject's burden and its increasing reliability to objectify chronic ankle instability.<sup>12</sup>

The sprained or injured ankle can cause the receptors in the joint to be subjected to damage and alteration in the motor control in the longer run-in which individuals report sensorimotor impairments following a history of ankle sprain that further corresponds to FAI or giving away.<sup>13</sup> Ankle sprain may reduce neural-muscular control causing a deficit in proprioception. Proprioceptive training is a time and cost-efficient treatment which is a neurological action in which the body gets sensory stimulus or input from the surrounding environment and interprets the received information to bring about a motor response.<sup>14</sup> Proprioception is important in

regulating the system to keep the ankle in neutral. This system subconsciously controls ankle movements and position in which, when a player is not able to comprehend their ankle position it is most likely to easily deviate from its neutral position. Plyometric training on the other hand is an extensively used intervention to enhance performance in the general athletic population. It is seen to be in the final stages of rehabilitation of various injuries involving the lower limb, especially ankle sprains. Previous studies show that Foot Intensive Exercise boosts proprioception, agility, and strength in individuals with past history of lateral ankle sprain.<sup>15</sup>

### Aim

To evaluate the effectiveness of Foot Intensive Exercise Training among subjects with Chronic Ankle Sprain.

### Material and Method

It was an experimental study conducted on 30 subjects with Chronic Ankle Sprain. The sample was collected at Kirubai Physio & Rehabilitation Centre, based on the inclusion and exclusion criteria. Participants received an extensive overview of the method and a formal consent form was acquired.

**Study Period:** from November 2022 to March 2023.

#### Inclusion Criteria

- Both male and female
- Aged between 18 to 30
- History of two or more ankle sprain
- Recurrent episodes of giving away
- CAIT score < 24

#### Exclusion Criteria

- Ankle sprain occurred within the past 3 months
- Recent fracture of the lower limb
- Surgeries of Ankle joint
- Deformity of the Ankle and Foot

#### Outcome Measures

Assessment was performed before and after the treatment.

- Cumberland Ankle Instability Tool (CAIT)
- Y-Balance Test

### Procedure

Participants were included considering the inclusion and exclusion criteria. Procedure was explained to the participant and participants were then asked to sign the consent form. Assessment of all the included participants was recorded using CAIT and Y-Balance Test. Participants were randomly divided into two groups; Foot Intensive Exercise Group and the Control Group. The assessment was performed after 6 weeks of intervention.

### Foot Intensive Exercise Group

Repetitions: 5-10 reps; 2-4 sets/session.

#### 1. Ankle Jumps

- Subjects were asked to stand upright with legs closed and keep hands placed on the waist.
- Then the subjects are asked to Jump straight up forward only by extending the ankle while avoiding bending the knees.

#### 2. Squat Jumps

- Subjects are asked to stand with feet slightly wider than hip and asked to lower the body to squat down.
- Then the subjects were asked to jump while lifting their arms overhead as they jump engaging the abs and Upon landing, they are asked to back down to the squatting position.

#### 3. Hopping for a Distance

- Subjects were asked to stand upright with a single leg and then hop to a distance.
- They were asked to start with a shorter distance and speed and then progress gradually.
- Perform with both left and right foot separately.

#### 4. Diagonal Hop

- Subjects were asked to stand with feet shoulder width apart.
- Take a step diagonally forward to the right with the right foot.

- Then hop diagonally to the left landing on the left foot.
- Focus on proper landing.
- Again, start with a shorter distance and speed and progress gradually.

### Control Group(Proprioception exercise)

Repetitions: 30 seconds – 1 minute hold;

3-4 sets/session

#### 1. Heel to Toe Stand (Tandem Stance)

- Subjects were asked to place hands on the hip and bring the heel of one foot touching the toes of the other foot in a straight line.
- Then they were asked to hold the position for 15 to 30 seconds. Subjects were asked to have a rest and repeat thrice and repeat for the opposite leg.
- Slowly progress by lifting both arms overhead, increasing hold time and by closing eyes.

#### 2. Single Leg Stand

- Place hands on the hip.
- Subjects were asked to stand with balance on a single leg keeping the other leg slightly lifted off the floor.
- Hold this position for 20 to 30 seconds. Progress slowly by increasing the duration, standing on a pillow and closing eyes.

#### 3. Ball Catching with single leg stance

- Subjects were asked to stand on a single leg.
- The person is thrown first gently that aims close to the body and slowly progresses to throwing harder and aiming slightly further off the body.
- Balance and catch the ball. This is continued for 30 seconds to 1 minute and performed up to 2 to 3 sets per session.
- Difficulty can be improved based on the ability to balance by standing on a pillow.

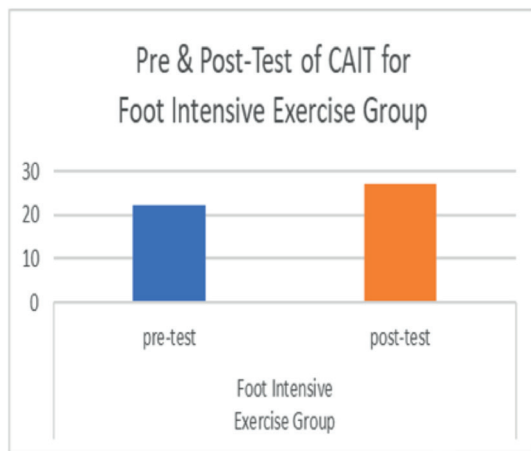
#### 4. Star Excursion Exercise

- Subjects were asked to stand in the center of the star with hands placed on the hips where tape is placed on the floor on a star pattern separated by a 45 degree angle.

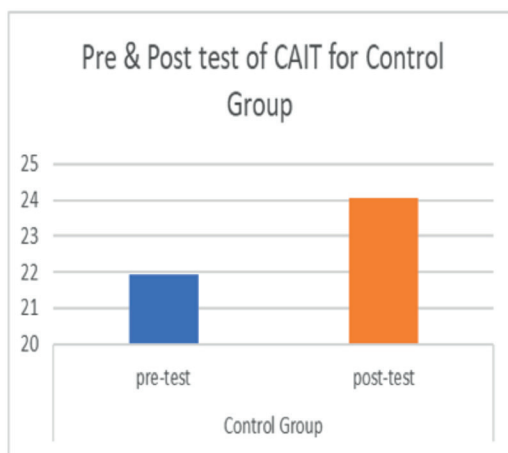
- Balancing with one leg, start touching the line in front as much as you can and return to the starting point allowing the suspended leg to touch the ground.
- Reach each line clockwise. Then repeat anticlockwise.
- 3 sets can be performed by alternating the legs.

**Data Analysis**

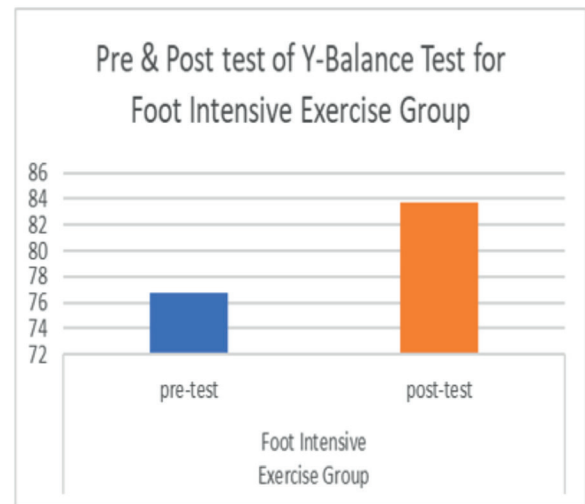
Using tabular and inferential statistics, the gathered data was evaluated. The mean and standard deviation (SD) were utilized for all parameters. The statistically significant differences between pre-test and post-test measures were examined using a paired t-test. When utilizing the unpaired t-test to look at significant changes in the experimental group, the significance level of  $p < 0.0001$  was determined to be statistically significant.



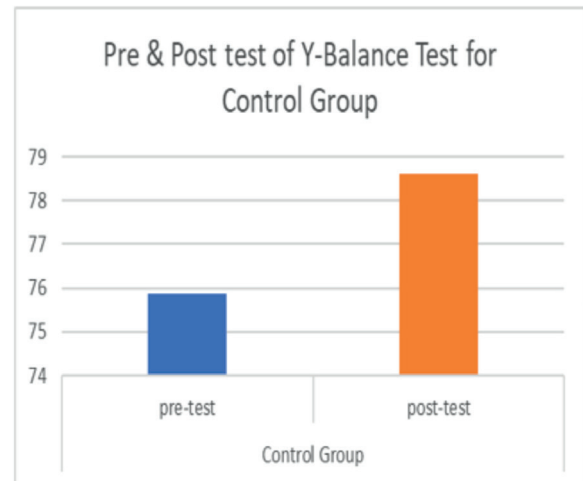
**Fig-1 Pre-test and post-test values of CAIT for Foot Intensive Exercise Group**



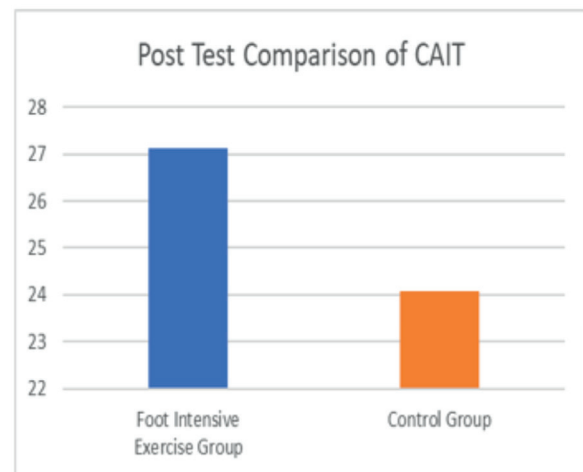
**Fig-2 Pre-test and post-test values of CAIT for Control Group**



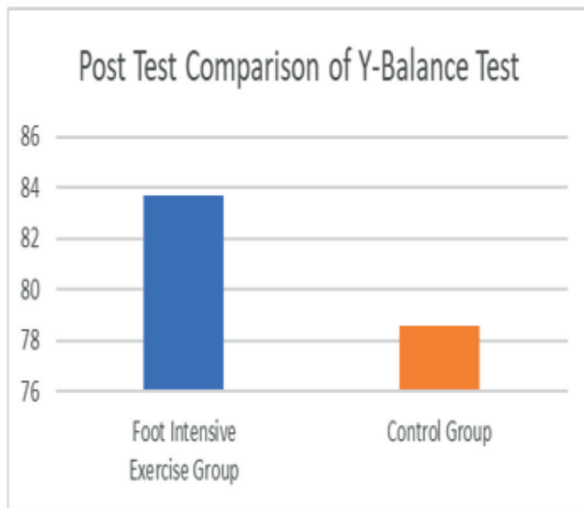
**Fig-3 Pre-test and post-test of Y-Balance Test for Foot Intensive Exercise Group**



**Fig-4 Pre-test and post-test of Y-Balance Test for Control Group**



**Fig-5 Post-test Comparison of CAIT for both groups**



**Fig-6 Post-test Comparison of Y-Balance Test for both groups**

### Result

As needed descriptive statistics, mean and SD were calculated. All p values were considered as statistically significant using paired t-test. The statistical analysis compares the post-test mean values of CAIT with 27.13 and 24.07 in Foot Intensive Exercise Training and Control Group respectively and post-test mean values of Y-Balance Test with 83.67 and 78.6 in Foot Intensive Exercise Training and Control Group respectively.

As a result of statistical analysis, the p value shows that both Foot Intensive Exercise group and Control Group are effective, however the values of Foot Intensive Exercise group were found to be slightly higher and showed significant effect of pain and functional outcome in subjects with chronic ankle sprain.

### Discussion

The motive of the study was to find the efficacy of foot intensive rehabilitation for individuals with chronic ankle sprain by comparing the efficacy of foot intensive exercise and proprioception training. Ankle sprains are recurrent or common amongst active individuals and athletes. A larger population who have experienced ankle sprains have various symptoms which comprise episodes of giving away, pain, re-injury, affected proprioception leading to chronic ankle instability. Recurrent ankle sprains

may develop into CAI or early osteoarthritis. 8 Ankle sprains have seemed to occur during the foot loading and unloading. Sprains are marked by internal twisting while the tibiotalar joint in plantarflexion. Beginning a physical therapy session early is important to reduce and control pain, to maintain and also improve ROM.<sup>15</sup>

Previous study has shown that a 6-week intervention comprising core stability, gluteal strengthening, and proprioception training have improved dynamic balance in the athletic population. Neuromuscular training program and single limb proprioceptive regimen reduces the evidence of ankle injury by 30% to 45%. This gives quality management post ankle sprains in decreasing the risk of acquiring chronic ankle instability.<sup>16</sup> A study showed a reduction in recurrent injuries by increasing the exercise session volume. A study also showed that subjects that received four training sessions were found to be superior to the subjects that received two training sessions. Rehabilitation program shows reduction in the risk of re-injury or reoccurring ankle sprain by 40% when compared to the Standard of Care (SOC). McKeon et al said that focused dynamic postural control training regimen sessions resulted in 20% to 60% relative reduction in risk for lateral ankle sprain, mostly in the athletic population having continuous history of ankle sprain. It also showed that neuromuscular training has shown success in the reduction in the risk of ankle sprain.<sup>17</sup> Paterno et al. showed that a neuromuscular program which comprises dynamic stability and plyometric training showed improvement in postural sway in anteroposterior direction whilst moving. Furthermore, Salezadeh et al. reported that a combined session of strength training, stability, and plyometric training have shown to improve anteroposterior balance. strengthening muscle around the ankle joint improves proprioception and kinesthetic feedback which has promising improvements in stability and postural control.<sup>18,24</sup>

McKeon and Wikstrom et al have shown improvement in single leg balance in subjects with CAI with plantar massage and also showed activation of the cutaneous plantar receptors. Joint mobilization with or without movement, manipulation improves dorsiflexion, ankle strength and balance. Manual

therapy as treatment protocol will have increased regulation or activation of the somatosensory receptors which in turn will reduce pain, enhance stability, dynamic balance and function of the ankle.<sup>19,20</sup> Studies report that functional stability of the ankle is related to loss in dynamic postural control and also shows that this is the reason for the etiology of ankle re-injury.<sup>21</sup> Furthermore, Mattacola and Dwyer concluded that the Ankle stability Exercise program which incorporates a series of strengthening and proprioception exercises for the ankle has enhanced dynamic balance. Hence dynamic balance control was shown significant improvement in ankle stability exercise.<sup>22</sup> Plyometric exercise regimen uses a short-stretching concept to desensitize the Golgi tendon organs, allowing the elastic components of the muscles to tolerate stretching more efficiently. Plyometric training involves repetitive jump landings that maximize hamstring activation, resulting in higher knee and hip joint flexion.<sup>23</sup> Preceding to plyometric training, Voigt et al. (1998) made an observation which shows greater soleus H-reflex during hopping exercise, which is attributed to more automatic control techniques which is being used during jumping sessions and less voluntary activation. Because of this, Plyometric training on a large scale may improve spinal reflex activity rather than voluntary activation, in contrast to pneumatic power training.<sup>25</sup>

### Conclusion

The aim of this study was to evaluate the effectiveness of Foot Intensive Exercise over proprioception training in subjects with chronic ankle sprain. From the collected data it has been proved that Foot Intensive Exercise is effective and increases functional ankle stability and decreases episodes of giving away in subjects with chronic ankle sprain.

**Ethical Clearance:** The ISRB committee of a private hospital and institution in Chennai has provided its clearance for the conduct of human research that complies with all applicable national laws, institutional regulations. (Application Number 03/071/2022/ISRB/SR/SCPT).

**Funding:** This study is a self-funded study.

**Conflict of Interest:** Nil

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