



(RESEARCH ARTICLE)



EFFECTIVENESS OF PROPRIOCEPTIVE TRAINING VERSUS FOOT INTENSIVE REHABILITATION IN ATHLETES WITH CHRONIC ANKLE INSTABILITY

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ABSTRACT

Background: Chronic ankle instability (CAI) is a common condition following repeated ankle sprains, characterized by persistent pain, instability, and recurrent injuries. Effective rehabilitation strategies are essential to restore function and prevent further damage. This study aimed to compare the effectiveness of proprioceptive training and foot intensive rehabilitation for athletes with chronic ankle instability

Methods: Experimental study. A total of 70 participants with diagnosed chronic ankle instability, 60 of them met the selection of criteria and were randomly assigned into two groups: Group A, 30 individuals received a proprioceptive training program, while Group B, 30 individuals underwent a foot intensive rehabilitation protocol for six weeks. Outcome measures included the Cumberland Ankle Instability Tool (CAIT), Y balance test, evaluated pre- and post-intervention.

Results: Both groups showed significant improvements within their respective interventions ($p < 0.05$). However, Group B demonstrated a significantly greater improvement in all outcome measures compared to Group A ($p < 0.01$). The foot intensive rehabilitation protocol was particularly effective in enhancing sensorimotor control, intrinsic foot muscle strength, and dynamic postural stability.

Conclusion: Foot intensive rehabilitation produced superior outcomes compared to proprioceptive training in individuals with chronic ankle instability. The findings suggest that targeted foot strengthening and functional retraining should be prioritized in rehabilitation programs for CAI. These results are statistically significant ($p < 0.01$) and support the implementation of foot-focused strategies in clinical practice.

Keywords: Chronic Ankle Instability, Proprioceptive Training, Foot Intensive Rehabilitation, Y Balance Test, Cumberland Ankle Instability.

1 INTRODUCTION

Chronic ankle instability (CAI) is characterized by recurrent episodes or the sensation of the ankle “Giving way,” along with persistent symptoms such as pain, weakness, reduced range of motion (ROM), decreased self-reported function, and repeated ankle sprains lasting more than one year after the initial injury. Lateral ankle sprains (LAS) are the most common injuries occurring during sports and physical activities.¹ An ankle sprain typically involves injury to the lateral ligaments due to rapid inversion and internal rotation of the ankle.²

CAI is often associated with complications such as ankle osteoarthritis and may lead to both mechanical and functional instability of the ankle joint.³ Impaired proprioceptive input from the ankle contributes significantly to instability, affecting balance and overall postural control. Acute LAS can cause primary damage to lateral ligaments, leading to Patho mechanical changes, altered motor behavior, and sensory-perceptual deficits.¹

The incidence of CAI is approximately 25%, and its prevalence among individuals with LAS is around 46% within the 40% who have experienced such injuries. CAI is most frequently observed in athletes aged 15–32 years.³ Ankle sprains occur at a rate of about 7 per 1000 person-years in the general population and 45 per 1000 person-years in athletes. Several risk factors contribute to ankle sprains, including reduced strength, abnormal BMI, anatomical variations, foot posture, female gender, and pre-existing instability. Additional contributing factors include ligament laxity, decreased dorsiflexion, hindfoot varus alignment, impaired neuromuscular control, altered gait patterns, and strength deficits.^{4,5}

Instability in CAI can be classified as mechanical or functional. Mechanical instability arises from ligament laxity, whereas functional instability is related to deficits in postural control, neuromuscular coordination, muscle strength, and proprioception.^{6,7,8} Freeman et al. highlighted the importance of proprioceptive dysfunction following ligament injury as a key factor in CAI development.⁹

Common symptoms include pain, swelling, tenderness, reduced ROM, weakness, and decreased functional ability.³ Diagnostic approaches include imaging techniques such as radiography, MRI, CT scans, and ultrasonography, along with nerve conduction studies. MRI is particularly useful in predicting the development of CAI following an initial sprain, while radiographs are typically used during initial evaluation.^{10,4}

Assessment of CAI focuses on stability and balance. The Star Excursion Balance Test (SEBT) is widely used to evaluate dynamic stability and injury risk, while the Y Balance Test serves as a modified alternative.^{11,12} The Cumberland Ankle Instability Tool (CAIT), a validated 30-point questionnaire, is commonly used to assess the severity of functional ankle instability due to its reliability and ease of use.¹³

CAI results from a complex interaction of mechanical insufficiencies and functional deficits, leading to repeated injuries and chronic dysfunction.¹⁴ Rehabilitation programs are therefore essential and typically include exercises targeting ankle mobility, muscle strengthening, proprioception, and agility.¹⁵ Evidence supports the effectiveness of interventions such as balance training, joint mobilization, resistance exercises, soft tissue techniques, and stretching in improving motor function in individuals with CAI.¹⁶

Proprioceptive training plays a central role in rehabilitation by enhancing joint position sense, balance, and neuromuscular control.¹⁷ Such training often involves wobble boards, controlled instability exercises, and dynamic balance tasks to improve afferent feedback and motor coordination.¹⁸ Studies have shown that tailored proprioceptive programs significantly improve stability and reduce re-injury rates in both adolescents and adults with CAI.^{19,20} Kwon et al. emphasized the importance of combining strength and proprioceptive exercises to improve both static and dynamic stability.²¹

Recently, foot intensive rehabilitation (FIRE) programs have emerged as a promising approach for CAI management. The FIRE model, proposed by Hoch et al., focuses on the entire foot complex, promoting superior neuromuscular adaptations compared to traditional balance training.²² It emphasizes intrinsic foot muscle activation and plantar sensory stimulation, improving sensorimotor function and quality of life.²³⁻²⁵

Despite growing evidence supporting both proprioceptive training and FIRE programs, further research is needed to determine which approach is more effective in improving stability and balance while reducing ankle instability. Therefore, the present study aims to compare the effectiveness of proprioceptive training and foot intensive rehabilitation in athletes with CAI, providing evidence-based recommendations for enhancing ankle stability, preventing injuries, and improving athletic performance.

2 METHODOLOGY

2.1 Study Design

Experimental Study

2.2 Study Setting

70 subjects who were diagnosed with chronic ankle instability were selected from the out-patient department of KIMS college of physiotherapy

2.2.1 Ethical clearance form

The study protocol approved by Ethical Committee of KIMS College Of Physiotherapy, amalapuram. The Procedure of the study was explained to the study population and subject information sheet were given. The participants were requested to provide their consent to participate in the study. All the participants signed the informed consent and the rights of included participants have been secured

2.2.2 Study period

1 Year (JULY 2024 TO JUNE 2025) **TREATMENT DURATION :6 WEEKS**

2.2.3 Sampling method

CONVENIENT SAMPLING

2.2.4 Sampling size

A Total of 70 Subjects were initially recruited for the study. Of these ,5 were dropped out and other 5 declined to participate in the study, leaving 60 subjects for final analysis. These participants allocated into two groups of 30 each.

Table 1: Distribution of Study Participants According to Group and Treatment

Groups	NO. OF SUBJECTS	TREATMENT
Group A	30	Proprioceptive training
Group B	30	Foot intensive rehabilitation training

- **INCLUSION CRITERIA** - Participants must be between the ages of 18 and 25, be male or female, have a history of more than one ankle sprain, and have experienced more than two instances of "Giving way" in the previous three months.
- **EXCLUSION CRITERIA**-A history of lower limb surgery, a recent ankle sprain within four weeks, neurological, vestibular, or ocular diseases impacting sensorimotor function, and lower extremity injuries within the previous 12 months

2.3 Outcome Measures

- CAIT to assess stability
- Y Balancing test to assess balance

3 INTERVENTION PROTOCOL

3.1 Group A – Proprioceptive Training:

Ankle proprioception is an important component of balance, as it enables the adjustment of ankle position to effectively perform multi motor tasks and plays a vital role in balance control. To improve balance and proprioception, proprioceptive training is provided to athletes with chronic ankle instability. Proprioceptive training refers to exercises aimed at improving both static and dynamic balance by enhancing proprioceptive receptor function, which positively influences joint stability during various tasks. These protocols include single-leg balance (forward and backward), squats, dorsiflexion, plantar flexion, weight-bearing positions on unstable surfaces, and hop-to-stabilization exercises.^{29,32,33,34} Proprioceptive exercises help improve stability, balance, and proprioception in patients with CAI

3.1.1 Dosage: 3 sets of 15 repetitions, 1-minute rest between sets, 30 minutes per day, 4 times per week for 6 weeks



Figure 1: Single leg balance with forward and backward movement



Figure 2: SQUAT



Figure 3: Dorsiflexion and plantar flexion



Figure 4: Hypo Stabilization



Figure 5: Weight Bearing Posture On Unstable Surface

3.2 Group B – Foot Intensive Rehabilitation (FIRE)

FIRE intervention improves both static and dynamic postural control while reducing the frequency of ankle sprains, episodes of ankle giving away, and the intensity of symptoms. • These consist of a number of activities such as plantar massage, range-of-motion exercises, foot muscle activation, strengthening exercises, and balance training.

- Dosage: 3 sets of 15 repetitions, 4 times per week for 6 weeks.

3.3 Ankle strengthening

Patient in the high sitting position. Patients were asked to do the ankle ROM'S (ankle dorsiflexion, plantar flexion, inversion, eversion) while giving resistance with the resistance bands. Patients will use heavy bands at first 2 weeks and increasing resistance for every 2 weeks. The dorsiflexion and plantarflexion muscle strengths were trained in a dorsiflexion/plantarflexion movement pattern, whilst the ankle invertor and evertor muscle strengths were trained in an inversion/eversion movement pattern.^{35,36,37}



Figure 6: A) Plantar Flexion B) Dorsiflexion



Figure 6: C) Inversion D) Eversion

3.4 Balance training:

- **Static:** Patient in the standing position. Patient instructed to do single limb stance from bilateral standing position on each limb with eyes open and closed on firm and foam surfaces. Patients stood still with the opposite limb raised, and any touchdown or loss of posture during the 10-second trial resulted in repeating the attempt.^{20,28}
- **Dynamic:** patient instructed to do single limb hops to stabilization, hops to stabilization and reach, and unanticipated hops to stabilization. ^{22,40}



Figure 7: A) Single leg stance on right leg with open and close eyes firm and foam surface



Figure 7: B) Single leg stance with left leg with open and close eyes on firm and foam surface

3.5 Plantar soft tissue manipulation

- This technique involves combination of effleurage and petrissage to the entire plantar aspect while the patient in the supine position.
- It helps to increase the single limb balance in patients with CAI.
- **Dosage:** for 1 min with 1 min rest between sets.²⁴



Figure 8: Effleurage

- **Foot muscle activation:** Intrinsic foot muscle (IFM) helps to transmit or attenuate the force during locomotion. IFM deficit seen in the patients with CAI. ³⁴

IFM exercise program includes toe spread out, first toe extension, second to fifth toe Extension exercises.

This exercise program performed in 3 positions 1) sitting position 2) standing position.³³ 3) one leg standing position.^{25,38}



Figure 9: Toe Spread Out

3.6 Conventional physiotherapy

Conventional physiotherapy was given for all the participants in group A and B, treatment was thermotherapy, electrotherapy, brace, taping

3.7 Statistical analysis

Data were analyzed using SPSS version 21.0. Descriptive statistics were expressed as mean and standard deviation. Within-group comparisons were analyzed using paired t-test, and between-group comparisons using unpaired t-test. A p-value < 0.05 was considered statistically significant.

4 RESULTS

The study included a total of 60 participants, with 30 subjects in each group.

The Y-Balance Test values measured after the intervention showed significant improvement compared to pre-test values in both groups ($p < 0.001$). However, Group B (Foot Intensive Rehabilitation) demonstrated greater improvement in dynamic balance when compared to Group A (Proprioceptive Training alone) (Table 3).

Similarly, the Cumberland Ankle Instability Tool (CAIT) scores showed significant improvement in both groups following the intervention ($p < 0.001$). Group B showed a significantly higher improvement in ankle stability and functional outcomes compared to Group A.(table 4)

Overall, both interventions were effective in improving balance and ankle stability in patients with chronic ankle instability. However, Foot Intensive Rehabilitation was found to be more effective than Proprioceptive Training alone in enhancing dynamic balance and reducing ankle instability

Table 1: Analysis of pre and post mean value of group a and group b and group a and b

GROUP A	mean	SD	T VALUE	P VALUE z
CAIT PRE TEST	17.5	2.3	2.00175	<0.001
CAIT POST TEST	25.8	1.7		

The above table shows pre and post mean value of CAIT in group A , group B and group A and B with T value 2.00175 and P value <0.05

Table 2: Analysis of pre and post mean value of y balance (anterior) - group a and group b and group a and b

GROUP A	MEAN	SD	T VALUE	P VALUE
Y BALANCE ANTERIOR PRE TEST VALUES	51	6.8	2.00172	<0.001
Y BALANCE ANTERIOR POST TEST VALUES	71.3	6.7		

GROUP B	MEAN	SD	T VALUE	P VALUE
Y BALANCE ANTERIOR PRE TEST VALUES	50.5	5.9	2.00172	<0.001
Y BALANCE ANTERIOR POST TEST VALUES	76.2	6		

The above table shows pre and post mean value of Y BALANCE (ANTERIOR) in group A , group B and group A and B with T value 2.00172 and P value <0.05 TABLE 3 :

Table 3: Analysis of pre and post mean value of y balance (posteromedial) - group a and group b and group a and b

GROUP A	MEAN	SD	T VALUE	P VALUE
Y BALANCE POSTEROMEDIAL PRE TEST VALUES	43	5.7	2.00172	<0.001
Y BALANCE POSTEROMEDIAL POST TEST VALUES	65.1	5.9		

GROUP B	MEAN	SD	T VALUE	P VALUE
Y BALANCE POSTEROMEDIAL PRE TEST VALUES	41.4	3.5	2.00172	<0.001
Y BALANCE POSTEROMEDIAL POST TEST VALUES	67.9	5		

The above table shows pre and post mean value of Y BALANCE ; (POSTEROMEDIAL) in group A , group B and group A and B with T value 2.00172 and P value <0.05

Table 4: Analysis of pre and post mean value of y balance (posterolateral) - group a and group b and group a and b

GROUP A		MEAN	SD	T VALUE	P VALUE
Y	BALANCE POSTEROLATERAL PRETEST VALUES	51.8	6.3	2.003	<0.001
Y	BALANCE POSTEROLATERAL POST TEST VALUES	74.1	6.5		

GROUP B		MEAN	SD	T VALUE	P VALUE
Y	BALANCE POSTEROLATERAL PRETEST VALUES	54.1	5.5	2.003241	<0.001
Y	BALANCE POSTEROLATERAL POST TEST VALUES	82.6	6.8		

The above table shows pre and post mean value of Y BALANCE ; (POSTEROLATERAL) in group A , group B and group A and B with T value 2.00324 and P value <0.05

5 DISCUSSION

The purpose of this study was to evaluate the efficacy of foot-intensive therapy and proprioceptive training in enhancing ankle stability and balance in individuals with persistent ankle instability. Following group A's proprioceptive training intervention, the ankle's stability (as determined by the CAIT questionnaire) and balance (as determined by the balancing test) significantly improved.

Proprioceptive training is one of the most effective exercise regimens used in CAI therapy to restore ankle stability and body balance, both of which are typically compromised by recurrent ankle sprains¹⁰. Proprioceptive training improves joint position awareness and sensory motor integration. Afferent sensory feedback from mechanoreceptors in the ankle joint and the soft tissues around it is improved by proprioceptive training. The likelihood of the ankle "giving way" is decreased as a result of quicker and more coordinated neuromuscular responses during disturbances¹¹.

Following Group B's intervention, there was a significant improvement in balance (Y Balance test) and a reduction in instability (CAIT). Foot-intensive rehabilitation (FIRE) significantly improved the Y balance test scores of people with chronic ankle instability.

Restoring the structural and functional capabilities of the foot and ankle complex is the aim of footintensive rehabilitation (FIRE), a structured therapeutic approach. Both motor and sensory therapy are impacted by the FIRE regimen.

Additionally, in patients with chronic ankle instability, strengthening both intrinsic and extrinsic muscles is crucial for reducing ankle instability because it enhances dynamic postural control, restores proprioceptive input, and improves foot alignment and arches while lowering recurrent sprains or ankle giving away^{17–19}.

According to Matthew C. Hoch et al., foot intensive rehabilitation training improves sensorimotor function, muscular activation, and toe flexion strength through targeted interventions. FIRE might enhance balance and stability⁸. In terms of CAIT outcome measures, foot intensive rehabilitation training (Group B) produced significant improvements in the CAIT questionnaire.

This improvement in the outcome measure suggests that athletes associated with CAI have significantly improved stability and balance.

More recent study lends support to the rationale for Group B's dominance. Strength with balance training significantly improves postural control and functionality more than balance training alone, as Su et al. showed in a thorough systematic review and meta-analysis²¹.

This finding is consistent with the design and results of the FIRE program used in this study.

6 CONCLUSION

Chronic Ankle Instability (CAI) is a common and functionally limiting condition resulting from repeated ankle sprains, leading to deficits in balance, proprioception, and neuromuscular control. This study compared the effectiveness of two

intervention strategies: proprioceptive training (Group A) and foot intensive rehabilitation (Group B) in individuals with CAI.

Both groups demonstrated statistically significant improvements in ankle function and stability following the intervention. However, **Group B, which received foot intensive rehabilitation, showed significantly greater improvements than Group A ($p < 0.01$)**. This suggests that a targeted approach focusing on strengthening the intrinsic foot musculature, enhancing sensorimotor feedback, and improving foot core stability provides more effective outcomes in managing CAI than proprioceptive training alone.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

Statement of ethical approval

The study was approved by the Institutional Ethics Committee of KIMS College of Physiotherapy, Amalapuram.

Statement of informed consent

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

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