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COMPARATIVE STUDY OF SHORT FOOT EXERCISES AND ECCENTRIC TRAINING ON ANKLE INSTABILITY AMONG FOOTBALLERS

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ABSTRACT

Background: Chronic Ankle Instability (CAI) often develops following recurrent lateral ankle sprains, particularly in footballers exposed to high-impact multidirectional movements. It is associated with mechanical laxity, functional instability, proprioceptive deficits, and recurrent injuries, which impair performance and increase long-term disability risk. Rehabilitation commonly targets neuromuscular control, with Short Foot Exercises (SFE) improving intrinsic foot muscle activation and Eccentric Training (ET) strengthening muscle-tendon units. However, comparative evidence in athletic populations remains scarce.

Objective: To compare the effectiveness of SFE and ET in improving ankle stability among footballers with CAI.

Methods: Forty male footballers (18–30 years) with unilateral CAI were randomized into two groups (n=20). Group A performed SFE, while Group B followed Alfredson's eccentric heel-drop program targeting the gastrocnemius-soleus and peroneal muscles. Interventions were conducted for eight weeks. Outcome measures included the Navicular Drop Test (NDT), Foot Posture Index (FPI), and

Functional Foot Index (FFI), assessed pre- and post-intervention. Statistical analysis used paired and independent t-tests.

Results: Both groups demonstrated significant within-group improvements ($p<0.001$). Between groups, ET produced greater improvements in navicular drop ($p=0.007$) and functional performance ($p=0.02$), while FPI changes were not significant ($p=0.08$).

Conclusion: Both interventions effectively improved ankle stability and foot function in footballers with CAI. However, eccentric training showed superior outcomes in dynamic control and functional performance. Integrating eccentric loading and intrinsic foot strengthening may enhance rehabilitation and injury prevention in high-demand sports settings.

Keywords: Chronic ankle instability, footballers, short foot exercises, eccentric training, navicular drop, functional rehabilitation

INTRODUCTION:

Ankle injuries, especially lateral ankle sprains, are among the most common musculoskeletal problems in footballers due to the sport's high-intensity, multidirectional, and contact-driven nature; repeated episodes often lead to chronic ankle instability (CAI), a prevalent and functionally limiting condition in this athletic population **[1]**. CAI is marked by recurrent episodes of the ankle "giving way," reduced proprioceptive feedback, and impaired neuromuscular control, significantly impacting athletic performance and increasing the risk of re-injury **[2, 3]**. In football, dynamic movements such as cutting, sprinting, jumping, and rapid changes in direction subject the ankle joint complex to repeated mechanical stress, predisposing athletes to instability.

The ankle-foot complex plays a vital role in weight-bearing and locomotion, comprising the talocrural joint (formed by the tibia, fibula, and talus) and the subtalar joint (between the talus and calcaneus), which together facilitate dorsiflexion, plantarflexion, inversion, and eversion **[4]**. This complex is stabilized by a combination of passive structures such as the lateral ligament complex, particularly the anterior talofibular ligament (ATFL) and active structures, including muscles and tendons. The ATFL is most commonly injured during forced inversion and plantarflexion, mechanisms frequently encountered in football **[5]**. Repetitive sprains compromise the integrity of these ligaments, leading to mechanical instability and functional limitations. Additionally, the peroneal muscles, key dynamic stabilizers on the lateral aspect of the ankle, often exhibit delayed activation and reduced strength in individuals with chronic ankle

instability (CAI), further diminishing joint stability and proprioceptive feedback **[6]**.

From a biomechanical perspective, the foot functions both as a rigid lever during propulsion and a shock absorber during impact. Dysfunction of intrinsic foot muscles including the flexor hallucis brevis, abductor hallucis, and quadratus plantae can weaken the medial longitudinal arch, impair balance, and contribute to faulty postural alignment **[7]**. CAI disrupts the sensorimotor system, leading to impairments in proprioception, joint position sense, and neuromuscular control. These deficits affect body's ability to detect foot placement and respond effectively to perturbations, resulting in postural instability and increased reliance on visual and vestibular input **[8]**.

Athletes with CAI commonly present with altered kinematics and kinetics, including excessive rearfoot eversion, increased navicular drop, and delayed peroneal muscle response, all of which interfere with normal foot function and load distribution during gait and sport-specific activities. These compensatory mechanisms can propagate further dysfunction by increasing stress on adjacent joints and tissues **[3]**.

Short Foot Exercises (SFE) are specifically designed to activate and strengthen the intrinsic muscles of the foot, primarily abductor hallucis, flexor digitorum brevis, and flexor hallucis brevis without engaging the toes. These muscles play a crucial role in maintaining the medial longitudinal arch, enhancing foot posture, and providing stability during weight-bearing activities **[10, 11]**. By targeting these underutilized muscles, particularly in individuals with chronic ankle instability (CAI), SFE helps improve plantar proprioception, postural control, and dynamic balance **[12]**. Improved neuromuscular control of the foot contributes to more effective load distribution and responsiveness during movement, which is especially beneficial for athletes such as footballers who rely on rapid directional changes and single-leg stability. The foot's intrinsic muscle system functions as a core stabilizer, and enhancing its strength through SFE has been shown to reduce compensatory movement patterns and mitigate instability, making it a valuable intervention in both rehabilitation and injury prevention programs.

Eccentric training, which emphasizes controlled muscle lengthening under load, is widely recognized for its role in enhancing tendon stiffness, muscular strength, and neuromuscular adaptation **[13]**. In ankle rehabilitation, eccentric exercises targeting the peroneus longus and brevis, gastrocnemius-soleus complex, and tibialis anterior are particularly effective in strengthening the active stabilizers that counteract excessive inversion forces and

contribute to joint integrity **[14]**. This form of training improves dynamic stability, deceleration control, and muscle-tendon resilience, which are essential for high-speed movements and rapid directional changes common in football. Furthermore, eccentric loading enhances the efficiency of the stretch-shortening cycle, a critical mechanism for generating explosive power during sprinting, jumping, and cutting actions **[15]**. As such, eccentric training not only aids in the rehabilitation of chronic ankle instability (CAI) but also serves as a preventive strategy by improving functional performance and reducing the risk of re-injury in athletes.

Although both interventions show individual promise in addressing ankle instability, few studies have directly compared their relative effectiveness in footballers with CAI. Given the sport-specific demands and high prevalence of instability reported as ranging from 18.4% to 73% among Indian footballers **[16]** there is a clear need to identify the most effective rehabilitative strategy.

Objectives of the Study

1. To assess the effect of short foot exercises on ankle stability and foot function using the Navicular Drop Test (NDT), Functional Foot Index (FFI), and Foot Posture Index (FPI).
2. To evaluate the impact of eccentric training on the same outcome measures.
3. To compare both interventions in improving navicular drop control, foot posture, and functional outcomes among footballers with ankle instability.

MATERIALS AND METHODS:

Study Design: This was a comparative study conducted over a duration of 8 weeks, aiming to evaluate and compare the effectiveness of Short Foot Exercises (SFE) and Eccentric Training (ET) on functional outcomes in footballers with chronic ankle instability (CAI).

Sample Size & Participants: A total of 40 male football players, aged 18–30 years, were recruited for the study and randomly assigned into two equal groups of 20 participants each. All subjects provided written informed consent before participation.

Materials Used: Navicular Drop Test (NDT) setup (ruler/Vernier caliper), Foot Posture Index (FPI-6), Functional Foot Index (FFI) questionnaire, Exercise mats, Chairs/benches, Step/raised platform, Weighted backpack, Stopwatch, Recording sheets

Participants included male footballers aged 18–30 years with unilateral chronic ankle instability, a history of more than one lateral ankle sprain in the past two years,

recurrent ankle "giving way," a CAIT score above 23, and positive anterior drawer or talar tilt tests, with informed consent provided. Exclusion criteria were recent ankle injury (within six weeks), balance or vestibular disorders, lower limb fractures, prior ankle, knee, or hip surgery, head injury, psychiatric illness, cardiorespiratory conditions, exercise-limiting muscle soreness, or negative results on both ligament integrity tests.

Intervention Protocol

Group A: Short Foot Exercises (SFE)

Participants in Group A performed short foot exercises focusing on activation of the intrinsic foot muscles by drawing the head of the first metatarsal towards the heel without toe flexion.

- Weeks 1–4: Exercises performed in a seated position
- Weeks 5–8: Progressed to standing and single-leg stance
- Each session included 3 blocks of 12 repetitions, with a 5-second hold per repetition, and 2 minutes of rest between blocks
- Exercises were performed 3 times per week for 8 weeks under physiotherapist supervision

Group B: Eccentric Training (ET)

Participants in Group B followed Alfredson's eccentric heel-drop protocol:

- Two variations:
  - ✓ Straight-knee (targeting the gastrocnemius)
  - ✓ Bent-knee (targeting the soleus)
- Each variation performed as 3 sets of 15 repetitions, twice daily for 8 weeks
- Exercises began using body weight, with progressive overload added using a weighted backpack as tolerated
- The non-injured leg was used to return to the starting position, emphasizing eccentric contraction of the affected side
- Participants were instructed to stop only if severe pain occurred; mild soreness was considered normal

Outcome Measures:

Assessments were conducted at baseline and after 8 weeks of intervention.

Navicular Drop Test (NDT): To assess changes in medial longitudinal arch height

The Navicular Drop Test assesses the mobility of the medial longitudinal arch by measuring the displacement of the navicular bone from a non-weight-bearing to a weight-bearing position, reflecting midfoot pronation and arch control. The participant sits with the subtalar joint in neutral, and the vertical distance from the navicular tuberosity to the ground is

recorded. The measurement is repeated in a relaxed standing position. The NDT has demonstrated good intra- and inter-rater reliability (ICC = 0.73–0.91) and construct validity in evaluating foot posture and arch function **[19]**.

Foot Posture Index (FPI): To evaluate static foot posture across six parameters

The Foot Posture Index is a visual assessment tool used to classify foot posture as neutral, pronated, or supinated based on six anatomical criteria observed in a relaxed standing position. Each of the six criteria is scored from -2 to +2, generating a composite score ranging from -12 (highly supinated) to +12 (highly pronated). FPI-6 shows excellent intra-rater (ICC = 0.94) and inter-rater reliability (ICC = 0.90), and is supported by strong criterion and construct validity in clinical and research settings **[20]**.

Functional Foot Index (FFI) – To measure pain, disability, and activity limitation associated with foot dysfunction

The Functional Foot Index is a patient-reported outcome tool that quantifies the impact of foot pathology on pain, disability, and activity limitation during daily and sports-related activities. Participants respond to 23 items across three subscales—pain, disability, and activity limitation—rated on a Likert scale. Scores are converted into a percentage, with higher values indicating greater impairment. The FFI has demonstrated high internal consistency (α = 0.96) and excellent test-retest reliability (ICC = 0.87–0.89), with well-established construct and criterion validity **[21, 22]**.

Procedure: The study was conducted following ethical clearance from the Institutional Ethics Committee. Participants were recruited according to predefined inclusion and exclusion criteria. Prior to enrolment, all eligible subjects received detailed information regarding the study's purpose, procedures, potential benefits, and possible risks, and written informed consent was obtained from each participant before any study-related procedures commenced. After screening, the eligible participants were randomly assigned into two groups of 20 each—Group A and Group B—using a simple random sampling method. The outcome measures included pain intensity, assessed with the Numerical Pain Rating Scale (NPRS), and functional ability, evaluated using the Shoulder Pain and Disability Index (SPADI).

Statistical Analysis: Data were analyzed using SPSS 25.0 software. Descriptive statistics were used to summarize baseline characteristics. Paired t-tests were applied within groups to assess pre- and post-intervention differences, while independent t-tests compared outcomes between the two groups. A p-value < 0.05 was considered statistically significant

RESULTS:

The demographic data presented in **Table 1** shows that the mean age of participants in Group A (Short Foot Exercises) was 24.35 ± 2.95 years, while in Group B (Eccentric Training), it was 23.95 ± 2.68 years. The close similarity in age distribution between the two groups indicates that participants were well-matched demographically at baseline.

This pie chart illustrates (**Chart 1**) the mean age distribution of participants in the two groups. Group A, which performed Short Foot Exercises (SFE), had a mean age of 24.35 years, while Group B, which underwent Eccentric Training (ET), had a mean age of 23.95 years. The chart shows that the average ages of both groups are very similar, indicating that the groups were age-matched and comparable, which reduces age-related bias in interpreting the outcomes of the study.

Both Group A (Short Foot Exercises) and Group B (Eccentric Training) showed significant improvements in all outcomes ($p = 0.001$ within groups). In the Navicular Drop Test, both groups improved, but Group B had greater gains ($p = 0.007$). The Foot Function Index also favoured Group B ($p = 0.02$). For the Foot Posture Index, both groups improved, though between-group differences were not significant ($p = 0.08$). Overall, eccentric training proved more effective for enhancing dynamic stability and foot function **(Table 2)**.

Table 1: Demographic Data of participants

Variable	Group A (Short Foot Exercises)	Group B (Eccentric Training)
Age (years)	24.35 ± 2.95	23.95 ± 2.68

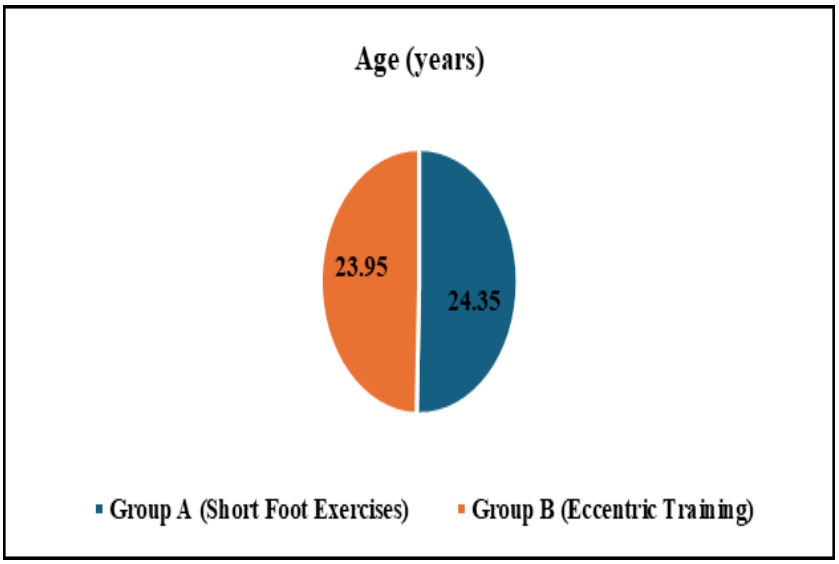

Chart 1: Age Distribution

Table 2: Comparison of Outcome Measures Within and Between Groups

Outcome measurement	Group	Time	Mean	SD	*p*-value (Within Group)	*p*-value (Between Groups)
Navicular Drop Test	A	Pre	11.75	1.86	0.001	0.007
		Post	8.55	1.43		
	B	Pre	11.60	2.13	0.001	
		Post	6.85	1.49		
Foot Posture Index	A	Pre	5.10	2.12	0.001	0.08
		Post	3.75	1.97		
	B	Pre	5.00	2.20	0.001	
		Post	2.60	2.11		
Foot Function Index	A	Pre	135.90	6.78	0.001	0.02
		Post	110.95	3.57		
	B	Pre	135.00	8.01	0.001	
		Post	106.80	4.31		

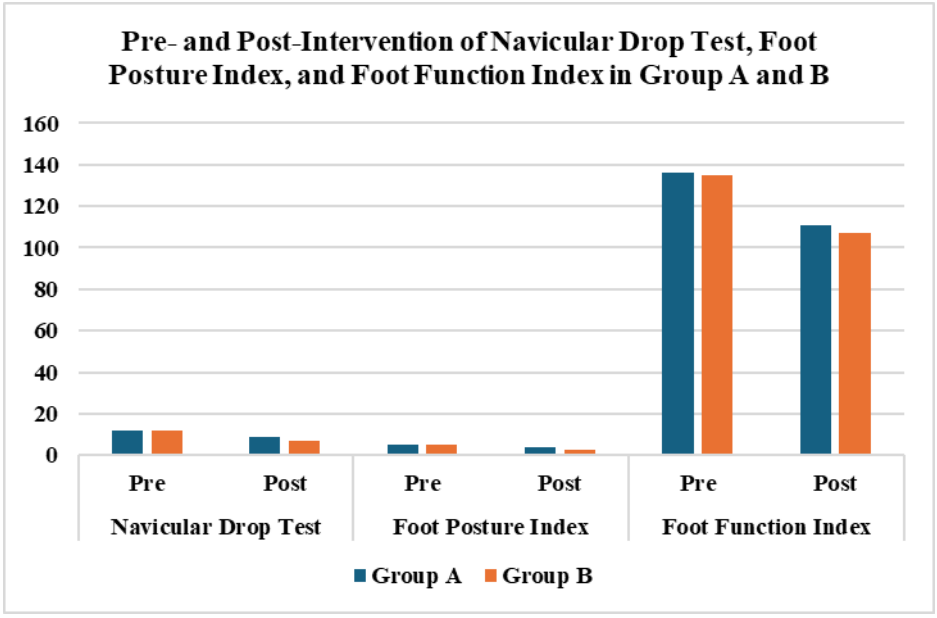

Chart 2: Pre- and Post-Intervention of Navicular Drop Test, Foot Posture Index, and Foot Function Index in Group A and B

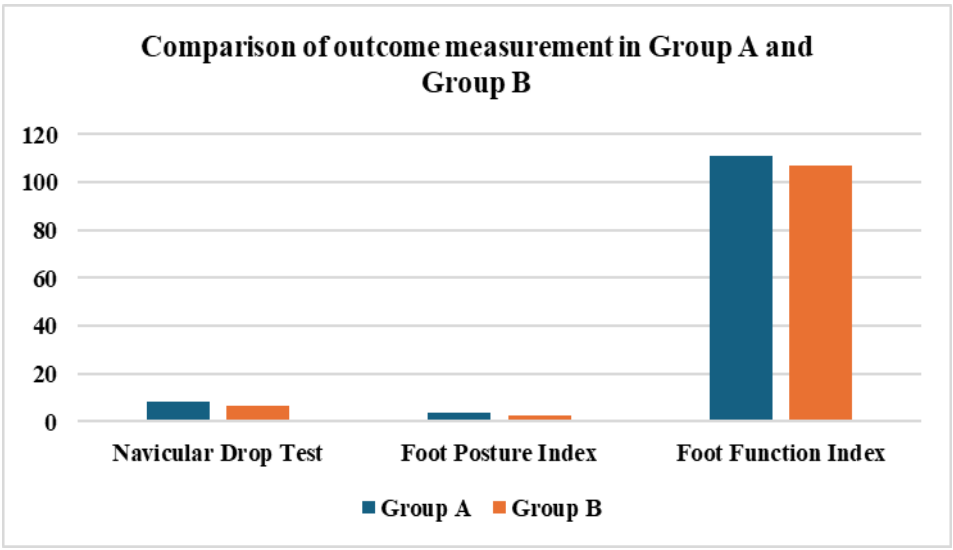

Chart 3: Between-Group Comparison of Navicular Drop Test, Foot Posture Index, and Foot Function Index in Group A and Group B

DISCUSSION:

Football is a high-impact, multidirectional sport that predisposes athletes to frequent ankle injuries, particularly lateral ankle sprains, due to rapid direction changes, jumping, tackling, and uneven surface contact. Repetitive ankle trauma, combined with inadequate rehabilitation, often leads to chronic ankle instability (CAI)—a condition characterized by recurrent sprains, joint instability, and impaired proprioception **[1]**. The present study aimed to compare the effectiveness of Short Foot Exercises (SFE) and Eccentric Training (ET) on improving ankle stability and foot function in footballers with CAI. Both intervention groups showed significant improvements in all outcome measures—Navicular Drop Test, Foot Posture Index, and Functional Foot Index indicating that both SFE and ET are effective in enhancing foot posture and function in athletes with CAI. However, the eccentric training group (Group B) demonstrated greater post-intervention improvements in navicular drop and functional outcomes compared to the SFE group (Group A).

Short Foot Exercises focus on activating intrinsic foot muscles such as the abductor hallucis and flexor digitorum brevis, which contribute to maintaining the medial longitudinal arch and improving foot posture. The findings of this study align with previous literature that supports the role of SFE in enhancing proprioception, postural control, and static foot alignment. Mulligan and Cook (2013) **[12]** highlighted that SFE improves plantar proprioception and neuromuscular coordination, while Jung *et al*. (2011) **[7]** demonstrated significant improvement in foot posture and dynamic balance after SFE in individuals with flat feet. Similarly, Moon *et al*. (2014) **[3]** observed a reduction in navicular drop and improved arch support following a structured SFE program, supporting the current study's outcomes in Group A.

On the other hand, eccentric training, particularly using heel-drop exercises based on Alfredson's protocol **[24]**, demonstrated superior improvements in dynamic function and load-bearing stability, particularly in Group B. This training method targets lengthening muscle contractions, especially in the gastrocnemius-soleus complex and peroneal muscles, which are crucial for deceleration, landing control, and inversion resistance. Alfredson *et al*. (1998) **[24]** showed that eccentric loading promotes tendon remodeling, reduces pain, and enhances muscle-tendon unit efficiency. Likewise, Mafi *et al*. (2001) **[25]** reported better outcomes with eccentric exercises than concentric training in managing Achilles tendinopathy, emphasizing their functional advantage. In the context of CAI, eccentric training has also been associated with improvements in

proprioception, joint position sense, and peroneal muscle strength, which help prevent recurrent sprains **[14, 15]**.

Moreover, Lopez-de-Celis *et al*. (2021) **[26]** confirmed the benefits of eccentric strengthening in CAI rehabilitation, particularly by improving functional performance, ankle eversion strength, and reducing the "giving way" sensation. The results of the present study further validate these findings, with the eccentric training group showing greater improvements in both navicular drop values and functional foot index scores, highlighting their relevance in sports involving explosive, multidirectional movements like football.

Despite the promising findings, several limitations must be acknowledged. Firstly, the sample size was relatively small (n = 40), which may limit the generalizability of the results. Secondly, the duration of the intervention was limited to 8 weeks, which may not fully reflect the long-term effects or maintenance of improvements. Third, the study was limited to male footballers, thereby excluding gender-based comparisons and insights into outcomes among female athletes or athletes from other sports disciplines.

From a clinical perspective, the findings suggest that both SFE and eccentric training can be effectively integrated into ankle rehabilitation programs for footballers with CAI. However, eccentric training may offer superior improvements in functional stability, making it particularly useful for athletes returning to high-level dynamic sports. Meanwhile, SFE remains a valuable low-load strategy for improving intrinsic foot muscle strength and static arch stability, especially during the early stages of rehabilitation.

CONCLUSION:

The present study indicates that both Short Foot Exercises (SFE) and Eccentric Training (ET) effectively improve ankle stability, foot posture, and functional performance in footballers with chronic ankle instability. While both interventions produced significant improvements, ET showed slightly superior effects, particularly in reducing navicular drop and enhancing functional foot use, likely due to its focus on dynamic muscle control and tendon resilience. Clinically, incorporating intrinsic foot muscle activation through SFE and eccentric strengthening is valuable, with SFE suitable for early-stage stability training and ET for later-stage rehab or return-to-play. Future research with larger, gender-inclusive cohorts and long-term follow-up, as well as exploring combined SFE and ET protocols, is recommended to optimize rehabilitation strategies for chronic ankle instability.

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