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Effect of Faradic Footbath and Concentric Exercise in Prevention of Non-Contact ACL Injury Among Male Soccer Players with Hyper Pronated Foot: A Randomized Clinical Trial

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Abstract

Background and objectives: The purpose of this study was to find the effect of faradic foot bath and concentric exercise in prevention of non-contact ACL injury among soccer players with hyperpronated foot.

Method: This study was conducted on 40 soccer players with hyperpronated foot.Subjects were randomly alloted into 2 groups [group-1 Concentric exercsie, group-2 Faradic Footbath]. NDT and DVJ were 2 outcome measures used to assessed at baseline and after 6 Weeks.

Result: Both groups showed significant difference in management of hyperpronated foot and there by reducing the risk of non- contact ACL injury[$p<0.05$]. And by comparing the mean difference from group discriptive it showed concentric exercise (NDT= 6.45+4.775, DVJ= - 0.287+0.061) is more effective then Faradic Footbath (NDT= 1.25,DVJ= -0.086).

Conclusion: In conclusion, this study suggest that Concentric exrecise is more effective then Faradic Footbath, so Concentric exercise can be used as a effective measure for prevention of non-contact ACL injury among soccer players with hyperpronated foot**.**

Keywords: Non-contact ACL injury, Faradic Footbath, Hyperpronated foot, Soccer players, Concentric exercise.

I. Introduction

Soccer is the most popular sport worldwide, with over 240 million active players.[1] The international popularity continues to rise as indicated by the 23 million increase in active soccer players compared to 8 years ago.During an average 90 min game, a player has an average of 51 contacts with the ball, 26 of those with the foot[2]. Soccer players are subjected to injuries during training as well as during competition.This game involve Kicking the soccer ball which plays both a direct and indirect role in the aetiology of soccer player injuries.The incidence of soccer related injuries is estimated to be 10–35 per 1000 playing hours in adult male players,and often higher in younger and less skilled players[3,4]. Approximately 60–80% of severe injuries occur in the lower extremities,most commonly at the knee or ankle[3,5].

Most common injuries in soccer are ACL tear,meniscus injury,collateral ligament injury,ankle sprain,ankle fracture,strains.An analysis of injury risk while playing soccer found that kicking accounted for 51% of potential actions that could lead to injury[6]. Knee injury is the most common type of injury sustained by soccer players. The structure that is most affected by sudden movements in football is the Anterior Cruciate Ligament (ACL). [7,8]Anterior cruciate ligament (ACL) injury is one of the most commonly seen injuries in sport and has a devastating influence on patients' activity levels and quality of life.An ACL injury in a professional football player is a potentially career-threatening injury.The reported incidence of ACL injury ranges from 0.06 to 3.7 per 1,000 h of active soccer playing.Also each team of 25 players can expect one ACL injury every 2 years[9]. The quick and reflexive movements of starting, stopping, bending, twisting and changing direction exert extreme force on the knee resulting in injuries to the ACL ligaments.ACL injury is mostly combined with medial meniscus injury[10].

The non-contact ACL injury compared with contact injury can be prevented by finding its modifiable risk factors. Hyper-pronated foot is a term, which is been used by number of authors to describe a flattening or loss of the medial longitudinal arch(MLA)[15,16].During gait, a foot with excessive pronation of the subtalar and mid-tarsal joints exhibits movement beyond the normal range of motion and is maintained pronated for a prolonged period of time.[17]These biomechanical changes can lead to a reduction in stability of the foot, stretching and weakening of ligaments, and stretching and increased demands on muscles, leading to painful syndromes in the lower limbs.[16] Also there appears to be a relationship between biomechanical abnormalities of the foot and ankle complex and knee pathologies[17,18].These abnormalities may relay stresses to any area proximal or distal to the lower extremity injury[18,19].

Several methods of management techniques have been reported in the management of hyperpronated foot. Long term goals of any flat foot rehabilitation program aims at strengthening of tibialis posterior muscle. Faradic current is a short duration of direct current. It has a pulse rate ranging from 0.1 to 1ms with a frequency of 50 to 100Hz.Faradic current creates prolonged contraction and relaxation of innervated muscle. Treatment with faradic current is otherwise called faradism. An innervated muscle is one in which the muscle is connected to a nerve, wherein the nerve is not damaged. While applying faradic current, the patient experience a pricking sensation due to short pulse duration. Whereas denervated muscle doesn't react to faradic current as the pulse rate is short. [24]

Understanding the situations and mechanisms which lead to ACL injuries is crucial to effectively design specific exercise programmes to reduce their incidence. Research on ACL injury prevention has focused on identifying risk factors for ACL injury, including neuromuscular and biomechanical factors. A previous study has found that hyperpronated foot is a risk factor for non- contact ACL injury in soccer players. There are plethora of data documenting ACL injury rates in professional male sports. But study lacks on the effective preventive programme for non-contact ACL injury. So this study aimed to find the effect of faradic foot bath and concentric exercise in prevention of non-contact ACL injury among soccer players with hyperpronated foot.

Methodology:

This randomized clinical trial (RCT) was conducted over a period of one year among professional male football players aged 18 to 25 years, from football academies in and around Kerala and Karnataka. Participants were selected using purposive block random sampling. Inclusion criteria for the study were professional football players who were male and within the age group of 18 to 25 years. Exclusion criteria included a previous history of ACL injury, history of knee surgery, previous meniscus injury, knee instability, any present knee conditions (e.g., patellofemoral pain syndrome), recent ankle or hip surgery, recent fractures of the proximal or distal joints or bones of the knee, and football players with hyperpronated feet.

Based on inclusion and exclusion criteria the subjects were included in this study after the approval from scientific and research committee. A consent form was been signed by the subjects and the purpose of the study was explained before participating in the study.Then the sujects were randomly allotted into two groups and intervention was given for 6 weeks.The subjects were assessed at baseline and after 6 Weeks.

Description of the Study Group 1: Concentric Exercise

Participants in Group 1 underwent a structured concentric exercise program that included the following exercises, performed for 15 repetitions, 3 sets per session, 4 days per week, for a duration of 6 weeks:

1. Dorsiflexion with Manual Resistance

Participants were seated in a long sitting position on a mat with their back supported. They were instructed to perform dorsiflexion of the foot while the therapist applied manual resistance in the opposite direction.

2. Inversion of the Foot with Manual Resistance

In the same long sitting position with back support, participants were instructed to invert the foot against manual resistance applied by the therapist on the opposite side.

3. Towel Curls

Participants sat on a chair with back support and a towel placed under their feet. They were instructed to curl their toes to lift the arch of the foot toward the body and then relax, repeating the process.

4. Heel Raises with Ball

Participants stood upright with a ball positioned between their medial malleoli (inner ankles). They were instructed to maintain balance while performing heel raises.

5. Foot Abduction with TheraBand

While seated on a chair with feet flat on the floor, participants performed foot abduction using a TheraBand. One end of the band was looped around the feet, and the other end was held by the therapist to provide resistance during the abduction movement.

Group 2- Faradic Foot Bath Electric stimulation of frequencies above 60 Hz helps in improving the muscular strength.[25] The pattern of electrical stimulation will set to reduce a maximum tetanic contraction within the participant's pain threshold. The Galvanic setting was zero. The Faradic setting was determined by patient's tolerance. Pulse Mode 10 minute (10 Sec Contraction with 50 Sec rest period and 10 repetitions) 5 sessions per week for 3 weeks. [27,28] The subjects were in sitting position and the foot placed in tray filled with water. The placement of the electrodes one at the heel and other at metatarsal head to stimulate the intrinsic muscles of foot [24] The first outcome measure was tested using The Navicular Drop Test (NDT) is commonly used to assess flatfoot or hyper pronation, with a sensitivity of 86%, specificity of 75%, and reliability ranging from 0.83 to 0.95 [29–33]. The subject stands with feet shoulder- width apart while the examiner marks the navicular tuberosity. With the foot placed in subtalar neutral (identified by equal palpation of the talus), the vertical distance from the navicular tuberosity to the floor is measured. The subject then relaxes the foot, and the measurement is repeated. The difference between the two readings indicates navicular drop; values over 10 mm suggest hyper pronation [31,32]

After the NDT, subjects performed the Drop Vertical Jump Test (DVJ), a tool used to assess non-contact ACL injury risk, with a sensitivity of 63.06%, specificity of 82.81%, and reliability between 0.82–0.96 [34–36]. Participants stood on a 31 cm box with feet shoulder-width apart and toes at the edge. They were instructed to lean forward and fall (not step) off the box, land on both feet, and immediately perform a maximal vertical jump, reaching upward with both arms. A demonstration and practice trials (2–3 reps) were given before recording three official jumps. A 2-D Dartfish camera, placed at waist height two meters away in the frontal plane, was used to capture the movements [36,37].

DARTFISH software/APP was used to analyse the DVJ. Digital vedio recorded was uploaded into Dartfish software/APP and the frame at the point of final landing was selected for analysis.The knee to ankle separation ratio is made using selected frame.The knee- to-ankle separation ratio was determined by placing a horizontal line between the visual estimation of the knee joint centers, and another horizontal line was drawn between the estimation of the ankle joint centers. The length of each line in pixels was measured, and the ratio between the length of the knee line and the length of the ankle line was computed. A value of 1.0 represents alignment of the knees directly over the ankles. A value less than 1 occurred when the knee joint centers were more medially aligned than the ankle joint centers and thus represented dynamic knee valgus or risk for ACL injury [38]

STATISTICAL ANALYSIS:

Data were collected and summarized using tables and graphs. All variables were coded and entered into Jamovi software (Version 2.3.28). Descriptive statistics (mean and standard deviation) were calculated, followed by normality testing. Paired t-tests were used for within-group comparisons (pre- and post-intervention), and unpaired t-tests for between-group comparisons. A 95% confidence interval was applied, and results were presented through tables and graphs.

Result

Data from 40 participants(20 participants in each group) were analyzed using the jamovi(Version 2.3) [40,41]. Baseline values of DVJ and NDT were tested using the Shapiro– Wilk normality test for normal distribution. Paired t-test was used to measure the difference between the pre and post-test values within groups. Independent t-test analysis was used to measure the pre and post-test values between the groups. p≤0.05 was regarded as signifcant, and the confdence interval was set at 95%.Descriptive statistics were presented as mean+standard deviation. Mean(standard deviation) of age,height,weight of the participants in the concentric group was

20.4 (1.66),166.8(6.58), 71.3(5.46) and in the Faradic group was 20.6(1.96),168.4(6.39),70.9(5.18) respectively. Table 1. Within group analysis for concentric group

Group		Test	statistic	df	p
Concentric group	NDT-Pre NDT-Post	Student's	22.6	19.0	< .001
	DVJ-Pre) DVJ-Post)	Student's	-15.3	19.0	< .001

Table 1 illustrate Students t test (Paired t-test) was used to compare the scores of the outcomes within group across the two time points (PRE and POST) for Concentric exercise. Shapiro–Wilk normality test, revealed normal distribution for baseline values of Concentric group [DVJ-p>0.559, NDTp>0.132]. The results from within group showed that there is significant difference(p<0.05) in the participants outcome parameters[DVJ,NDT] across the two time points of the study. So the result suggest that there is significant increase in foot arch and decrease in DVJ ratio when compared the scores of the outcomes within group for Concentric Exercise.

Table 2. Within group analysis for Faradic group

Group		Test	statistic	p
Faradic Group	NDT-Pre NDT-Post	Wilcoxon W	105 [a]	< .001
	DVJ-Pre) DVJ-Post)	Wilcoxon W	0 [b]	< .001

Table 2 illustrate Shapiro–Wilk normality test, revealed that there is no normal distribution forbaseline values of Faradic group[DVJ- p>0.012, NDT-p>0.010], so Wilcoxon W(Paired t-test) was used to compare the scores of the outcomes within group. The

results from within group showed that there is significant difference(p<0.05) in the participants outcome parameters[DVJ,NDT] across the two time points of the study. So the result suggest that there is significant increase in foot arch and DVJ ratio when compared the scores of the outcomes within group for Faradic Footbath.

Table 3. Between Group Analysis- Concentric * Faradic

Group	Test	Statistic	P value
NDT-Pre(c.m)	Mann-Whitney U	170.50	0.421
NDT-Post(c.m)	Mann-Whitney U	1.00	< .001
DVJ-Pre(ratio)	Mann-Whitney U	143.50	0.125
DVJ-Post(ratio)	Mann-Whitney U	38.00	< .001

Table 3 illustrate between group analysis. shapiro–wilk normality test, revealed that there is no normal distribution for baseline values of concentric and faradic group.so mann-whitney u(independent samples t-test) was used to campare the scores of the outcomes between two group across the two time points(pre and post). there is statistically significant differences between the pre-test and post- test in favour of the post-test in both groups,because the p<0.05in the applied test. the comaprision of mean difference (preand post) from group descriptives of both group showed, concentric group(ndt= 6.45+4.775, dvj= -0.287+0.061) is more effective then faradic group (ndt= 1.25,dvj= -0.086). so the result suggests that more significant increase in foot arch and dvj ratio was noted in concentric group compared to faradic group.

Discussion:

The purpose of this study was to investigate the effects of faradic foot bath and concentric exerise in prevention of non-contact ACL injury among soccer players with hyperpronated foot. There are many studies on rehabilitation of ACL injury but studies lacks on effective prevention programme. The result of this Randomized clinical trail, demonstrated that both Concentric exercise and Faradic Footbath has significant effect in prevention of non-contact ACL injury but between group analysis showed Concentric exercise is more effective then Faradic Footbath. All the 40 participants completed the study without any known or serious adverse events.

As the feet serve as the body's foundation, forces transmitted through them during gait and sports activity can influence injury risk. Studies have linked hyperpronation to increased risk of non-contact ACL injuries due to compensatory internal tibial rotation affecting the knee joint [42]. Excessive navicular drop and subtalar pronation are more frequent in ACL-injured athletes compared to non-injured ones [43]. During landing maneuvers, near full knee extension limits muscular support for the ACL, making it more vulnerable when combined with internal tibial rotation [44]. Dynamic knee valgus observed during jumping also increases strain on the ACL, contributing further to injury risk [43].

Strengthening the plantar intrinsic foot muscles is commonly recommended for individuals with flat feet due to their role in supporting the medial longitudinal arch. A study by Gheitsai et al. [45] found intrinsic muscle exercises to be more effective than extrinsic ones in improving flatfoot among adolescents. The tibialis posterior is widely recognized for providing dynamic stability to the arch during walking and running and is believed to function synergistically with the peroneus brevis, tibialis anterior, and gastrocnemius during weight-bearing activities.

In this study, Group 1 received concentric exercises targeting the extrinsic muscle tibialis posterior to assess their effect on ACL injury prevention in individuals with hyperpronated feet. Results showed significant improvements in both within- and between-group analyses, indicating enhanced medial longitudinal arch support and reduced ACL injury risk. This may be attributed to the tibialis posterior's insertion into the navicular bone, where concentric contraction helps elevate the arch [46].

Group 2 received Faradic Foot Bath therapy for six weeks. Consistent with earlier studies [24], our within-group analysis showed significant improvement in medial arch height and reduced hyperpronation, suggesting a potential role in ACL injury prevention. Faradic stimulation (>60 Hz) is known to enhance muscle strength, likely contributing to the strengthening of the tibialis posterior and providing dynamic arch support during weight-bearing activities [26].

In both groups, within-group analysis revealed significant improvements ($p < 0.05$) between pre- and post-intervention measurements, indicating that both concentric exercises and Faradic Footbath are effective in managing hyperpronated foot and potentially reducing the risk of ACL injury. However, between-group analysis showed a greater mean improvement in Group 1 (Concentric Exercise), suggesting it is more effective than Faradic Footbath in enhancing medial longitudinal arch support and lowering ACL injury risk.

This study has several limitations. The small sample size may have influenced the results. Conducting the intervention in an academic setting posed challenges, including limited time for treatment due to player schedules and participant drop-outs during tournaments. Additionally, the findings are specific to soccer players and may not be generalizable to athletes in other high-risk sports like Kabaddi, Rugby, or Basketball. Despite these limitations, this is the first study to compare the effects of Faradic Footbath and concentric exercise on the prevention of non-contact ACL injuries.

Clinical implication:

Concentric exercise can be used as a effective measure for prevention of non-contact ACL injury in both onfield as well as in off-field set-up. To perform concentric exercsie it doesn't require much equipments,so it can be used as a effective measure over Faradic Footbath for management of hyperpronated foot and there by reducing the risk of ACL injury.

Future recommendations:

- Study with larger sample size should be done.
- Should extend to other sports like Kabaddi, Rugby, Basketball where noncontact ACL injury is common.
- Study focusing on effect of this intervention on other injuries in soccer players associated with Hyperpronated foot.

Conclusion:

Faradic Footbath and Concentric exercsie have clinical relavance and significant effect in reducing hyperpronation of the foot. The reduction in hyperpronation of foot was also associated with reduced risk of ACL injury in soccer players. In conclusion, this study suggest that Concentric exrecise is more effective then Faradic Footbath, so Concentric exercise can be used as a effective measure for prevention of non-contact ACL injury among soccer players with hyperpronated foot.

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