

# Effectiveness of Ankle Rehabilitation Programme on Balance and Functional Ability in Adolescent Badminton Players with Chronic Ankle Instability: An Experimental Study

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## ABSTRACT

**Background:** Chronic ankle instability (CAI) is mostly found in athletes of ages between 18 and 25 years. CAI usually occurs in persons with ankle sprain if they do not receive the appropriate rehabilitation training. Effectiveness of ankle rehabilitation programme on Balance and functional ability in adolescent Badminton players with chronic ankle instability.

**Objectives:** To study the effect of ankle rehabilitation programs on balance using Y balance test and functional ability using side hop test and foot and ankle ability measure scale in adolescent badminton players with chronic ankle instability at the end of 4 weeks.

**Methods:** The experimental study was carried out by selecting the adolescent badminton players with chronic ankle instability, aged 18 to 25. Pre outcome measure such as Y-balance test score, side hop test and FAAM (Foot and Ankle Ability Measure) scale score was taken and players were selected based on inclusion criteria. Written consent was taken. A session of ankle rehabilitation programme was taken and post outcome measure was compared after 4 weeks. Analysis was done using Microsoft excel and Graph pad.

**Result:** The total pre and post score of Y-balance test, side hop test and FAAM (Foot and Ankle Ability Measure) scale were compared and analyzed by paired t- test, the p -value was <0.0001 which is considered extremely statistically significant.

**Conclusion:** The study concluded that ankle rehabilitation programme is effective in improving balance, strength and functional performance in badminton players with chronic ankle instability.

**Keywords:** Ankle rehabilitation programs, chronic ankle instability, badminton players, Y-balance test, side hop test, FAAM scale.

## INTRODUCTION

The ankle joint is most commonly affected joint in sports in which lateral ankle sprains are the most common. A systemic review revealed the percentage of recurrent ankle injury as ranging from 5% to 73% in badminton athletes<sup>1</sup>.

Chronic ankle instability (CAI) is mostly found in athletes of ages between 18 and 25 years<sup>1</sup>. CAI usually occurs in persons with ankle sprain if they do not receive the appropriate rehabilitation training. Due to ankle sprain, the ligaments, tendons, and also mechanoreceptors around the ankle

joint are injured. These lead to a laxity of the injured ligaments/tendons and impaired ankle proprioception, which affects the neuromuscular control of the ankle<sup>2</sup>. Individuals with CAI experience both mechanical and functional instability of the ankle joint<sup>3</sup>.

Pain, swelling, weakness, instability, and repeated episodes of “giving way.”<sup>4</sup> These residual symptoms can impede young patients’ physical activity, which can negatively affect their overall health and quality of life by leading to obesity and other general health problems. Chronic ankle instability is defined as a history of at least 1 significant ankle sprain, giving way, recurrent sprain, and/or feelings of instability<sup>5</sup>.

Persistence of such instability over time increases the risk of articular damage and developing Osteoarthritis<sup>6</sup>. The cost of treating and preventing such injuries is very high that has a major effect on the athlete’s training and return to play<sup>7</sup>. The main cause of chronic ankle instability that have been found are decreased proprioceptive abilities because loss of mechanoreceptor and decreased muscle strength of evertor and invertor.

Balance training is the main component of rehabilitation plans, has been widely used for patients with CAI<sup>8</sup>. Balance training can promote the recovery of motor perception by stimulating the receptors of the ankle joint capsule and ligaments, increasing the input of motor sensation and activating gamma motor neurons<sup>9</sup>.

Strength training is important in rehabilitation. Deficits in evertor strength would reduce the ability of these muscle to resist inversion and return the foot to the neutral position and thereby prevent the inversion sprain<sup>10</sup>. Not concentric but eccentric evertors weakness has been demonstrated in patients suffering from chronic ankle instability. A second cause could be the deep peroneal muscle nerve dysfunction as a result of over-stretching peroneal nerve<sup>9,10</sup>.

Functional performance tests are dynamic measures used to assess general lower body function. These tests are helpful because they combine multiple components, such as muscular strength, neuromuscular coordination and joint stability which could be affected after joint injury<sup>5</sup>.

Badminton game revolves around the speed and deception and abrupt jerking movement with rapid footwork. This combination of repetitive maneuver places major stresses on lower extremities and increases the risk of chronic injuries.

This study aims to find the effect of ankle rehabilitation programs on balance and functional ability in adolescent badminton players with CAI.

The objective is to compared the pre and post effect of ankle rehabilitation programs in adolescent badminton players using Y - balance test, side hop test and FAAM scale.

## **MATERIALS & METHODS**

**Study design-** Experimental (pre-post)

**Sample size-** 43

**Study population-** 18 to 25 years old badminton players

**Study duration-** 4 weeks

**Sampling method** - convenient sampling

**Study setting** - badminton clubs in and around Pune

**Selection criteria:**

**Inclusion criteria:**

1. History of least 1 substantial ankle sprain
2. Multiple episodes of the ankle “giving way,” recurrent sprain.
3. “Feelings of instability” in the 6 months before the study
4. Participant willing to participate
5. Both male and female badminton players
6. Age group 18-25 years

**Exclusion criteria:**

1. An acute lower extremity injury in the 3 months before the study

2. Participants who are participated in rehabilitation in the 3 months before the study.
3. Participants with history of any lower extremity surgery.
4. Participants having any recent of lower extremity injury.
5. History of lower extremity fracture.
6. Individual with any neurological disorders

## PROCEDURE

Participants were selected on the basis of the inclusion and exclusion criteria. The purpose of the study was explained to participants and written consent will be taken. Participants were assured regarding confidentiality of their information or collected data. Chronic ankle instability was assessed. Pre-Assessment by Y-balance test, side hop test and foot ankle ability measure scale were taken. Protocol was given to the participant. Post assessment was taken after 4 weeks. All the data was collected, analyzed and interpreted.

### Outcome measure:

#### 1. DYNAMIC BALANCE TEST- Y balance test

A dynamic balance test was performed using the Y-Balance test (YBT) equipment (FMS TM, Chatham, VA, USA) according to the recommended guidelines. The examiner demonstrated the YBT and provided an explanation to the participants. Each participant's foot was placed on the examination table with one foot held in the center, to be extended to the anterior, posterior lateral, and posterior medial directions as far as possible. The healthy side was tested first, followed by the injured side. The examiner provided verbal instructions and signals to start. Each side was tested 3 times, and the highest value was recorded. The recordings were made at 0.5-cm increments. If the foot touched the ground due to loss of balance, a retest was conducted after an explanation. The test was performed indoors under quiet conditions to

avoid interference from the environment. An examiner observed from behind the participants to avoid distracting them. The length of the lower limb was measured from the anterior superior iliac bone to the middle of the medial ankle bone using a tape measure to calculate the total score. The formula for calculating the total score is as follows:  $[(\text{sum of the 3 distances})/(\text{length of lower limb} \times 3)] \times 100$   
(Inter rated reliability ICC=0.88-0.99, intra reliability 0.85 to 1.00)

## FUNCTIONAL PERFORMANCE-

### 1.Side hop test

Patients stood on their involved limb and hopped 30 cm laterally, side to side, for 10 repetitions as fast as possible. A single practice trial for patient familiarization was allowed before the test trials. The test was conducted twice on the involved limb, with a 60-second rest provided between trials. The shortest trial was used for analysis (ICC ranging from 0.92-0.97)

### 242.Foot and Ankle ability measure (FAAM) scale

Sport subscale-(ICC=0.87; SEM=4,5points)

ADL subscale: (ICC = 0.89; SEM = 2,1 points)

## STATISTICAL ANALYSIS

All data were analyzed with Microsoft excel and Graph Pad. The data pass the Kolmogorov-Smirnov test of normality for all the data hence parametric test that is paired t test used. Levels of significance was set at p value<0.05.

## RESULT

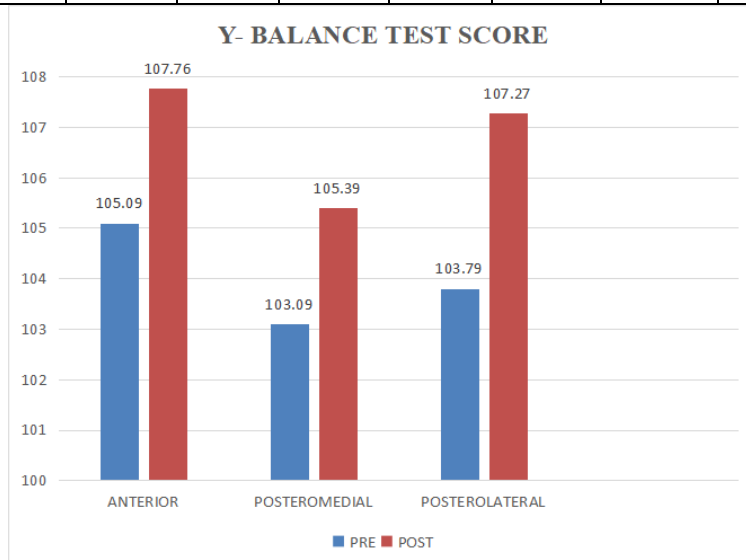
In this study, total 43 subjects, both male (86.04%) and female (13.95%) with the mean age 21. Group was given ankle rehabilitation programme to improve balance and functional ability in adolescent badminton players, were selected using convenient sampling method. In intra-group analysis (within the group) for Y-balance test using paired t test was done. In this study pre and post intervention mean and SD score was for anterior direction pre

score ( $105.09 \pm 10.954$ ) and post score ( $107.76 \pm 11.032$ ), posteromedial direction pre score ( $103.09 \pm 11.034$ ) and post score ( $105.39 \pm 10.946$ ) and posterolateral direction pre score ( $103.79 \pm 11.803$ ) and post score ( $107.27 \pm 11.89$ ) of Y- balance test. Intra group analysis for Y- balance test was revealed a significant difference between pre and post intervention ( $p \leq 0.0001$ ). Thus, ankle rehabilitation programme was effective in improving balance in adolescent badminton players at the end of 4 weeks. In intra-group analysis (within the group) for Side Hop test using paired t test was done. In this study pre and post intervention mean and SD score was pre score ( $36.65 \pm 4.047$ ) and post score ( $40.20 \pm 4.14$ ) of Side Hop test. Intra group analysis for Side Hop test was revealed a significant difference between pre and post intervention ( $p \leq 0.0001$ ). Thus, ankle

rehabilitation program me was effective in improving functional ability in adolescent badminton players at the end of 4 weeks. In intra-group analysis (within the group) for FAAM Scale using paired t test was done. In this study pre and post intervention mean and SD score was for ADL Sub-scale pre score ( $70.32 \pm 7.930$ ) and post score ( $79.90 \pm 6.229$ ) and Sport sub-scale pre score ( $65.34 \pm 9.429$ ) and post score ( $81.37 \pm 6.963$ ) of FAAM Scale. Intra group analysis for FAAM Scale was revealed a significant difference between pre and post intervention in both sub-scale ( $p \leq 0.0001$ ). Thus, ankle rehabilitation programme was effective in improving functional ability in adolescent badminton players at the end of 4 weeks.

### 1) EFFECT OF ANKLE REHABILITATION PROGRAMME ON BALANCE USING Y- BALANCE TEST.

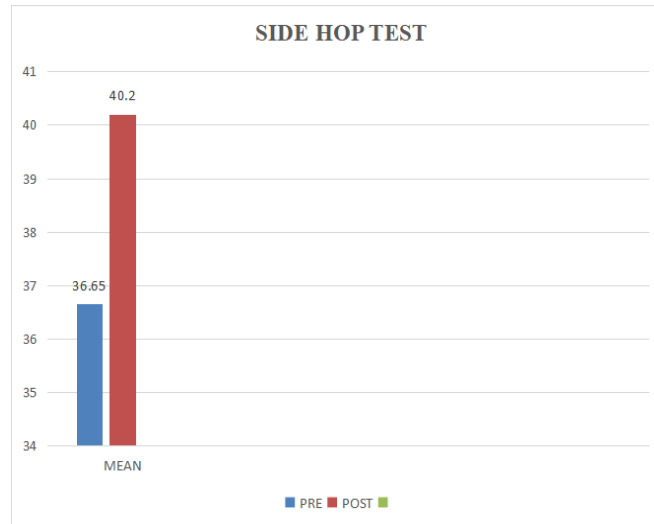
DIRECTION	PRE		POST		t Value	p Value	RESULT
	MEAN	SD	MEAN	SD			
ANTERIOR	105.09	10.954	107.76	11.032	9.360	<0.0001	Extremely significant
POSTEROMEDIAL	103.09	11.034	105.39	10.946	10.367	<0.0001	Extremely significant
POSTEROLATERAL	103.79	11.803	107.27	11.89	7.351	<0.0001	Extremely significant



**INTERPRETATION-** Table no.1 Graph no.1 the above table shows that within the group analysis of anterior direction pre ( $105.09 \pm 10.954$ ) and post ( $107.6 \pm 11.032$ ), posteromedial direction pre ( $103.09 \pm 11.034$ ) and post ( $105.39 \pm 10.946$ ) and posterolateral direction pre ( $103.79 \pm 11.803$ ) and post ( $107.27 \pm 11.89$ ) values of Y- Balance test. The data was analyzed using paired t test. There was statistically significant difference between the pre and post values with the p value  $\leq 0.0001$ .

**2) Effect of ankle rehabilitation programs on functional performance using side hop test.**

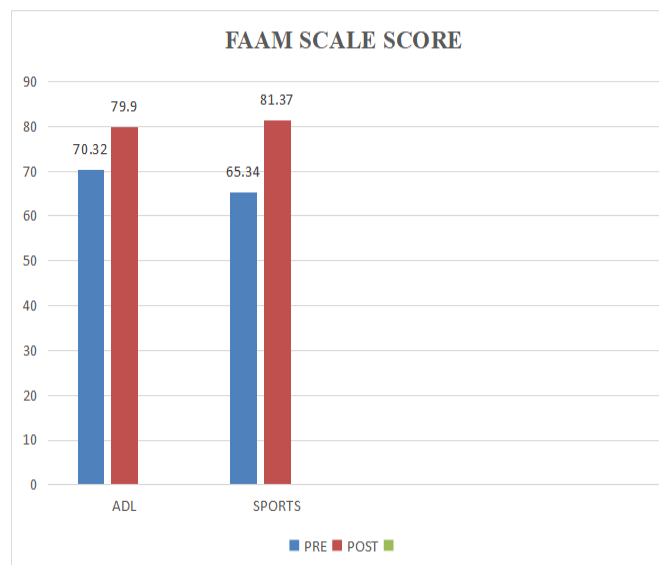
SIDE HOP TEST	PRE		POST		t Value	P Value	RESULT
	MEAN	SD	MEAN	SD			
	36.65	4.047	40.20	4.14	18.528	<0.0001	Extremely significant



**INTERPRETATION-** Table no.2 Graph no.2 the above table shows that within the group analysis of pre ( $36.65 \pm 4.047$ ) and post ( $40.20 \pm 4.14$ ) values of Side Hop Test. The data was analyzed using paired t test. There was statistically significant difference between the pre and post values with the p value  $\leq 0.0001$ .

**3) Effect of ankle rehabilitation programs on functional ability using FAAM scale.**

FAAM SCALE SCORE	PRE		POST		t Value	p Value	RESULT
	MEAN	SD	MEAN	SD			
ADL	70.32	7.930	79.90	6.229	14.198	<0.0001	Extremely significant
SPORTS	65.34	9.429	81.37	6.963	15.488	<0.0001	Extremely significant



**INTERPRETATION-** Table no.3 Graph no.3 the above table shows that within the group analysis of FAAM (ADL Sub-scale) pre ( $70.32 \pm 7.930$ ) and post ( $79.90 \pm 6.229$ ) and FAAM (SPORT Sub-scale) pre ( $65.34 \pm 9.434$ ) and post ( $81.37 \pm 6.963$ ) values of FAAM Scale. The data was analyzed using paired t test. There was statistically significant difference between the pre and post values with the p value  $\leq 0.0001$ .

## DISCUSSION

The purpose of the study was to find the effectiveness of ankle rehabilitation programme on balance and functional ability in adolescent badminton players with chronic ankle instability (CAI). It has been previously studied that balance deficit and lack of strength in muscle leads to ankle sprain. Lateral ankle sprain is most common musculoskeletal condition we see in badminton players. Recurrence of lateral ankle sprain causes chronic ankle instability. It has been also suggested that poor neuromuscular control, lack of balance training and strength training are also the contributing risk factors for the chronic ankle instability in adolescent badminton players as per the available literature. In our study we provide protocol to improve strength, balance and functional performance training in badminton players.

The study conducted by Zhang, C et.al stated that prevalence of chronic ankle instability in adolescent badminton players is ranging from 5% to 73%<sup>2</sup>. According to McKay GD et.al stated that out of all the patients 56% are attributed to lateral ankle sprains<sup>13</sup>. In this study, total 43 numbers of subjects were included with the mean age of 21 years by convenient sampling method. Chronic ankle instability players were included among them male (86.04%) and female (13.95%).

The intrinsic muscle of the foot works as important stabilizers. As well, the tibialis posterior is the main medial dynamic stabilizer of the ankle and also stabilizes the medial longitudinal arch of the foot, while the peroneus longus is the main lateral dynamic stabilizer of the ankle. Anterior talo-fibular ligament plays major role in ankle sprain, injury to the ligaments of the ankle results in adverse changes to the neuromuscular system that provides dynamic support to the ankle. Attributed impaired balance in individuals with lateral ankle sprains to damaged articular mechanoreceptors in the lateral ligaments which resulted in proprioceptive deficit.

In the present study, baseline treatment to improve balance training exercises includes single legged stance, resistance band training etc. were given to the adolescent badminton players. The Y- balance score shows that the players who performed specifically design balance training program have better result in improving dynamic balance and strength in badminton players affected by CAI.

Balance training improves proprioception, neuromuscular control, and stability by stimulating sensory receptors, activating muscles involved in maintaining balance, and promoting adaptive responses in the central nervous system. It involves exercises targeting visual, vestibular, and somatosensory systems to enhance postural control and reduce the risk of falls.

Emily A. et. al has been proved that strength training protocol for balance deficits was beneficial in chronic ankle instability<sup>14</sup>. Its already proven in the previous studies that balance and strength training programme was effective in chronic ankle instability. In our study we gave the balance training and strength training exercises to the adolescent badminton players which found to be effective.

In chronic ankle instability the functional performance of the players was affected. Joint injury results in proprioceptive decrements, which also leads to impairments in neuromuscular control. These changes limit the dynamic defense system of the ankle and predispose the ankle to recurrent episodes of instability. Altered muscle spindle activity, as mediated through the Y motoneuron system, may be the keystones to this interrelated symptom. The key to treating functional insufficiency may lie in restoration of normal Y motoneuron activity.

Strengthening involves physiological process like muscles hypertrophy, where muscle fibers increase in size due to resistance training which occurs through mechanism such as increased protein synthesis and recruitment of muscle fibers<sup>5,6</sup>.

In the present study the protocol was set to train adolescent badminton players affected by CAI, which results in poor functional performance. Ankle rehabilitation programme to improve functional performance includes single-legged hop, steamboats, hop up and down etc. were given. In our study the result shows that the effect of these exercises in adolescent badminton players shows significant post rehabilitation score inside hop test which concludes improved functional performance. Smash is technique in badminton game, jumping and landing sequence is associated with injury; Badminton requires a lot of quick changes in direction, agility jumps and landing so to prevent lateral ankle sprains it requires good functional performance in badminton players.

M. Spencer et.al stated in their studies that the provided ankle rehabilitation programme based on resistance band exercises and balance board exercises were effective in improving clinical measures of functional and patient reported outcomes<sup>4</sup>.

Similar to the result of side hop test and Y - balance test for functional performance and balance respectively the present study indicated that significant difference in pre post FAAM scale (patient reported outcomes) in adolescent badminton players with CAI. The result implies that ankle rehabilitation programme was effective in functional ability and reduction in functional deficits in adolescent badminton players.

Christopher R. et. al stated in their study that FAAM scale used to detect self reported functional deficit in athletes with chronic ankle instability<sup>15</sup>. Hence, it is proved that the ankle rehabilitation programme was effective in adolescent badminton players with chronic ankle instability

## CONCLUSION

It is concluded that the ankle rehabilitation programme is effective in improving balance,

strength and functional performance in badminton players with chronic ankle instability.

## Declaration by Authors

**Ethical Approval:** Approved

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**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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