

## A COMPARATIVE STUDY ON THE EFFECTIVENESS OF FUNCTIONAL TRAINING PROGRAM AND STANDARDIZED REHABILITATION PROGRAM AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION IN IMPROVING FUNCTIONAL PERFORMANCE OF FOOTBALL PLAYERS

Sam Thamburaj A<sup>1</sup>, Karthikeyan Rajendran \*<sup>2</sup>, Rajeev Kuppalagan Rajendran <sup>3</sup>.

<sup>1</sup> Academic coordinator, Vinayaka Missions College of Physiotherapy, Salem, Tamil Nadu, India.

\*<sup>2</sup> Senior lecturer, Department of Physiotherapy, Asia Metropolitan University, Cheras, Selangor, Malaysia.

<sup>3</sup> Chief Physiotherapist, AR Hospital P Ltd, Madurai, Tamil Nadu, India.

### ABSTRACT

**Objective:** The objective of this study was to find out whether there is any significant difference between the functional training program and standardized rehabilitation program in improving functional performance of anterior cruciate ligament reconstructed (ACLR) football players.

**Methods:** A total of 30 subjects who met the selection criteria were divided into two groups respectively (15 per group). Subjects were randomly assigned in to two groups: a functional training group A (FTG, n = 15) and a control group B (CG, n = 15) at 3 months post- Anterior Cruciate Ligament Reconstruction (ACLR). The FTG participated twice per week in the functional training program (4hrs/week) including: a variety of intense, more aggressive and complex exercises designed to specifically increase neuromuscular control, muscle strength and power, proprioception, speed, and agility of the lower limbs, combined with an aerobic running training. The CG did not participate in any exercises performed by the FTG, following the standardized rehabilitation protocol, i.e., 3 sessions per week (6hrs/week) (consisting of running and strengthening, a few plyometric exercises with low intensity and slow progression, very few exercises of directional changing but no horizontal jump nor agility exercises. The two groups were assessed at 3<sup>rd</sup> and 6<sup>th</sup> month post-ACLR and the effects of training were measured using the following assessments: the functional performance done by standing long jump test and 3 hop test.

**Results:** Paired t-test was used to compare the effect within the group and paired t-test of statistical analysis shows that the pre and post comparison for the standing long jump score (Group A: p=0.000, Group B: p=0.000) and three hop test score (Group A: p=0.000, Group B: p=0.000) shows significant difference (p<0.05). Independent 't' test used to compare the difference between two groups. Result shows that there is statistical significant difference in the result in which the p-value is less than 0.05. This indicates that the functional training group have more effect on physical performance of subjects than the control group.

**Conclusion:** The results of the study made us to conclude that functional training program was effective than the standardized rehabilitation program in improving functional performance of anterior cruciate ligament reconstructed (ACLR) of football players.

**KEY WORDS:** ACL reconstruction, Knee Injury, Functional Training, Functional Performance.

**Address for correspondence:** Karthikeyan Rajendran, Senior lecturer, Department of Physiotherapy, Asia Metropolitan University, Cheras, Selangor, Malaysia. Mobile Number: +60183750027

**E-Mail:** [keyan7cn@gmail.com](mailto:keyan7cn@gmail.com)

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## INTRODUCTION

Ligaments around the knee help to stabilize the joint which includes collateral and cruciate ligaments. The anterior cruciate ligament is an important, internal, stabilizer of the knee joint, restraining hyperextension. It is injured when its biomechanical limits are exceeded (over stretched), often with a hyperextension mechanism.

Anterior cruciate ligament (ACL) rupture is a serious knee injury sustained by athletes during sport and leisure time activities. The risk of anterior cruciate ligament injury is significantly greater in individuals during pivoting and cutting movements and also causing severe functional problems that seem to be unrelated to the degree of knee joint laxity [1].

The re-establishment of neuromuscular control of the lower extremity has been recognized as one of the keys to restoring dynamic joint stability and functional movement patterns [2,3]. Athletes often find it difficult to return to full function after injuring the ACL, and frequently surgery is carried out to re-establish joint stability. However, it has been suggested that, after surgery the ability to perform functional activities and balance may be decreased and deficit presents in the muscular and sensory process after surgery [4].

Anterior cruciate ligament reconstruction (ACL reconstruction) is a surgical tissue graft replacement of the anterior cruciate ligament, located in the knee, to restore its function after anterior cruciate ligament injury. The torn ligament is removed from the knee before the graft is inserted. The surgery is performed arthroscopically.

The vital goal after Anterior cruciate ligament after reconstruction (ACLR) and rehabilitation is to regain normal range of motion, knee joint stability, muscle strength, and neuromuscular control, which all contribute to normal functional performance [5].

Athletes often find it difficult to return to full function after injuring the ACL, and frequently surgery is carried out to re-establish joint stability. However, it has been suggested that, after surgery the ability to perform functional

activities and balance may be decreased [6], most studies reported the effects of the neuromuscular programs on decreasing the incidence of ACL injury among athletes as a preventive program [7,8] or in increasing strength and function in healthy subjects [9,10].

Rehabilitation following ACLR is focused on acute and sub-acute management with relatively strict guidelines which includes the progression of weight bearing, improvement of range of motion, and progressive introduction of specific types of exercises through the rehabilitation phase [11]. The final phases of rehabilitation are typically more general, with more global categorizations of appropriate exercises and progressions, without specific milestones for when it is safe to introduce risky and high joint-loading activities, and also with the goal to transit the athlete after ACLR from the ability to perform daily activities to proficiency with higher level sport-related activities [12,13].

Regular training with healthy subjects, the inclusion of intense exercises such as plyometric, high intensity strength contractions along with agility drills, could lead to improved general functional performances without threatening knee safety [14,15].

Several studies reported that various tests are used to assess the functional outcomes after anterior cruciate ligament reconstruction such as jump tests, hop tests and agility tests. These are the significant tests which are commonly used in sports field, clinical settings to evaluate the functional improvements after lower extremity injury or surgery, especially after ACLR. With respect to the frequency training programs are performing too many intense sessions lead to higher risk of injury or re-injury [16-18], some studies suggested that subjects tolerate 2 sessions at a specific intensity without any adverse response before the intensity of the program is progressed. In this context, performing plyometric and intense exercises only twice per week allows sufficient recovery between workouts and possibly induces effective training stimuli increasing the outcome of training with such a low training frequency [19,20]. The purpose of the present study was to examine the effects of functional retraining

program and standardized rehabilitation program in improving functional performance of football players with Anterior Cruciate Ligament Reconstruction (ACLR).

## MATERIALS AND PROCEDURE

**Study Design and Location:** After the university research ethical committee gave the approval for the experiment those who had undergone an anterior cruciate ligament reconstruction, were invited to participate in this experimental study. The experiment is based on the two group pre-test post-test design. This study was conducted at Vinayaka Mission College of Physiotherapy attached to Vinayaka Mission Medical College Hospital, Salem, Tamilnadu, India. Purposive sampling was used to collect subjects within the area and the samples were randomly picked and split in two different groups.

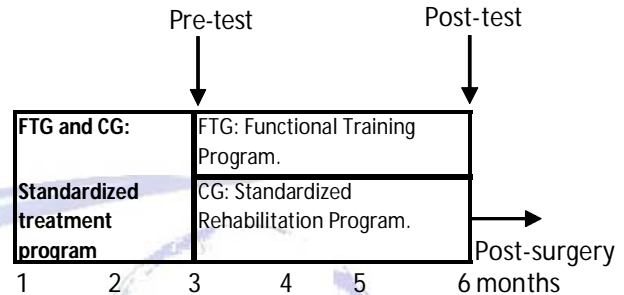
A total of 30 subjects that met the selection criteria were divided into two groups respectively (15 per group). The Inclusion criteria was the samples were in 18-25 years of age, Football players, unilateral injury to the knee and post operation ACLR and the exclusion criteria were previous injury to the knee, any past operation done to any of the knee and any current orthopaedic or neurological injury or with pain or swelling at 3 months post-operation.

Written informed consent was received from all subjects after a detailed explanation about the benefits, and risks involved with this investigation. Subjects were told that they were free to withdraw from the study at any time. No subjects experienced setbacks with this rehabilitation study causing them to drop out. Subjects were randomly assigned to two groups: a functional training group A (FTG, n = 15) and a control group B (CG, n = 15) at 3 months post-Anterior Cruciate Ligament Reconstruction (ACLR). Demographic data details such as name and age was recorded. The surgery site was also observed and data was taken. The duration of the study takes a total of 12 weeks.

**Standardized Postoperative Rehabilitation:** All subjects underwent a standardized post-ACLR physiotherapy protocols for first 3 months which includes electro stimulation, range of

motion improvement, proprioception training and coordination exercises, focusing on neuromuscular control of the involved knee. Functional training and plyometrics exercises were progressively added at 3rd months post-surgery (12 weeks) after fulfilling some criteria, such as ability to hop on one leg without pain, no effusion or swelling, and attainment of full range of motion evaluated by clinical examination [21,22].

**Fig. 1:** Shows study plans of subjects in the two groups.



**Rehabilitation protocols:** The 2 groups were tested at 3rd and 6th month post-surgery (pre-test and post-test) by an experienced physiotherapist who was blinded to the present study protocol design (Figure 1). The subjects in both the groups were confirmed with no pain or joint problem during the rehabilitation. The FTG participated twice per week in the functional training program (4hrs/week) including: a variety of intense, more aggressive and complex exercises designed to specifically increase neuromuscular control, muscle strength and power, proprioception, speed, and agility of the lower limbs, combined with an aerobic running training. These exercises were slowly progressed with low to high intensity. As tolerance improved, the subject advanced to a more intense exercise. The safety and efficacy of adding intense exercises were fully monitored [23,24].

The CG did not participate in any exercises performed by the FTG, following the standardized rehabilitation protocol, i.e., 3 sessions per week (6hrs/week) (consisting of running and strengthening, a few plyometric exercises with low intensity and slow progression, very few exercises of directional change [24].

Training session began with a warm up of 20-min (including 10-min of active static stretching, and lower limbs exercises). The plyometric

training component progressively emphasized double, then single-leg movements throughout the training sessions. However, the uninjured leg was trained with fewer sets than the injured side.<sup>25</sup> Subjects were trained on flat and regular ground wearing adequate footwear.

**Outcome Measures:** The efficiency of this experimental study is measure by the physical performance of the athlete. The physical performance of the athlete was measured by the usage of two tests. During these tests, the subjects performed the first trial with the injured leg; followed by the uninjured one [17]. The standing long jump which is the first test is conducted to measure the explosive power of the quadriceps and hamstring. The second test is the 3 hop test which is conducted to calculate the ability of the subject to maintain the power of quadriceps and hamstring during movement. Both of the tests were conducted before (pre) and after (post) the intervention along the duration of the study.

Fig. 2: Standing long jump



Fig. 3: Three hop test



**Statistical Analysis:** All statistical analysis was done using SPSS 23 for windows software. The level of significant was set at  $p=0.05$ . To calculate mean and standard deviation for demographic characteristics was used descriptive statistics. Individual statistical comparison of pre and post standing long jump and 3 hop test for both group A and B was analysed by using paired t-test statistics. Group analysis for comparison of post test scores standing long

jump and 3 hop test between two groups was analysed by using independent t-test.

## RESULTS

The present study was conducted from the 3<sup>rd</sup> to 6<sup>th</sup> month post-surgery and the functional training program result showed significant improvements than the standardized rehabilitation program concerning the functional tests.

Total of 30 subjects that had undergone ACLR with the age of 18-25 years mean (21.10 years  $\pm$  3.23 SD) were studied.

**Table 1:** Shows the demographic and clinical characteristics baseline for two groups.

GROUP	N	Age (yrs.)	Standing long jump	3 hop test
		Mean (SD)	Mean (SD)	Mean (SD)
GROUP A	15	21.27 (3.990)	0.169 (0.003)	0.483 (0.007)
GROUP B	15	20.93 (2.374)	0.164 (0.005)	0.482 (0.006)

**Table 2:** Shows the mean comparison between male and female within sample.

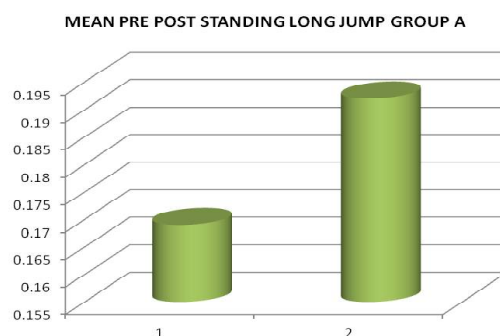
GENDER	N	AGE (yrs.)
		Mean (SD)
Male	22	21.27 (3.467)
Female	8	20.62 (2.615)

**Table 3:** Shows the group comparison of pre and post standing long jump and three hop test.

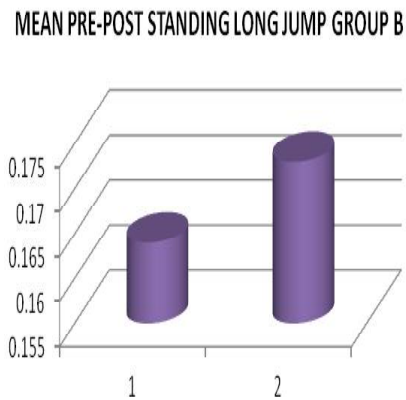
GROUP		Standing long jump		Three hop test	
		Mean (SD)	Sig (2-tailed) p-value	Mean (SD)	Sig (2-tailed) p-value
A	pre	0.169 (0.003)	0	0.483 (0.007)	0
	post	0.192 (0.005)		0.503 (0.109)	
B	pre	0.164 (0.004)	0	0.482 (0.006)	0
	post	0.173 (0.003)		0.487 (0.005)	

Table 3: By using paired t-test of statistical analysis, the pre and post comparison for the standing long jump score (Group A:  $p=0.000$ , Group B:  $p=0.000$ ) and three hop test score (Group A:  $p=0.000$ , Group B:  $p=0.000$ ) shows highly significant difference ( $p<0.05$ ).

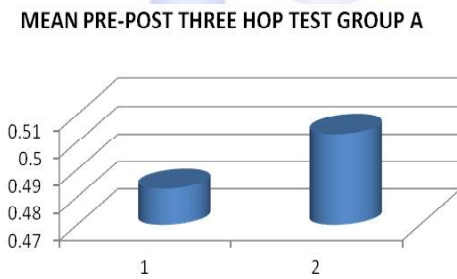
**Fig. 4:** Shows the comparison mean of pre and post-tests standing long jump in group A.



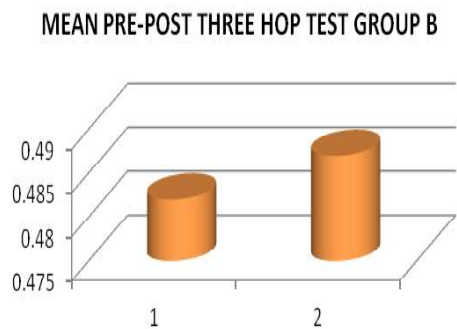
**Fig. 5:** Shows the comparison mean of pre & post-tests standing long jump in group B.



**Fig. 6:** Shows the comparison mean of pre & post- tests three hop test in group A.



**Fig. 7:** Shows the comparison mean of pre & post- tests three hop test in group B.



**Table 4:** Independent 't' test results for both tests.

		INDEPENDENT SAMPLES TEST				
		t-test for Equality of Means				
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Single Leg Jump Tests Between 2 groups	Equal variances assumed	0	0.01873	0.00163	0.01539	0.02208
3 Hop Jump Tests Between 2 groups	Equal variances assumed	0	0.01587	0.00306	0.0096	0.02213

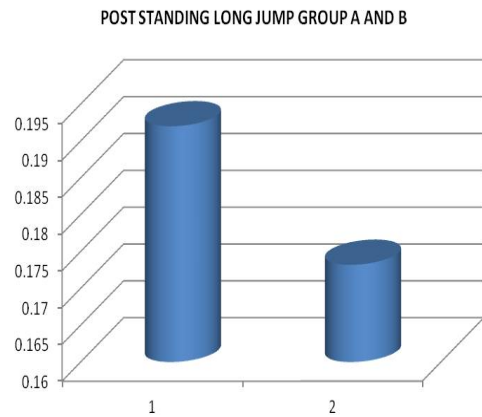
Table 4: The comparison of post-tests scores of standing long jump and post-tests scores of 3

hop tests between group A and group B were analysed using independent t-test statistical analysis. Result shows that there is statistical significant difference in the result in which the p-value is less than 0.05. This indicates that the functional training group have more effect on physical performance of subjects than the control group.

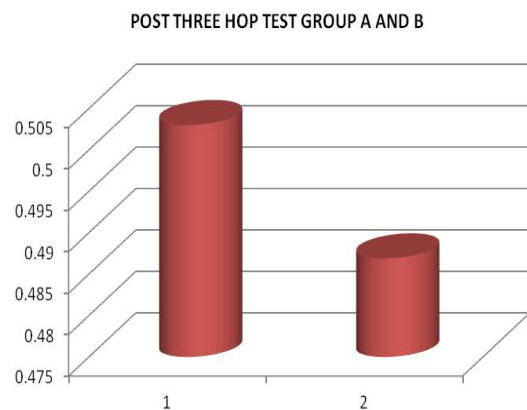
**Table 5:** Shows post-tests mean comparison of (Group A & B) standing long jump and 3 hop test.

outcome measures	Group A	Group B
	mean (SD)	mean (SD)
standing long jump	0.192 (0.005)	0.1732 (0.003)
three hop test	0.503 (0.011)	0.4869 (0.005)

**Fig. 8:** Shows the comparison of post-test mean between group A and B for standing long Jump Test.



**Fig. 9:** Shows the comparison of post- test mean between group A and B for 3 Hop Test.



## DISCUSSION

This aim of this study is to find out the effectiveness of functional training program on post-operative Anterior Cruciate Ligament reconstruction (ACLR) football players. 30 subjects were taken from Vinayaka Mission

Medical College Hospital with age ranging from 18-25 years of age. The university research committee approved the study and informed consent obtained from all subjects before measurements were taken from them.

The results show that both the functional training group and control group had increase in physical performance. However, there is significant difference in the effect of functional training program on improving functional performance of post-operative Anterior Cruciate Ligament reconstruction (ACLR) football players based on the statistical data that states ( $p < 0.05$ ) compared to the standardized rehabilitation program.

White et al (2007) on his study of Anterior cruciate ligament specialized post-operative return-to-sports training shows that the program will help clinicians to better determine an effective post-operative treatment program that will improve modifiable impairments that influence outcomes after ACLR. In addition to the previous study according to Filipa et al (2008) in her studies Neuromuscular Training Improves Performance on the Star Excursion Balance Test in Young Female Athletes is that 6-week duration neuromuscular training program that focused on lower extremity strength and core stability improved performance. This experimental study states their results of using plyometric training can increase the physical performance of a football athlete as described by Wroble and Moxley (2001) The effect of winter sports participation on high school football players: strength, power, agility, and body composition the context of regular training with healthy subjects, the inclusion of intense exercises such as plyometric, high intensity strength contractions along with agility drills, could lead to improved general functional performances without threatening knee safety.

As described by Andrea Reid et al (2007) Hop Testing Provides a Reliable and Valid Outcome Measure during Rehabilitation after Anterior Cruciate Ligament Reconstruction. The results show that the described series of hop tests provide a reliable and valid performance-based outcome measure for patients undergoing rehabilitation following ACL reconstruction. These findings support the use and facilitate the

interpretation of hop tests for research and clinical practice.

The present study showed that from 3rd to 6th month post-Anterior Cruciate Ligament Reconstruction (ACLR), 2 physical training sessions a week (4hrs/week) of intensive training is at least comparable and even more effective (for some functional performances) than 3 sessions a week (6hrs/week) of relatively low intensity training. This could spare time for an eventual progressive introduction of sport specific technical training.

#### LIMITATION OF THE STUDY

- The sample set of the study is very small thus there is less variation of the subjects in terms of gender and unilateral injury.
- There is no long term record of the progress of intervention was assessed, recorded and measured.

#### CONCLUSION

The results of the study made us to conclude that functional training program was effective than the standardized rehabilitation program in improving functional performance post-operative Anterior Cruciate Ligament Reconstruction (ACLR) of football players.

#### RESEARCH RECOMMENDATION

- To widen the sample set towards a larger group of population.
- Increase the baseline measuring tool to 3 or 4 such as the usage of agility 't' test and other plyometric exercise to increase the effectiveness of data accuracy.
- Increase the intervention given that covers not only strengthening but agility speed and balance.

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**Conflicts of interest: None**

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