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Effect of proprioceptive training on knee mobility among athletes with anterior cruciate ligament injury with or without reconstruction

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Abstract
Background: Anterior cruciate ligament serves as the primary restraint to anterior translation of the tibia relative to the femur and also resists excessive internal rotation and valgus stress. Injuries to the anterior cruciate ligament (ACL) are among the most common and functionally disabling injuries in athletes, particularly those engaged in high-impact or pivoting sports such as football, basketball, and handball. Anterior cruciate ligament reconstruction (ACLR) is often performed to restore knee stability and allow return to sport, but postoperative rehabilitation plays a critical role in determining the functional outcome and reducing the risk of re-injury.
Aims and Objectives: To evaluate the effects of proprioceptive training and resistive training to improve knee mobility among athletes having anterior cruciate ligament injury or reconstruction.
Methodology: Thirty athletes with anterior cruciate ligament injury or reconstruction were randomly divided into two groups: Group A and Group B. Group A treated with proprioceptive training and Group B given resistive training. Pre-test evaluation was done on commencement of the study and post-test evaluation was done after 12 weeks of intervention period. Knee goniometry was used as a outcomes measure to assess the knee flexion range of motion. Paired t-test was used to analyze the difference within group and unpaired t-test was used to analyze the data between both groups.
Results: The mean improvement in knee flexion range of motion was in group A and in group B. Both groups showed significant improvements in knee flexion range of motion post-test ($p<0.05$). However, Group A treated with proprioceptive training showed significantly higher improvements than Group B treated with resistive training.
Conclusion: Proprioceptive training was effective tool to improve knee mobility than resistive training in athletes with pre or post anterior cruciate ligament reconstruction.

Keywords: Anterior cruciate ligament injury, reconstruction, knee, flexion, range of motion, proprioceptive training, resistive training

Introduction
Anterior cruciate ligament (ACL) injury is the most common and functionally disabling injuries in athletes, particularly those engaged in high-impact or pivoting sports such as football, basketball and handball. Anterior cruciate ligament reconstruction (ACLR) is often performed to restore knee stability and allow return to sport, but postoperative rehabilitation plays a critical role in determining the functional outcome and reducing the risk of re-injury.
Following anterior cruciate ligament reconstruction, rehabilitation is essential to restore optimal knee function postoperatively. Restoring muscle strength, joint stability and mobility after anterior cruciate ligament reconstruction is complex. Athletes frequently experience deficits in quadriceps and hamstring strength, impaired proprioception and limited range of motion. These impairments can persist even after surgery and traditional rehabilitation and may hinder an athlete's return to pre-injury performance levels. A structured, progressive and individualized rehabilitation program is particularly crucial for individuals aiming to return to sport, where the physical demands on the knee are substantially higher.
The primary goal of rehabilitation following an anterior cruciate ligament (ACL) rupture or reconstruction is to restore full knee function by improving neuromuscular control. This is achieved through a structured approach that targets muscle strength, coordination and

proprioceptive ability. Proprioceptive training (PT) plays a central role in this process, as it focuses on retraining the sensorimotor system to restore dynamic joint stability. Physiotherapy programs are designed to enhance muscle activation patterns, improve joint position sense, and re-establish movement strategies used in both daily activities and sports-specific tasks. These exercises typically include balance tasks, perturbation training, and functional drills that stimulate afferent input from the joint and surrounding musculature, thereby promoting improved reflex responses and motor control. Effective proprioceptive rehabilitation is especially important in athletes, as it helps to reduce the risk of re-injury and supports a safer return to high-level performance.

Resistive training (RT) is a fundamental component of rehabilitation following anterior cruciate ligament reconstruction (ACLR), aiming primarily to restore muscular strength and neuromuscular control.[25] Among the various variables in resistive training, training intensity is considered one of the most critical for achieving specific adaptation outcomes. By manipulating intensity, clinicians and trainers can optimize resistive therapy to target different neuromuscular and physiological adaptations, such as muscular endurance, hypertrophy and maximal strength. For instance, low-to-moderate intensities may promote muscular endurance and early-phase rehabilitation gains, while higher intensities are necessary for building maximal strength and preparing the athlete for the demands of return to sport.

This study aims to evaluate and compare the effects of proprioceptive training and resistive training on improving knee mobility in athletes who have undergone anterior cruciate ligament reconstruction. By focusing specifically on athletic individuals, the study seeks to provide evidence-based insights that are directly applicable to return-to-play protocols and performance-oriented rehabilitation.

Methodology

The 30 athletes with anterior cruciate ligament injury and with or without reconstruction without any complication were recruited as per inclusion and exclusion criteria and randomly divided into group A and group B. Group A received proprioceptive training while group B received resistive training for 12 weeks. The knee flexion range of motion was assessed by goniometry.

Results and Discussion

1. Analysis of Pre-Test and Post-Test Scores Of Knee Flexion Range of Motion within Groups

Table 1: Group A

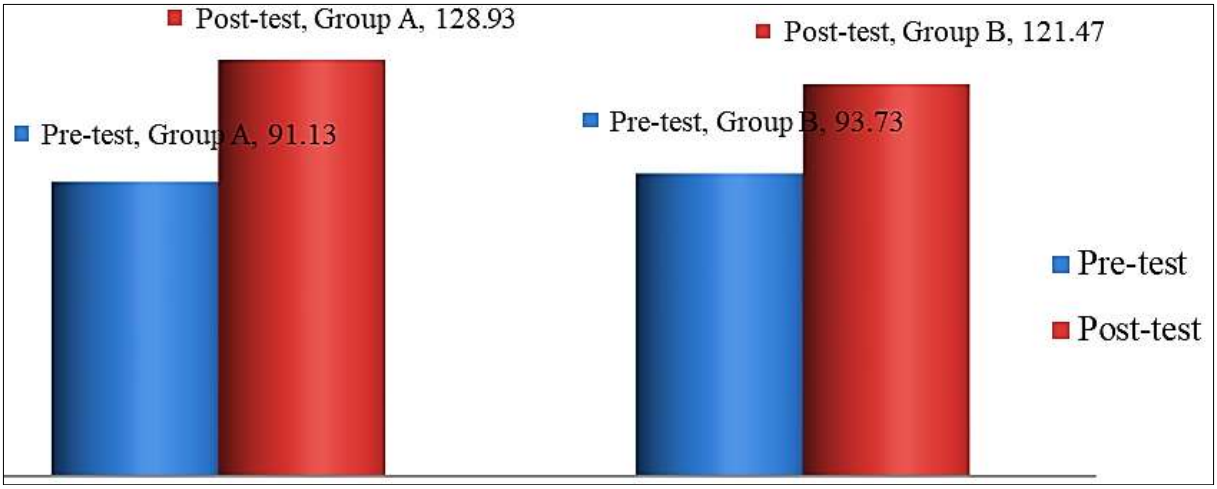
	Mean	N	SD	SEM	R	Mean Diff	SD Diff	T	P
Pre-test	91.13	25	11.363	2.94	0.7470	37.80	0.98	19.242	0.0001*
Post-test	128.93	25	07.583	1.96					

***** Significant difference (P<0.05)

Table 2: Group B

	Mean	N	SD	SEM	R	Mean Diff	SD Diff	T	P
Pre-test	93.73	25	10.833	2.80	0.8350	27.74	0.22	16.477	0.0001*
Post-test	121.47	25	11.686	3.02					

***** Significant difference (P<0.05)



Graph 1: Comparison of Pre-test and Post-test Scores Between Group A and Group B

2. Analysis of Knee Flexion Range of Motion between Groups

Table 3: Pre-Test Scores

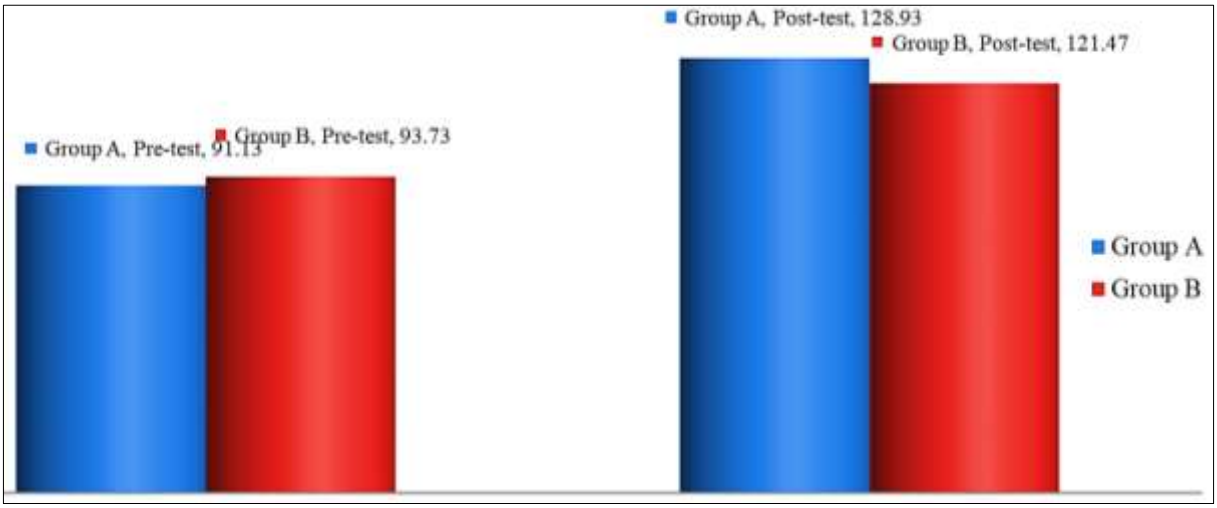
Group	Mean	N	SD	SEM	Mean Diff	SD Diff	T	P
A	91.13	25	11.363	2.94	2.60	0.530	0.8392	0.4154[NS]
B	93.73	25	10.833	2.80				

[NS] Non-Significant difference (P<0.05)

Table 4: Post-Test Scores

Group	Mean	N	SD	SEM	Mean Diff	SD Diff	T	P
A	128.93	25	07.583	1.96	7.46	4.103	2.076	0.0472*
B	121.47	25	11.686	3.02				

*Significant difference (P<0.05)



Graph 2: Comparison of Pre-test and Post-test Mean Scores Between Group A and Group B.

The goniometry of knee joint scores demonstrated a statistically significant improvement in group A treated with proprioceptive training. The mean knee flexion goniometry scores increased from 91.13º at pre-test to 128.93º at post-test, with a mean difference of 37.80º (t = 19.242, p = 0.0001). These findings suggest that proprioceptive training was effective in improving knee joint flexion range of motion. Group B received resistive training showed an increased mean knee flexion goniometry scores from 93.73º at pre-test to 121.47º at post-test, with mean difference of 27.74º (t = 16.477, p= 0.0001). These findings indicate that resistive training was also effective in improving knee joint flexion range of motion. The findings demonstrated significant improvements in both groups; however, the proprioceptive training group (Group A) exhibited a greater mean improvement (37.80º) compared to the resistive training group (27.74º).

The pre-test knee flexion goniometry scores recorded 91.13º in group A and 93.73º in group B, with mean difference of 2.60º. The p value was 0.4154, which was non-significant. Both groups demonstrated comparable baseline scores for flexion range of motion, as there was no significant difference in knee flexion goniometry during the pre-test assessment. This indicates that the groups were homogenous at the start of the intervention, minimizing the possibility of bias related to initial functional status. Following the intervention period of 12 weeks, group A treated with proprioceptive training demonstrated significantly greater improvement compared to group B treated with resistive training in knee flexion goniometry scores. The mean knee flexion goniometry score was 128.93º in group A and 121.47º in group B, with mean difference of 7.46º. The t-value was 2.076 and p-value was 0.0472, which was statistically significant. The post-test analysis between groups revealed that group A treated with proprioceptive training achieved higher mean scores of knee flexion goniometry than group B treated with resistive training.

The findings of this study revealed that both proprioceptive and resistive training interventions led to significant improvements in knee joint flexion range of motion following anterior cruciate ligament reconstruction. However, the post-test comparison between groups indicated that the proprioceptive training group achieved significantly greater gains, suggesting that proprioceptive exercises may offer superior benefits for restoring joint flexibility and functional movement. This indicates that while both interventions were effective, proprioceptive training yielded superior outcomes in restoring knee flexion mobility. These results align with previous research highlighting the crucial role of proprioceptive exercises in post-anterior cruciate ligament rehabilitation. Proprioceptive training enhances neuromuscular control, joint position sense and dynamic stability, all of which are essential for functional recovery and joint mobility (Lephart et al., 1997; Risberg et al., 2001)10 [10, 11]. By stimulating mechanoreceptors and improving sensorimotor feedback, proprioceptive exercises help in regaining coordinated muscle activation around the knee joint, thereby facilitating greater range of motion (Ageberg, 2002) [12]. In contrast, resistive training primarily targets muscle strength, particularly of the quadriceps and hamstrings, which are vital for joint stabilization and functional performance (Palmieri-Smith et al., 2008) [13]. The improvement observed in Group B is consistent with earlier studies demonstrating that progressive resistance exercises enhance muscle force and contribute to improved knee range of motion post-anterior cruciate ligament reconstruction (Petersen et al., 2005) [14]. However, strength training alone may not fully address proprioceptive deficits or neuromuscular coordination, which could explain the smaller improvement in knee flexion compared to proprioceptive training (Fitzgerald et al., 2000) [15]. The greater enhancement observed in the proprioceptive training group may also be attributed to the integrative nature of these exercises, which combine balance, coordination, and functional movement patterns, thereby promoting joint flexibility and dynamic stability (Zatterstrom et al., 1994; Hewett et al., 2002) [16, 17]. This underscores the importance of including proprioceptive

components in anterior cruciate ligament rehabilitation protocols to achieve optimal recovery of joint motion and function. Overall, the present findings support the inclusion of both proprioceptive and resistive training in post-anterior cruciate ligament reconstruction rehabilitation, with emphasis on proprioceptive exercises for maximizing knee joint mobility.

In summary, the results of this study demonstrate that proprioceptive training is more effective than resistive training in improving knee flexion range of motion following anterior cruciate ligament injury or post-reconstruction. Incorporating proprioceptive exercises early in the rehabilitation process can optimize functional outcomes, enhance neuromuscular control and contribute to a more comprehensive recovery.

Conclusion

The study concluded that proprioceptive training is more effective than resistive training in improving knee flexion range of motion following anterior cruciate ligament injury or post-reconstruction. Thus, the proprioceptive training can be included in rehabilitation program of anterior cruciate ligament injury and post-reconstruction rehabilitation.

References

1. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sport following anterior cruciate ligament reconstruction surgery: A systematic review and meta-analysis of the state of play. Br J Sports Med. 2011;45(7):596-606.
2. Hewett TE, Di Stasi SL, Myer GD. Current concepts for injury prevention in athletes after anterior cruciate ligament reconstruction. Am J Sports Med. 2013;41:216-224.
3. Panariello R, Stump T, Allen A. Rehabilitation and return to play following anterior cruciate ligament reconstruction. Oper Tech Sports Med. 2017;25:181-193.
4. Edwards PK, Ebert JR, Joss B. Patient characteristics and predictors of return to sport at 12 months after anterior cruciate ligament reconstruction: The importance of patient age and postoperative rehabilitation. Orthop J Sports Med. 2018;6:2325967118797575.
5. Nagano Y, Ida H, Akai M, Fukubayashi T. Biomechanical characteristics of the knee joint in female athletes during tasks associated with anterior cruciate ligament injury. Knee. 2009;16(2):209-218.
6. Barret DS. Proprioception and function after anterior cruciate reconstruction. J Bone Joint Surg Br. 1991;73(5):833-837.
7. Hoover DL, VanWye WR, Judge LW. Periodization and physical therapy: Bridging the gap between training and rehabilitation. Phys Ther Sport. 2016;18:1-20.
8. Kraemer W, Fleck S. A review: Factors in exercise prescription of resistance training. J Strength Cond. 1988;10:36-41.
9. Potter S. Review of the literature: Guidelines for resistance training for Australian rules football. JASC. 2016;24:59-68.
10. Lephart SM, Pincivero DM, Giraldo JL, Fu FH. The role of proprioception in the management and rehabilitation of athletic injuries. Am J Sports Med. 1997;25(1):130-137.
11. Risberg MA, Holm I, Myklebust G, Engebretsen L. Neuromuscular training versus strength training during first 6 months after ACL reconstruction: A randomized clinical trial. Phys Ther. 2001;81(3):436-447.
12. Ageberg E. Consequences of a ligament injury on neuromuscular function and relevance to rehabilitation – Using the anterior cruciate ligament-injured knee as model. J Electromyogr Kinesiol. 2002;12(3):205-212.
13. Palmieri-Smith RM, Thomas AC, Wojtys EM. Maximizing quadriceps strength after ACL reconstruction. Clin Sports Med. 2008;27(3):405-424.
14. Petersen W, Zantop T, Madajewski B, Schindler A, Schumacher T, Raschke M, et al. The effect of neuromuscular training on the development of strength and proprioception after anterior cruciate ligament reconstruction. Am J Sports Med. 2005;33(1):100-107.
15. Fitzgerald GK, Axe MJ, Snyder-Mackler L. The efficacy of perturbation training in nonoperative anterior cruciate ligament rehabilitation programs for physically active individuals. Phys Ther. 2000;80(2):128-140.
16. Zätterström R, Fridén T, Lindstrand A, Moritz U. Muscle training in chronic anterior cruciate ligament insufficiency — A comparative study of closed and open kinetic chain exercises. Am J Sports Med. 1994;22(5):597-600.
17. Hewett TE, Paterno MV, Myer GD. Strategies for enhancing proprioception and neuromuscular control of the knee. Clin Orthop Relat Res. 2002;402:76-94.