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Revolution in Hamstring Factors after Arthroscopic anterior cruciate ligament Reconstruction using Hamstring Graft

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Abstract

Context: Following anterior cruciate ligament reconstruction (ACLR), patients often experience muscle weakness, with weaker extensor muscles when using BPTB grafts and weaker flexor muscles when using HT grafts. Isokinetic testing is commonly used to measure torque and evaluate knee muscle performance post-ACLR, typically performed between five to six months post-surgery. During this period, extensor torque deficit in the injured leg can exceed 10% and persist for up to two years post- anterior cruciate ligament reconstruction. Various measurements of muscle performance are crucial for facilitating the return to sports and physical activities after anterior cruciate ligament reconstruction. Peak torque, obtained from isokinetic dynamometry and normalized to body mass, is a reliable indicator of joint function and relative muscle strength compared to peers.

Aims: To evaluate changes in hamstring strength and power following anterior cruciate ligament reconstruction with a hamstring autograft at 6 weeks and 6 months post-operatively.

Methods and Material: This observational study was conducted at hospital, following 30 anterior cruciate ligament injury patients between July 2023 to June 2024. The study included all patients with anterior cruciate ligament injuries presenting to the OPD.

Statistical analysis used: The results of the paired t-tests and repeated measures ANOVA are presented, demonstrating the significance of observed changes and recovery trends. Regression analysis explores the relationship between various factors (e.g., age, sex, baseline strength) and recovery outcomes. Longitudinal analysis identifies patterns and trends that inform rehabilitation practices.

Results: A significant increase in maximum range of motion (ROM) extension was observed in the injured knee at the 6-month follow-up compared to 6 weeks. Patients undergoing surgery within 6 months of injury showed better outcomes than those operated on between 6-12 months. Functional outcomes were significantly better in patients with isolated anterior cruciate ligament injury compared to those with anterior cruciate ligament and meniscus injury.

Conclusions: Rehabilitation post- anterior cruciate ligament reconstruction has evolved from a protocol-based approach to a progressive program with increasing difficulty. Early weight-bearing post- anterior cruciate ligament reconstruction is crucial for quadriceps muscle rehabilitation. Patients undergoing anterior cruciate ligament reconstruction shortly after injury showed promising results with improved functional outcomes.

Keywords: Ligament Reconstruction, Injury, Hamstring, Flexor Strength, Gradual Muscle

Introduction

Anterior cruciate ligament reconstruction is pivotal for restoring knee stability and function following an anterior cruciate ligament injury, which is prevalent among athletes and active individuals. The anterior cruciate ligament, connecting the femur to the tibia, prevents excessive anterior tibial translation and provides rotational stability. Injuries to this ligament typically result from non-contact mechanisms such as sudden deceleration, pivoting, or landing from a jump.[1]

Over the years, various graft options have been employed for ACL reconstruction, with the bone-patellar tendon-bone (BPTB) graft historically favored due to its robust fixation properties. However, complications like anterior knee pain and long-term quadriceps dysfunction have led to a shift towards the quadruple hamstring tendon graft. This graft option offers reduced donor site morbidity and quicker recovery, making it increasingly popular in clinical practice.

The primary objective of ACL reconstruction is to restore knee function and muscle strength, particularly in the quadriceps and hamstrings, which are crucial for knee stability. Muscle strength deficits post-surgery are common, varying based on the graft type used and rehabilitation protocols. This study focuses on assessing changes in hamstring muscle strength and power within the first year following ACL reconstruction using an autologous hamstring tendon graft. Hypothesize that complete muscle strength recovery may not be achieved within one year, with knee flexor strength recovery potentially lagging behind that of knee extensors.[3]

The rupture of the ACL often results in increased laxity in the knee joint, leading to episodes of anterior and rotational instability, quadriceps atrophy, degeneration of the articular surfaces, meniscal damage, osteoarthritis, and recurrent pain. To address these symptoms and progressive knee dysfunction, two primary treatment options are available following an anterior cruciate ligament injury conservative rehabilitation or reconstructive surgery.

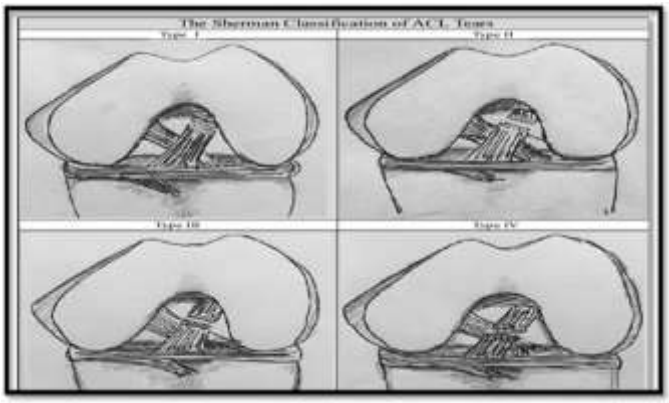

Figure 1: Classification of anterior cruciate ligament injury

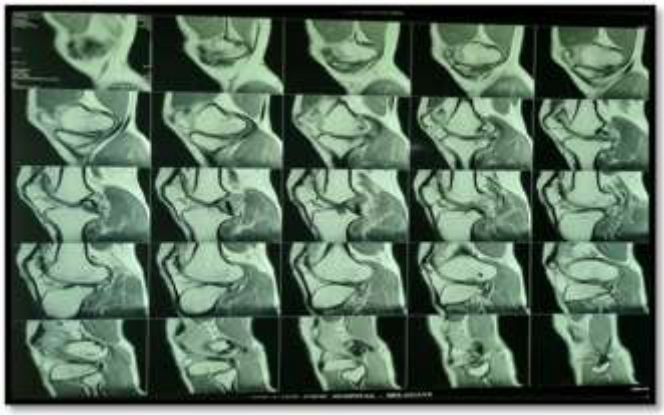

Figure 2: MRI of anterior cruciate ligament injury

Subjects and Methods

This longitudinal study involves patients who have undergone anterior cruciate ligament reconstruction using an autologous hamstring tendon graft. The study employs isokinetic dynamometry to measure peak torque and power of the hamstrings at 6 weeks and 6 months post-surgery. This design allows for the assessment of muscle strength recovery over time and provides insights into the effectiveness of rehabilitation protocols.

Participants

Participants include individuals aged 20-40 years, undergoing primary anterior cruciate ligament reconstruction with hamstring autografts.

Exclusion criteria

1. Previous anterior cruciate ligament injury
2. Concomitant ligament injuries, and any conditions affecting muscle performance.

Inclusion criteria

1. Ensure a homogenous sample
2. Reducing confounding factors that could influence the results.

Data Collection

Isokinetic dynamometry is used to assess peak torque and power of the hamstrings. Measurements are taken at baseline (pre-surgery), 6 weeks, and 6 months' post-surgery. This timeline allows for the evaluation of short-term and mid-term recovery trends.

Data Analysis

Data will be analyzed using paired t-tests to compare peak torque and power between the operated and contralateral sides at each time point. Recovery trends over the 6-month period will be analyzed using repeated measures ANOVA. This statistical approach allows for the assessment of changes over time and the comparison of different time points.

Rehabilitation Process

The rehabilitation process included three phases: early rehabilitation (0-6 weeks), intermediate rehabilitation (6 weeks-3 months), and advanced rehabilitation (3-6 months). Early rehabilitation focused on pain management, reducing swelling, and restoring range of motion. Intermediate rehabilitation emphasized muscle strengthening, proprioception, and gradual return to functional activities. Advanced rehabilitation included sport-specific training and high-intensity exercises to prepare the athlete for return to sport.

Rehabilitation Protocols

Standard Protocol: Emphasized gradual progression with a focus on reducing pain and swelling, restoring range of motion, and gradual muscle strengthening.

Accelerated Protocol: Included early weight-bearing and aggressive strengthening exercises, aiming for a quicker return to functional activities.

Early Rehabilitation Phase (0-6 weeks)

Goals: Pain management, reduction of swelling, restoration of range of motion.

Key Exercises: Ankle pumps, quadriceps sets, heel slides, and passive range of motion exercises.

Challenges: Managing post-operative pain, preventing muscle atrophy, and avoiding excessive strain on the graft.

Intermediate Rehabilitation Phase (6 weeks-3 months)

Goals: Strengthening muscles, improving proprioception, gradual return to functional activities.

Key Exercises: Leg presses, hamstring curls, balance exercises, and proprioceptive drills.

Challenges: Balancing muscle strengthening with the risk of overuse injuries and ensuring proper technique.

Autologous Hamstring Tendon Graft

Muscle strength recovery post-ACL reconstruction using autologous hamstring tendons. Their study revealed that although knee muscle strength progressively improves, it does not fully return to pre-injury levels, with approximately 80% recovery achieved after one year. This persistent muscle strength deficit underscores the need for effective rehabilitation strategies to optimize recovery.

Highlighted a quadriceps strength deficit of nearly 20% post-ACL reconstruction, which can impair knee function and increase the risk of re-injury. This finding emphasizes the importance of targeted rehabilitation programs to address these deficits and promote optimal recovery.[2]

Figure 3: Graft Harvesting

Bone-Patellar Tendon-Bone Graft

The BPTB graft has been a gold standard due to its high initial stability and solid fixation. However, studies have shown that patients often experience anterior knee pain and long-term quadriceps weakness. This graft type is associated with an increased risk of patellar fractures and tendinitis, leading to a shift towards alternative grafts such as the hamstring tendon graft.

Isokinetic Dynamometry

Isokinetic dynamometry is a widely utilized method for assessing muscle strength and power during rehabilitation. It provides objective measures that are essential for monitoring progress and adjusting rehabilitation protocols. Despite its popularity, isokinetic testing has faced criticism regarding the reliability and validity of its devices.

Figure 4: Isokinetic Dynamometer

Mechanisms of ACL Injury

ACL injuries commonly occur in sports that involve pivoting, sudden stops, or landing from jumps, such as soccer, basketball, and skiing. Non-contact injuries account for approximately 70% of all ACL injuries and typically result from a combination of factors, including improper landing techniques, muscle imbalances, and inadequate neuromuscular control. Contact injuries,

though less frequent, often result from a direct blow to the knee.

Statistical Analysis

The results of the paired t-tests and repeated measures ANOVA are presented, demonstrating the significance of observed changes and recovery trends. Regression analysis explores the relationship between various factors (e.g., age, sex, baseline strength) and recovery outcomes. Longitudinal analysis identifies patterns and trends that inform rehabilitation practices.

Results

The baseline characteristics of the study participants are summarized, including age, sex, and initial muscle strength and power measurements. This information provides context for the study population and helps interpret the results. The changes in peak torque and power of the hamstrings over the 6-month period are reported. Comparative analysis between the operated and contralateral sides is provided, highlighting significant findings and trends.

Table 1: Right knee involvement is more than left in this study.

Complaint	Number	%
Left Knee Pain	15	48.57
Right Knee Pain	20	51.43
Total	35	100.00

Table 2: ACL grade 3 is more in this study

Anterior Cruciate Ligament Reconstruction Tear Grade	2	3	Total
Left Knee Pain	10	7	17
Right Knee Pain	6	12	18
Total	16	19	35

Table 3: Showing normal and injured site parameters at 6 weeks of follow up.

	Injured Side				Normal Side					
	MEAN	S.D.	Min	Max	Mean	S.D.	Min	Max	P Value	Inference
Rom Max Ext	30.94	28.80	1	114	30.40	29.08	0	115	0.8194	NS
Rom Max Flx	78.80	37.28	0	123	77.14	36.62	0	123	0.2021	NS
Avg. Peak Torque Ext	46.31	42.80	12	220	43.86	46.98	4	220	0.4550	NS
Avg. Peak Torque Flx	27.40	35.96	5	183	28.17	33.94	4	179	0.6699	NS
Max Power Ext	72.17	85.26	8	395	67.06	72.30	1	303	0.2358	NS
Max Power Flx	30.63	45.05	1	239	34.40	43.26	0	179	0.3674	NS

Table 4: Showing injured and normal side parameters at 6 month follow up.

	Injured Side				Normal Side					
	Mean	S.D.	MIN	Max	Mean	S.D.	Min	Max	P Value	Inference
Rom Max Ext	39.71	30.83	1	110	40.20	26.39	1	88	0.8541	NS
Rom Max Flx	77.94	44.02	0	140	78.49	32.91	12	134	0.8881	NS
Avg. Peak Torque Ext	61.97	56.13	5	186	51.94	34.00	5	159	0.2473	NS
Avg. Peak Torque Flx	41.40	34.05	4	140	34.74	25.24	7	102	0.1648	NS
Max Power EXT	72.46	61.34	5	284	76.11	55.05	1	283	0.5080	NS
Max Power Flx	39.09	35.57	3	155	38.23	26.51	3	104	0.8492	NS

Discussion

The study's findings are interpreted in the context of existing literature on muscle strength recovery post-ACL reconstruction. Potential reasons for incomplete recovery of hamstring strength and power are discussed, including factors such as surgical technique, rehabilitation protocols, and patient adherence.

anterior cruciate ligament reconstruction with an autogenous graft. This slower recovery rate for quadriceps strength can be attributed to the invasive nature of the surgery and subsequent immobilization, leading to muscle atrophy and weakness.[3]

anterior cruciate ligament reconstruction does not significantly affect clinical outcomes or knee stability post-surgery. This suggests that other factors, such as rehabilitation protocols and patient adherence, play a more critical role in determining recovery outcomes.[4]

anterior cruciate ligament reconstruction injury treated with reconstruction compared with the contralateral healthy knee. No differences in the prevalence of OA between the BPTB and quadrupled ST reconstructions were found.

Conclusion

The muscle strength during knee flexion is a composite of the coordinated movement of various muscles, including the biceps muscle of the thigh, the semimembranosus muscle, the semitendinosus muscle, and the gracilis muscle, and accordingly, it is difficult to analyze the properties of the individual flexor muscles.

Optimal function following anterior cruciate ligament reconstruction is dependent on many factors of which muscle strength is one of the most important. Any loss of strength may result in decreased dynamic stability of the knee and place a greater reliance on the passive restraints of the knee.

References

1. Carofino B, Fulkerson J. Medial hamstring tendon regeneration following harvest for anterior cruciate ligament reconstruction: fact, myth, and clinical implication. Arthroscopy. 2005;21:1257–1264. doi: 10.1016/j.arthro.2005.07.002.
2. Eriksson K, Hamberg P, Jansson E, Larsson H, Shalabi A, Wredmark T. Semitendinosus muscle in anterior cruciate ligament surgery: morphology and

function. Arthroscopy. 2001;17:808–817. doi: 10.1016/s0749-8063(01)90003-9.

3. Ferretti A, Conteduca F, Morelli F, Masi V. Regeneration of the semitendinosus tendon after its use in anterior cruciate ligament reconstruction: a histologic study of three cases. Am J Sports Med. 2002;30:204–207.
4. Makihara Y, Nishino A, Fukubayashi T, Kanamori A. Decrease of knee flexion torque in patients with ACL reconstruction: combined analysis of the architecture and function of the knee flexor muscles. Knee Surg Sports Traumatol Arthrosc. 2006;14:310–317. doi: 10.1007/s00167-005-0701-2.
5. Nakamura N, Horibe S, Sasaki S, Kitaguchi T, Tagami M, Mitsuoka T, Toritsuka Y, Hamada M, Shino K. Evaluation of active knee flexion and hamstring strength after anterior cruciate ligament reconstruction using hamstring tendons. Arthroscopy. 2002;18:598–602. doi: 10.1053/jars.2002.32868.
6. Rispoli DM, Sanders TG, Miller MD, Morrison WB. Magnetic resonance imaging at different time periods following hamstring harvest for anterior cruciate ligament reconstruction. Arthroscopy. 2001;17:2–8. doi: 10.1053/jars.2001.19460.
7. Weiler A, Unterhauser FN, Bail HJ, et al. Alpha-smooth muscle actin is expressed by fibroblastic cells of the ovine anterior cruciate ligament and its free tendon graft during remodeling. J Orthop Res. 2002;20:310–317. doi: 10.1016/S0736-0266(01)00109-7.
8. Unterhauser FN, Bosch U, Zeichen J, et al. Alpha-smooth muscle actin containing contractile fibroblastic cells in human knee arthrofibrosis tissue. Winner of the AGA-DonJoy Award 2003. Arch Orthop Trauma Surg. 2004;124:585–591. doi: 10.1007/s00402-004-0742-x.
9. Scheffler SU, Unterhauser FN, Weiler A. Graft remodeling and ligamentization after cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2008;16:834–842. doi: 10.1007/s00167-008-0560-8
10. Lane JG, McFadden P, Bowden K, et al. The ligamentization process: a 4 year case study following ACL reconstruction with a semitendinosis graft. Arthroscopy. 1993;9:149–153. doi: 10.1016/S0749-8063(05)80364-0.
11. Zaffagnini S, De Pasquale V, Marchesini Reggiani L, et al. Neoligamentization process of BTPB used for ACL graft: histological evaluation from 6 months to 10 years. Knee. 2007;14:87–93. doi: 10.1016/j.knee.2006.11.006.
12. Spindler KP, Andrish JT, Miller RR, et al. Distribution of cellular repopulation and collagen synthesis in a canine anterior cruciate ligament autograft. J Orthop Res. 1996;14:384–389. doi: 10.1002/jor.1100140307.
13. Murray MM, Martin SD, Martin TL et al (2000) Histological changes in the human anterior cruciate ligament after rupture. J Bone Joint Surg 82-A:1387–1397.
14. Lee RJ, Ganley TJ. The 5-strand hamstring graft in anterior cruciate ligament reconstruction. Arthrosc Tech 2014;3:e627-31.
15. Darnley JE, Léger-St-Jean B, Pedroza AD, et al. Anterior cruciate ligament reconstruction using a combination of autograft and allograft tendon: a MOON cohort study. Orthop J Sports Med 2016;4:2325967116662249.