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The Efficacy of Aquatic Exercise in Rehabilitation Post-Intra-Articular ACL Reconstruction: A Randomized Controlled Trial

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***Abstract*: Effective rehabilitation following intra-articular anterior cruciate ligament (ACL) reconstruction is critical for restoring knee function and enabling a return to daily activities. Aquatic exercise has been proposed as a beneficial intervention due to its low-impact nature, which may enhance muscle strength and joint mobility. This study aimed to evaluate the efficacy of aquatic exercise compared to traditional land-based physical therapy in the rehabilitation of patients post-ACL reconstruction. The primary objectives were to assess improvements in knee function, pain levels, and muscle strength, while secondary objectives included evaluating range of motion (ROM) and patient satisfaction. A randomized controlled trial was conducted with 30 patients post-ACL reconstruction, randomly assigned to either an aquatic exercise group or a traditional land-based therapy group. Both groups underwent therapy sessions five times per week for 12 weeks. The aquatic exercise regimen included resistance and aerobic exercises in a heated pool. Outcomes were measured using the Lysholm Knee Scoring Scale, Visual Analogue Scale (VAS) for pain, isokinetic muscle strength testing, ROM measurements, and patient satisfaction surveys. Both groups showed significant improvements in knee function, pain reduction, and muscle strength after 12 weeks and at a 24-week follow-up. However, the aquatic exercise group demonstrated significantly greater improvement in knee function (mean difference of 12.4 points, 95% CI 9.1 to 15.7) and pain reduction (mean difference of 2.3 points on the VAS, 95% CI 1.7 to 2.9). They also had superior gains in muscle strength and ROM. Patient satisfaction was higher in the aquatic group, with reports of greater comfort and enjoyment. In conclusion, aquatic exercise is more effective than traditional land-based therapy for post-ACL reconstruction rehabilitation, leading to better outcomes in knee function, pain relief, muscle strength, and patient satisfaction. These findings support incorporating aquatic exercise into rehabilitation protocols for ACL reconstruction patients.**

***Keywords*: ACL reconstruction, aquatic exercise, rehabilitation, pain relief, patient satisfaction.**

1. Introduction

The anterior cruciate ligament (ACL) is the most commonly injured ligament of the knee, playing a crucial role in preventing anterior translation of the tibia relative to the femur and assisting in knee stabilization. ACL injuries, often caused by both contact and non-contact mechanisms, are prevalent among individuals aged 20 to 40. Notably, women are three times more likely to sustain ACL injuries in non-contact scenarios compared to men. These injuries can lead to pain, inflammation, and muscle inhibition, necessitating either conservative treatment or reconstruction surgery if knee instability occurs.

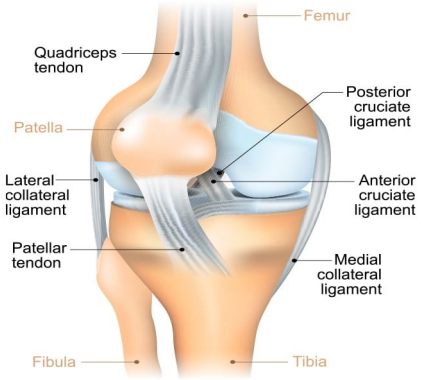

Fig. 1.

ACL reconstruction has advanced significantly, with bone patellar tendon bone autografts being the gold standard. Rehabilitation post-surgery has also evolved, transitioning from long-term immobilization to accelerated protocols allowing immediate weight bearing and quicker return to activities. The primary goals of rehabilitation include restoring knee extension, patellar mobility, reducing inflammation, re-establishing quadriceps control, and achieving full knee range of motion.

Closed-chain exercises, which limit knee stress, are considered safer than open-chain exercises for ACL rehabilitation. Aquatic exercises, leveraging the properties of water, may further reduce joint stress, enhance circulation, and facilitate early mobilization. Research suggests that aquatic exercises do not increase shear forces on the ACL graft and may reduce joint effusion, promoting higher functional activity levels.

Despite the extensive study of land-based rehabilitation, the

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combined effects of land and aquatic exercises have not been thoroughly explored. This study aims to compare the effectiveness of aquatic versus land-based exercises on reducing joint effusion, preventing thigh atrophy, and improving daily living activities post-ACL reconstruction, using the modified Lysholm scale for outcome measurement.

2. Method

A. Subjects

Thirty respondents, aged 20 to 40 (@=29.0, SD=7.8), participants, took part in this research. The same orthopedic physician had conducted arthroscopically assisted intra-articular ACL restoration on all participants, utilizing a bonepatellar tendon-bone autograft. The research excluded participants who had undergone meniscus repair at the time of surgery or who had previously undergone ACL surgery on one of their knees.

B. Detailed Procedure

1) Participant Selection

- Recruit subjects who underwent intra-articular ACL reconstruction based on the following inclusion criteria:
  - Diagnosis of ACL injury requiring surgical reconstruction.
  - Willingness to participate in the study.
- Obtain informed consent from all subjects prior to participation.
- Randomly divide subjects into two groups (n=15 each) using the lottery method to minimize bias.

2) Data Collection

- Collect baseline data from all subjects, including:
  - Name, age, address, occupation, and chief complaints related to the ACL injury.
- Administer the Lysholm scale, a functional questionnaire assessing various parameters such as limp, support, squatting, stair climbing, walking, pain, swelling, and atrophy, at three time points: 2nd week, 4th week, and 8th week postoperatively.

3) Initial Rehabilitation (First Postoperative Week)

Both groups follow an identical rehabilitation program:

- Stretching exercises for hamstrings and calf muscles.
- Ankle pumps and toe movements to promote circulation and prevent stiffness.
- Quadriceps muscle sets to strengthen the thigh muscles.
- Active-assisted range of motion (ROM) exercises for knee flexion and extension (10 minutes).
- Heel drag to improve proprioception and lower limb control.
- Assisted straight leg raises (SLR) to strengthen the quadriceps and hip flexors (3 sets x 10 repetitions).
- Gait training with axillary crutches and a hinged knee brace, gradually progressing to weight-bearing as tolerated.

4) Rehabilitation Program (Second Week Onwards)

a) Group A (Aquatic Exercises):

- Perform exercises in waist-deep water, including:
- Ped-o-cycle for cardiovascular conditioning (10 minutes).
- Gait training without brace, focusing on forward and backward ambulation (10 minutes).
- Range of motion (ROM) exercises for hip flexion, extension, abduction, and adduction (3 sets x 10 repetitions).
- Knee flexion and extension ROM exercises (3 sets x 10 repetitions).
- Step-up and step-down exercises, including front and side variations (3 sets x 10 repetitions).

b) Group B (Land Exercises):

- Perform exercises on land, including:
- Stationary bicycle for cardiovascular conditioning (10 minutes).
- Gait training without brace, focusing on forward and backward ambulation (10 minutes).
- Hip and knee ROM exercises (3 sets x 10 repetitions).
- Step-up and step-down exercises, including front and side variations (3 sets x 10 repetitions).

5) Follow-Up and Data Collection

- Administer the Lysholm scale at the designated time points: 2nd, 4th, and 8th weeks postoperatively to assess functional outcomes.
- Record post-exercise readings after 8 weeks of rehabilitation to evaluate the effectiveness of the intervention programs.

Table 1
Lysholm score mean and standard deviation after 8 weeks in Group A and Group B

Groups	Mean	Standard Deviation	Significance
GROUP A	91.8	4.59	P= 0.31
GROUP B	93.47	4.32	t = 1.02

Table 2
The mean and standard deviation of Lysholm score in Group A (aquatic exercise group) at 2nd, 4th and at 8 weeks

Groups	Pre-Operative	After Four Weeks	After Eight Weeks	Significance
Mean	58.2	80.4	91.8	P= <0.0001
Standard Deviation	10.04	7.17	4.59	f = 265.49

Table 3
The mean and standard deviation of Lysholm score in Group B (land exercise group) at 2, 4 and 8 weeks

Groups	Pre-Operative	After Four Weeks	After Eight Weeks	Significance
Mean	56.67	79.07	93.47	P= <0.0001
Standard Deviation	9.24	5.06	4.32	f = 248.51

6) Data Analysis

- Compile and analyze the collected data, focusing on the outcomes measured by the Lysholm scale.
- Utilize statistical methods to compare the results between the two groups.
- Present the findings using tables and graphs for interpretation and conclusion.

3. Discussion

The ACL of the knee controls movement of the lower leg bone (tibia) relative to the thigh bone (femur) and guides knee extension. The tibiofemoral joint is the largest joint in the body, a modified hinge joint with two degrees of freedom.

The knee joint is particularly susceptible to traumatic injury due to its location at the junction of two long lever arms, the tibia and the femur. Since the joint connects one long bone resting on another, its stability relies on surrounding ligaments and muscles rather than its bony configuration. The cruciate ligaments, which run from the middle of the tibial plateau to the intercondylar area of the femur, play a vital role in stabilizing the knee. "Cruciate" refers to the ligaments crossing each other.

Ligament injuries most frequently occur in individuals between 20 and 40 years of age, with the ACL being the most commonly injured ligament, both through contact and non-contact mechanisms. The most common non-contact mechanism involves rotational forces, where the tibia is externally rotated on a planted foot. This mechanism can account for up to 78% of all ACL injuries.

Assessment of ligament injuries has led to the development of numerous outcome measures, with the modified Lysholm scale being one of the most commonly used scoring systems, first published in 1984.

Studies have shown that water and land exercises, particularly in soccer players, result in significant improvements in function, range of motion, and pain reduction during rehabilitation. Hydrotherapy, especially accelerated hydrotherapy, is a useful adjunct to land-based programs after ACL reconstruction surgery.

A study aimed to determine whether exercises performed in a pool lead to less difficulty with daily activities in patients after intra-articular ACL reconstruction compared to exercises on land. The study duration was eight weeks, with subjects randomly selected and divided into two groups: Group A (aquatic exercises) and Group B (land exercises), each with 15 subjects.

During the first postoperative session, both groups performed the same exercise program. From the second week onwards, subjects performed three sets of ten repetitions of all exercises. From the fourth week until the eighth postoperative week, subjects performed the same exercises, progressing to three sets of fifteen repetitions without difficulty.

The exercises in both groups were carefully matched to ensure that any differences in rehabilitation programs were due to the environment. Outcome measures, using the Lysholm score, were taken at two weeks, four weeks, and eight weeks postoperatively, and data analysis was conducted using statistical software, including the unpaired t-test and ANOVA.

Results showed that both rehabilitation programs were equally effective overall, but differences were noted. Aquatic exercises (Group A) were particularly effective in reducing joint effusion and facilitating lower-extremity function recovery, as indicated by Lysholm scores. Thus, the alternate hypothesis (H_1) was proven, indicating a significant difference between the effects of aquatic and land-based exercises on patients with intra-articular ACL reconstruction.

4. Conclusion

With respect to the rehabilitation of intra articular ACL reconstruction exercises in water and on land, the finding shows that the rehabilitation program for Group A and Group B are equally effective but Aquatic exercises are more effective in reducing joint effusion and facilitating recovery of lower-extremity function as indicated by Lysholm scores. Hence the alternate (H_1) hypothesis has to be proved, that there is significant difference between the effects of Aquatic and Land based exercise on patient with intra-articular ACL, reconstruction.

References

[1] Agrberg E., Consequences of a ligament injury on neuromuscular function and relevance to rehabilitation using the anterior cruciate ligament-injured knee as model, Journal of Electromyography and Kinesiology 2002:12(3):205-12.

[2] Trees AH, Howe TE, Dixon, White L. Exercise for treating isolated anterior cruciate ligament injuries in adults. Cochrane Database of Systematic Reviews 2005, Issue 4.

[3] Snyder-Mackler L., De Luca PF, Williams PR, Eastlack ME, Bartolozzi AR 3rd. Reflex inhibition of the quadriceps femoris muscle after injury or construction of the anterior cruciate ligament. Journal of Borne and Joint Surgery-American Volume 1994, 7641555-60.

[4] Carolyn Kisner, Lyan Allen Colby. Therapeutic exercise 5th edition, New Delhi: Jaypee Brothers Medical Publisher: 2007.

[5] Noyes, F. R., Bassett, R. W., Grood, E. S., & Butler, D. L. (1980). Arthroscopy in acute traumatic hemarthrosis of the knee. Incidence of anterior cruciate tears and other injuries. The Journal of bone and joint surgery. American volume, 62(5), 687–757.

[6] Arendt, E., & Dick, R. (1995). Knee injury patterns among men and women in collegiate basketball and soccer. NCAA data and review of literature. The American journal of sports medicine, 23(6), 694–701.

[7] Paulo's LE, Payne FC. Roseaberg TD. Rehabilitation after anterior cruciate ligament surgery. In: Jackson DW, Drez D It. eds. The Anterior cruciate Ligament of Knee. St Louis, Mo: CV Mosby Co: 1987:291-314.

[8] Beynson, HD, Johnson RJ, Abate JA, et al Treatment of arteries cruciate ligament injuries part 2 Am J Sports Med 33(11) 1751-1767,2005.

[9] Brodersen, MP: Anterior cruciate ligament reconstruction. In Morrey BF (ed) Reconstructive Surgery of the Joints, ed 2. Churchill Livingstone. New York, 1996, p. 1639.

[10] Laimins PD, Powell, SE: Principles of surgery. Part C. Americe cruciate ligament reconstruction: techniques past and present. In Pedowitz RA, O'Connor, II, Akeson, WH (eds) Daniel's Knee Injuries: Ligament and Cartilage Structure, Function, Injury, and Repair, ed 2. Lippincott Williams & Wilkins, Philadelphia, 2003, pp. 472-491,

[11] Mirza F, et al: Management of injuries to the anterior cruciate ligament: results of a survey of orthopaedic surgeons in Canada. Clin. J Sport Med 10:85, 2000.

[12] Shelburne KD, Nits P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. Am Sports Med. 1990:18:292-299.

[13] Kim, CW, Pedowitz, RA: Principles of surgery. Part A. Graft choice and the biology of graft healing. In Pedowitz, RA, O'Connor, II, Akeson, WH (eds) Daniel's Knee Injuries: Ligament and Cartilage Structure, Function, Injury and Repair, ed 2. Lippincott Williams & Wilkins, Philadelphia, 2003, pp. 435-455.

[14] Lee, S., Seong, S. C., Jo, H., Park, Y. K., & Lee, M. C. (2004). Outcome of anterior cruciate ligament reconstruction using quadriceps tendon autograft. Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association, 20(8), 795–802.

[15] Manifold, SG, Cushner, FD, Scott, W N. Anterior cruciate ligament reconstruction with bone-patellar tendon-bone autograft: indications, technique, complications, and management. In Insall, IN, Scott, WN (eds) Surgery of the Knee, Vol. 1, ed 3. Churchill Livingstone, New York, 2001. P. 665.

[16] Mologne, TS, Friedman M J: Arthroscopic anterior cruciate reconstruction with hamstring tendons indications, surgical technique, complications and their treatment. In Insall, IN, Scott, WN (eds) Surgery of the Knee, Vol. I, ed 3. Churchill Livingstone, New York, 2001, p 681.

[17] Fineberg, MS, Zarins, B, Sherman, OH: Practical considerations in anterior cruciate ligament replacement surgery. Arthroscopy 16:715, 2000.

[18] Noyes, FR, Butler, DL, Grood, ES, et al: Biomechanical analysis of human ligament grafts used in knee ligament repairs and reconstructions. J Bone Joint Surg Am 66:334, 1984.

[19] Paulos LE. Noyes FR, Grood ES, Butler DL. Knee rehabilitation after anterior cruciate ligament reconstruction and repair. Am Sports Med. 1981, 9:140-149.

[20] Wilk KE et al. Recent Advances in the Rehabilitation of Anterior Cruciate Ligament Injuries. Orthop Sports Physic Ther 2012; 42(3): 153-171.

[21] Shelburne KD, Wilckens JH. Current concepts in anterior cruciate ligament rehabilitation. Orthop Rev, 1990, 11:957-964.