

Relationship of return to sport time and muscle strength with knee function and muscle endurance after anterior cruciate ligament reconstruction

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ABSTRACT

Background: Anterior cruciate ligament reconstruction (ACLR) is a surgical procedure performed to replace the ligament by grafting tissue that aims to restore stability to the knee joint. Knee function is impaired because the ligament that maintains knee stability is torn. Good knee function is also a reason to return to sports. Decreased muscle strength and endurance can occur in ACL patients, especially those who have undergone ACLR surgery. In order to be able to return to sport is still determined based on time after surgery and improved knee function. This study aimed to determine the relationship of return to sport time and muscle strength with knee function and muscular endurance after ACLR.

Methods: The research method used a literature review compiled using secondary data from relevant journals. The search for journal literature was carried out online through PubMed and Google Scholar using the keywords "ACL", "return to sport", "function", "strength", and "endurance".

Results: Based on the results of the journal review, it was found that muscle strength and endurance will decrease, which will affect knee function. Knee function, in general, is still one of the factors determining return to sport time.

Conclusion: This study concluded that there were possible problems that arise due to ACLR, such as decreased muscle strength and muscle endurance, which could affect knee function and return to sports time.

Keywords: ACL, anterior cruciate ligament reconstruction, knee function, muscle strength, return to sport.

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Introduction

Anterior cruciate ligament reconstruction (ACLR) is a surgery performed to replace the ligament by grafting tissue.^{1,2} ACLR is performed to restore stability to the knee joint.^{3,4} The timing of reconstruction is a factor that can affect the length of recovery and post-reconstruction stiffness.⁵ Delaying reconstruction allows optimization of tissue recovery from the initial injury to be reduced because delayed reconstruction can cause new trauma after recovery from the first injury. Whereas if reconstruction is performed early, there is only one trauma. Early reconstruction also speeds up the return to sport.⁵ Post ACLR, a rehabilitation period is required, which aims to restore normal knee function and strengthen the knee. The post-ACLR rehabilitation period is one part of ACL injury management which also aims to regain the knee's original flexibility. Post ACLR rehabilitation will be needed, especially in athletes, so that they can return to sports immediately.⁶

Decreased muscle strength can occur in ACL patients, especially those who have undergone ACLR surgery.^{7,8} This decrease is due to the loss of afferent reaction from the ACL

to the gamma motor neurons. An imbalance of different muscle strengths also arises post ACLR. If, there is a failure to treat the imbalance, it can affect the patient's functional recovery and the risk of recurrent injury.⁸ The recovery of muscle strength also still has an effect in the form of changes in the pattern of muscle activity.

The occurrence of an injury to the ACL leads to impaired knee function, which also affects muscular endurance. Knee function is impaired because the ligament that is supposed to maintain knee stability is torn.⁷ Muscular endurance is one of the physical components that is considered when improving physical fitness in the form of the ability of one muscle or muscle group to carry out activities, especially exercise, for a long duration without experiencing fatigue.⁹ One test that can be used to determine muscle endurance is the single-leg squat test. This test is a test to determine the functional condition of an extremity.¹⁰ If there is a disturbance in the form of a decrease in muscle endurance, it can affect knee function because the muscles are not able to undergo strenuous activity.⁹ Good knee function is also a reason to return to sports.

Based on the description above, this study aims to find out more about the relationship between return to sport time and muscle strength with knee function and muscle endurance after ACL surgery. The author wants to know more about how much influence muscle strength has on the patient's knee function and how it affects the determination of return to sports time for patients. This research is expected to have benefits for students in adding insight and be useful for physiotherapists in determining an excellent return to sports time for patients.

Methods

This research uses a method in the form of a literature review study or literature review in which the preparation uses secondary data in the form of research journals that have been published and obtained from various scientific journal databases on the internet relating to the relationship between return to sport time and muscle strength with knee function and muscle endurance after anterior cruciate ligament surgery. The journal literature search was conducted online through Google Scholar and PubMed using the keywords "ACL", "return to sport", "function", "strength", and "endurance" by combining the boolean operators "or" and "and." Literature selection was determined based on inclusion criteria and exclusion criteria. The inclusion criteria used in this literature review included: 1) Literature published from credible institutions, 2) The literature reviewed was literature published from the last 10 years. The exclusion criteria in this literature review were patients who did not perform ACL reconstruction and received severe concomitant injuries, including dislocation and fracture. The literature used in the literature review has met the criteria set by the author.

Results

From the results of the literature that has been collected by the author, 5 journals are relevant to the title of this research, which have been included in Table 1.

In the study of Stephan Bodkin et al., it was found that the relationship between lower limb muscle function and subjective knee function had different results depending on the time after ACL surgery.¹¹ The first group of patients less than 2 years post ACLR showed a stronger relationship between measures of involved limb strength and subjective function. The second group of patients 2-5 years post ACLR had a strong relationship between limb strength and measures of single hop symmetry ($r=0.69$, $p=0.002$) and extension work ($r=0.71$, $p=0.002$) as well as measures of unilateral triple hop ($r=0.52$, $p=0.034$) and extension work ($r=0.66$, $p=0.004$).¹¹ The third group of patients who were more than 5 years post ACLR showed a strong relationship between jump symmetry and subjective function.¹¹

In Susanne Beischer et al.'s study, it was found that athletes who returned to knee-loading sports before 9 months post-ACLR had a new ACL injury rate of about 3 to 7 times riskier when compared to those who delayed returning to sports until at least 9 months after surgery. Post-op (hazard

ratio 6.7; 95% CI: 2.6, 16.7; $P<0.001$).¹² However, there was no association between achieving symmetrical muscle function or quadriceps strength with new ACL injury in young athletes.

In the study of O-Sung Lee et al., it was found that post-ACLR patients using hamstring autograft had hamstring muscle strength that remained at the same level of strength as the non-operated leg.¹³ Clinical results obtained in the form of subjective IKDC scores: post-op, 88.1 ± 12.9 , p -value: 0.548. Objective International knee documentation committee (IKDC) score: post-op (A/B/C/D) = 27/12/1/0, p -value: 0.104, and others showed no significant difference after 2 years.

A study by Daniel Niederer et al., found that post-ACLR patients had lower peak knee extensor torque compared to their contralateral extremity (3.2 ± 0.3 Nm/kg vs. 3.5 ± 0.3 Nm/kg). The patient also showed quadriceps dysfunction and asymmetry of the lower extremity. This study also suggests that rehabilitation programs for post-ACLR patients should focus on improving quadriceps muscle function and reducing the level of limb asymmetry. It aims to lower the risk of recurrent injury.¹⁴

In the study of Matthew P. Ithurburn et al., it was found that KOOS scores at 2 years post-op were associated with higher T1rho or T2 relaxation times in the involved knee at 5 years post-RTS ($p < 0.05$).¹⁵ This study also found that athletes undergoing ACLR may experience early cartilage degeneration in the knee joint

Discussion

ACL patients who have undergone ACLR surgery will experience several effects of changes from the reconstruction. Changes that occur after ACLR are decreased knee function and reduced muscle strength. Knee function is one thing that is considered in the rehabilitation phase after ACLR.^{16,17} The goal of ACL reconstruction is to restore the stability of knee function to normal. Knee function will give good results along with the recovery period after reconstruction is carried out. In accordance with the journal results in Table 1, it shows that the longer the post-reconstruction time the functional knee also improves. The time of improvement in knee function is also one of the reasons for patients to return to sports.¹⁷ In Table 1, it is also found that the knee function score after 2 years of RTS has an association with higher T1rho and T2 relaxation times in knee cartilage at 5 years post-RTS.

Return to sport is something that is desired by patients who perform ACLR. Return to sport after ACLR is very risky for re-injury if done before the right time. Time post-ACLR is a common criterion used to determine readiness to return to sport.¹⁹ Another factor in returning to sport is good knee function. Almost one-third of injured athletes stop playing soccer because of poor knee function and fear of new injury.¹⁷

Table 1. Five articles of return to sport time and muscle strength with knee function and muscle endurance after anterior cruciate ligament reconstruction

Author	Title	Methods	Results
Stephan Bodkin, MEd, ATC, John Goetschius, PhD, ATC, Jay Hertel, PhD, ATC, and Joe Hart, PhD, ATC (2017)	Relationships of Muscle Function and Subjective Knee Function in Patients After ACL Reconstruction	Study design: descriptive laboratory study. Total sample size: 51 people. Independent variable: time post ACLR. a. 9 months-2 years, b. 2-5 years, c. 5-15 years. Dependent variable: IKDC score, KOOS. Statistical tests: Chi-square tests, Pearson r correlation coefficients (2-tailed).	Group a: KOOS and unilateral flexion peak torque measures (r=0.514, p=0.035), power flexion (r=0.54, p=0.027). Group b: KOOS and single hop symmetry measures (r=0.69, p=0.002) and extension work (r=0.71, p=0.002). unilateral triple hop measure (r = 0.52, p = 0.034) and extension work (r = 0.66, p = 0.004). Group c: 6-m time hop symmetry and IKDC (r = 0.716, p = 0.001) KOOS (r = 0.71, p = 0.001).
Susanne Beischer, Linnéa Gustavsson, Eric Hamrin Senorski, Jón Karlsson, Christoffer Thomeé, Kristian Samuelsson, Roland Thomeé (2020)	Young Athletes Who Return to Sport Before 9 Months After Anterior Cruciate Ligament Reconstruction Have a Rate of New Injury 7 Times That of Those Who Delay Return	Study design: prospective cohort study. Total sample size: 159 people. Independent variable: muscle function performance. Dependent variable: Tegner Activity Scale score. Statistical tests: SAS statistical analysis system, Man tel-Haenszel chi-square, Mann- Whitney U.	RTS before 9 months post-op (hr=6.7; 95% CI: 2.6, 16.7; p<0.001).
O-Sung Lee , Yong Seuk Lee (2020)	Changes in hamstring strength after anterior cruciate ligament reconstruction with hamstring autograft and posterior cruciate ligament reconstruction with tibial allograft	Study design: case-control study. Sample size: 40 people. Independent variable: type of operation. Dependent variable: hamstring muscle strength. Statistical tests: Student's t test, Mann- Whitney, Pearson's chi-square test.	Subjective IKDC score: post-op, mean±standard deviation= 88.1±12.9, p-value: 0.548 Objective IKDC score: post-op (A/B/C/D) = 27/12/1/0, p-value: 0.104

Daniel Niederer , Kristin Kalo , Johanna Vogel , Jan Wilke , Florian Giesche , Lutz Vogt , Winfried Banzer (2020)

Quadriceps Torque, Peak Variability and Strength Endurance in Patients after Anterior Cruciate Ligament Reconstruction: Impact of Local Muscle Fatigue

Study design: quasi-experimental
Sample size: 19 people
Independent variable: muscle fatigue
Dependent variables: motion variability, peak torque variability
Statistical tests: SPSS 20 (SPSS Inc., Chicago, IL, USA), BiAS for Windows (version 10, 2012, Goethe-University of Frankfurt) or GPower 3.

Post-op patients have a lower peak torque compared to the contralateral limb.
(3.2 ± 0.3 Nm/kg v/s 3.5 ± 0.3 Nm/kg), ($p > 0.05$).

Matthew P. Ithurburn, Andrew M. Zbojniec, Staci Thomas, Kevin D. Evans, Michael L. Pennell, Robert A. Magnussen, Mark V. Paterno, Laura C. Schmitt (2018)

Lower patient-reported function at 2 years is associated with elevated knee cartilage T1rho and T2 relaxation times at 5 years in young athletes after ACL reconstruction

Study design: prospective cohort study
Sample size: 25 people
Independent variable: knee function at 2 years post-RTS
Dependent variable: knee cartilage integrity at 5 years post-RTS
Statistical tests: SPSS (Version 22.0; IBM SPSS Statistics; Armonk, NY) and STATA (Version 14.0; StataCorp; College Station, TX) software.

KOOS scores at 2 years post-RTS were associated with higher T1rho or T2 relaxation times in the involved knee at 5 years post-RTS ($p < 0.05$).

IKDC 2000, International Knee Documentation Committee 2000; ACL-RSI, Anterior Cruciate Ligament Return to Sport After Injury; ANOVA, Analysis of variance; KOOS, knee injury and osteoarthritis outcome score; ROC, receiver operating characteristics; ACLR, Anterior cruciate ligament reconstruction; ACL, Anterior cruciate ligament.

Delaying ACLR may lead to a decrease in muscle strength due to muscle atrophy. The decrease in muscle strength due to disuse of the thigh muscles is essential, as the rehabilitation period will usually take a long time to regain the original muscle strength, compromising lower limb muscle function and the patient's quality of life. Muscle weakness usually appears at 12 weeks post ACLR.²⁰

In this study, the authors realize that there are still several things that are weaknesses and obstacles to this research. The obstacles to this research include difficulties in finding journals that are in accordance with the variables in the research title. Besides that, the author also experienced problems in accessing several journals that had been found. However, this has been handled so that this research can be completed on time.²¹

Conclusion

Based on some of the literature that has been collected along with the previous discussion, the results of the above studies indicate that there are possible problems that arise due to ACL reconstruction, such as decreased muscle strength and muscle endurance, which can affect knee function and *return to sport* time. Therefore, it can be said that there is a possible relationship between return to exercise time and muscle strength with knee function and muscle endurance after ACLR.

Conflict of interest

The author declares no conflict of interest in making this case report.

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Ethical Consideration

This review study used published articles that are accessible. Thus, this study did not require any informed or ethical consideration.

Author Contribution

IDAAFPI conducted a literature search, conceptualized the research design, and prepared and edited the paper; IPYPP and IK also conducted a literature search and reviewed the paper

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