

Relationship between lower limb muscle strength and knee function with quality of life after anterior cruciate ligament reconstruction patients: a literature review

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ABSTRACT

Background: Anterior Cruciate Ligament Reconstruction (ACLR) is an orthopedic surgical procedure to restore a functional knee. Surgical treatment in ACL reconstruction can be performed to optimize the quality of life after ACL injury. Decreased knee function after ACLR is closely related to a person's quality of life in the long term, considering that the knee and other lower limbs have a crucial role in mobilizing and controlling the human body.

Objective: To determine if there is a relationship between lower limb strength after ACL reconstruction and knee function also the quality of life.

Methods: The research method used is a literature review method using secondary data sources through a database of various scientific treatises accessible from internet sites. Scientific papers were searched using keywords such as ACL reconstruction, lower limb strength, knee function, and quality of life to facilitate proper literature retrieval.

Results: Based on the results of the journal study, it was found that there was a decrease in lower extremity muscle strength and a decrease in knee function compared to participants who did not experience ACL injury-ACLR, which caused a decrease in the quality of life of a person so that the preference of physical activity carried out in daily activities also changed with a low level of satisfaction from the expectations and expectations of individuals with ACLR.

Conclusion: Based on some literature that has been discussed, there may be a correlation between the strength of the lower extremities and knee function with the quality of life of a person after anterior cruciate ligament reconstruction with the main predictor of decreased performance in daily physical activity which is closely related to the primary function of the lower extremities, especially the knee.

Keywords: Anterior cruciate ligament reconstruction, knee function, lower extremity muscle strength, quality of life

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Background

The most common injury to the lower extremity is the anterior cruciate ligament (ACL) injury. The incidence of ACL injury is dominant during sports activities that require agility and speed of movement, such as soccer, basketball, and volleyball. ACL injuries generally occur due to a mechanism of trauma with a rotational knee position and hyperextension (non-pivoting injury).¹ An increased knee valgus angle during landing is one of the main causative factors for ACL injuries.² Dynamic knee valgus, described as a combination of hip adduction, hip internal rotation, and knee abduction, is recognized as a common lower extremity alignment seen in non-contact ACL injury situations.³

Anterior cruciate ligament reconstruction (ACLR) is a standard procedure in sports medicine, with an estimated surgery rate of 52 per 100,000 in Australia and 7 and 32 per 100,000 in Sweden.⁴ It is also reported that an estimated 350,000 ACLR are performed annually in the United States.⁵ ACL injury and subsequent reconstruction can lead to ongoing knee symptoms, associated impairment, participation restrictions, and related psychosocial implications.⁶

Poor knee function after ACL reconstruction is likely to increase the risk of future knee disorders demonstrated through abnormal knee joint movements, especially during high-intensity activities. A further study suggested a significant association between a minor degree of knee

flexion during running, a reduced degree of knee extension, and weakness in the quadriceps muscle, which may influence changes in walking patterns and indications of patellofemoral joint problems.⁷ It is believed that changes in the frequency of activity of the quadriceps muscle, hamstring muscle, and both ends of the gastrocnemius muscle after ACLR due to changes in morphology and the nervous system are considered to be risk factors for such weakness.^{8,9} Examination of knee function due to decreased quadriceps and hamstring muscle strength can use the KOOS (knee injury and osteoarthritis outcome score) questionnaire, which serves as an instrument to determine the condition of knee injuries that can be such as post-traumatic osteoarthritis (OA), meniscus, cartilage, and others.¹⁰ The knee score measurement scale and KOOS can also use Lysholm, designed to measure outcomes after knee ligament surgery. The Lysholm score emphasizes the evaluation of knee instability from the patient's opinion regarding knee function and signs of knee instability.¹¹

A person's quality of life after experiencing muscle weakness due to ACLR is less accurate if measured subjectively. High objectivity is needed to determine the quality of life after undergoing ACLR using research instruments designed, validated, and patented according to specifications. The Short Form Health Survey (SF-36) questionnaire contains 36 items used to assess health-related quality of life.^{12,13} Other research instruments that can determine the degree of quality of life of a person after ACLR are Knee Injury Osteoarthritis Outcome Score-Quality of Life, Anterior Cruciate Ligament-Quality of Life, and Assessment of Quality of Life-8D.¹⁴

Research related to ACL injury and its recovery phase in the form of ACL reconstruction has received little attention, especially in Indonesia. The lower extremities, especially the knee, play a significant role in daily activities, from standing, walking, climbing stairs, and other activities that are considered crucial enough to get research to find out how lower extremity muscle strength and knee function decrease after ACLR and its effect on a person's quality of life over a long period. Therefore, the author wants to conduct a literature review to prove whether there are studies that show the possibility of a relationship between lower extremity muscle strength and knee function with quality of life after ACL reconstruction. It is also hoped that through this paper, physiotherapy students in the future can learn the handling related to post-ACLR patients with any symptoms.

Methods

The research method was a literature review using secondary data sources through a database of various scientific articles accessed through internet pages. Scientific reports were reviewed using keywords such as "ACL reconstruction," "knee function," "lower extremity muscle strength," and "quality of life" on search engines such as Google Scholar, PubMed, and Pedro to help identify literature that supports the relationship between lower extremity muscle strength and knee function with quality of life after

anterior cruciate ligament reconstruction. Inclusion criteria for the journals reviewed were literature published by credible institutions, containing three or more variables according to the topic of discussion, and using appropriate measurement tools. The exclusion criteria in this literature review study were the exclusion of research samples that did not have post-ACLR knee symptoms.

Results

Based on a literature review conducted on four types of literature studies, the results of the analysis of scientific articles regarding the description of lower extremity muscle strength and knee function after anterior cruciate ligament reconstruction and its relationship with quality of life are presented.

The study by Jennifer L (2020) is a cross-sectional study in which individuals aged six months to 2 years post ACLR undergo an assessment in the following order: quadriceps isometric strength and central activation, isokinetic strength, functional tests, patient-reported outcomes, and magnetic resonance imaging (MRI) of the lower extremity. Before the MRI, each patient was given time to rest and completed a patient-reported outcome questionnaire.¹⁵

Thirty participants underwent unilateral ACLR, neuromuscular strength was measured using an isokinetic dynamometer, knee function was measured using a hop test, and the patient-reported outcome was measured using the International Knee Documentation Committee and the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire. These measurements showed an association between ACLR and decreased leg muscle strength with a unidirectional nature of the relationship ($P < 0.05$). The results of this study also found that there was a significant relationship between the IKDC questionnaire score and the description of the condition of the knee extensor isokinetic strength deficit ($P = 0.039$), and there was a significant relationship between the symmetry of the single-hop test and symmetry in the isometric knee-extensor ($P = 0.002$).¹⁵

A case-control study by Thomas (2013) involving 15 individuals as research participants who had ACL injuries and ACL reconstruction, had measured hip, knee, and ankle muscle strength using an isokinetic dynamometer and obtained the results of the study that there was a relationship between muscle strength of the hip adductor and hip extensor which was stronger postoperatively in the ACLR group ($P < 0.05$), besides that in this study also found that there was a relationship between ACLR and knee flexor-extensor muscle strength in patients ($P < 0.05$) where muscle strength was greater postoperatively. In the ankle region, the measurement results in this study have different results from the measurement of muscle strength in the hip and knee region, and the study results in state that there is no relationship between ACLR and plantar flexor and dorsi flexor muscle strength in postoperative patients ($P > 0.05$).¹⁶

A cohort study by Soderman (2017) with 61 patients was conducted to measure quadriceps muscle strength, knee

function, and knee biomechanics during running. The average patient in this study had undergone ACLR within 12 to 24 months before the study. Quadriceps muscle strength measurements were performed with an isokinetic dynamometer and showed a little flexion moment when muscle measurements were taken ($P=0.03$). This result also refers to poor knee function as it affects biomechanics during running ($P=0.03$).¹⁷

Stephanie R Filbay (2018) conducted a cross-sectional study that measured the quality of life of a person after undergoing ACL reconstruction by comparing groups of participants measured using a specific quality of life measurement questionnaire related to knee conditions (KOOS-QoL) and groups of participants measured using a general quality of life questionnaire (SF-36). A total of 113 participants who had undergone quality of life measurements with specific questionnaires (KOOS-QoL, ACL-QoL, and AqoL-8D) at 5 to 20 years post ACLR showed more significant limitations in sports and socioemotional activities in individuals with lingering knee complaints post ACLR.¹⁴

Discussions

Anterior cruciate ligament reconstruction (ACLR) is one of the surgical procedures performed to restore joint stability after ACL injury and aims to facilitate functional recovery of the leg.¹⁵ Although the primary goal of ACLR is to restore knee functionality, ACLR is also said to have an unfavorable impact on decreased muscle strength. In addition to decreased strength, there is an approximate 3% decrease in the quadriceps muscle's volume and surface cross-sectional area postoperatively.^{18,19} Many individuals exhibit long-term effects such as knee instability, pain, decreased quadriceps muscle strength and atrophy, and even reduced range of motion such as knee flexion and extension which can lead to the inability of patients to perform targeted activities of daily living.¹⁵ The decrease in quadriceps muscle strength in the inactive limb after ACL injury compared to the active dominant limb.^{20,21} The limb that underwent surgery was weaker and had a smaller volume and less activation than the contralateral side of the limb. In addition, scores on the single-hop test showed lower results with a shorter distance traveled in the limb that underwent surgery.¹⁶

ACLR results in decreased strength and volume in the quadriceps muscle and weakness in the hamstrings or hamstrings, gastrocnemius, and ankle plantar-flexor muscles, which are also common after ACL injury and reconstruction. It is hypothesized that after an individual sustains an ACL injury and undergoes reconstruction, the hip flexor and hip extensor muscles will experience weakness. There was a difference between knee flexor and extensor strength between individuals on average 40 months after ACL reconstruction. Furthermore, it was also mentioned that the ACL injury group showed more significant ankle-plantar flexor muscle weakness preoperatively than postoperatively. Pre-operative weakness of the gastrocnemius muscle, which acts as a plantar flexor, is likely a consequence of the ACL injury as the gastrocnemius muscle is connected to the quadriceps and

has the potential to atrophy due to prolonged disuse in the pre-operative phase.¹⁷

Decreased lower limb muscle strength and volume certainly affect knee function in the long term. Patients with intact ACL grafts report higher sports and recreational activity levels than those with ruptured or missing ACL grafts. The data reinforced this argument that 36 out of 60 patients had abnormal knee extension, followed by the results that 40 out of 60 patients had osteoarthritis in the tibiofemoral compartment. It was concluded that, on average, patients who underwent ACL reconstruction after 31 years with intact ACL grafts reported higher levels of sport and recreational activity compared to patients who underwent ACL reconstruction with ruptured or missing ACL grafts, whereas patients with severe osteoarthritis reported significantly lower sport and recreational activity when measured using the Knee Osteoarthritis Outcome Score.¹⁴

Muscle strength and knee function after anterior cruciate ligament reconstruction affect a person's quality of life, considering that the leg is dominant in supporting the body. Their daily activities have changed, and they feel dissatisfied with their level of physical activity because before experiencing ACL injury and then performing ACL reconstruction, they had a high level of physical activity. A study showed that the ACLR cohort group had weaker performance related to knee function compared to the group that did not undergo ACLR. Reduced quadriceps femoris muscle strength leads to decreased physical activity performance in individuals reported by the IKDC score and single-leg hop test.²⁰

Quality-of-life measurements were made in post-ACLR individuals who experienced complaints with or without radiographic osteoarthritis. The measuring instrument used to measure the quality of life scale is the ACL-QoL which is used to get a description of the patient's condition, such as pain or decreased physical activity, with 31 question items divided into five categories, namely: symptoms and physical complaints, work-related concerns, recreational activities and sports participation or competition, lifestyle, and social and emotional. In addition, quality of life measurements was also carried out using instruments such as KOOS-QoL and AqoL-8 Dimensions to obtain objectivity values from each individual. Pain, stiffness, and weakness in the knee were joint in patients with post-ACLR complaints in both patients with and without radiographic osteoarthritis (ROA), with a value of ($P<0.001$) in individuals without ROA.¹⁵

In the aspect of work-related concerns, the quality of life of individuals can be said to be affected after ACLR due to the loss of part of working time to carry out post-ACLR knee rehabilitation. In terms of recreational and sports participation, individuals with knee complaints without ROA are limited in participating in the level of sports activities, and there is a fear of exercising after ACLR; patient psychology ($P<0.04$) which in the future will undoubtedly affect the physical fitness of individuals and affect their quality of life. In the lifestyle item, the impact seen after ACLR was issues related to safety in every concept of activity, limitations in

gym activities, limitations in other fitness activities, concerns about knee problems, and lifestyle modifications caused by post-ACLR complaints in individuals without ROA ($P < 0.05$). In the socio-emotional aspects of individuals with post-ACLR knee complaints without ROA, there were many worries due to limitations in socializing with others due to poor knee complaints, difficulty handling knee complaints during activities, and decreased self-confidence in carrying out daily activities, especially in public places due to existing knee complaints ($P < 0.03$).¹⁴

The limitations of this study were not explained regarding the surgical technique, time of surgery, and the type of graft used, so there is a possibility of bias, and it cannot be generalized to all patients with ACL reconstruction. Future studies can explain the specifics of the surgical technique, time of surgery, and type of graft in patients with ACL reconstruction and their relationship between lower limb muscle strength and knee function with quality of life.

Conclusion

Based on some of the literature reviewed, it was found that there is a possible correlation between lower extremity muscle strength and knee function with a person's quality of life after anterior cruciate ligament reconstruction, with the main predictor being decreased muscle strength which affects performance in daily physical activities and is closely related to the primary function of the lower extremities, especially the knee.

Conflict of interest

This research is devoid of any conflicts of interest.

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Ethical consideration

This literature review used publicly accessible documents as evidence and did not require institutional ethics approval.

Author contribution

NPACD conceptualized the research design, conducted a literature search, and prepared and edited the paper; AAGAPN also conducted a literature search and reviewed the text.

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