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# EVALUATION OF ISOKINETIC KNEE STRENGTH IN INDIVIDUALS WHO HAVE RECEIVED ADVANCED ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH DIFFERENT AUTOGRAFT METHODS – A MINI-REVIEW

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**Abstract:**
The anterior cruciate ligament (ACL), which has an important place in the biomechanics of the knee joint, is the most frequently injured ligament due to various reasons,

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especially sports injuries. Injury to ACL reduces the mechanical stability and proprioception of the knee joint, and long-term pain, decreased muscle strength, and functional loss may occur in the knee joint. Isokinetic tests, which are objective evaluation methods, are frequently preferred in the evaluation of muscle strength. There are many different protocols for reconstruction, which is one of the most common surgical procedures for the knee area. It is important to monitor the functional level and muscle strength of the knee joint at regular intervals after the reconstruction in order to measure the success of the surgical procedure and to compare different surgical protocols. This mini-review presents evidence for the results of isokinetic muscle strength tests after ACL repair performed with different autograft methods.

**Keywords:** isokinetic tests; ACL reconstruction; athletes

## 1. Introduction

Anterior cruciate ligament arthroscopic reconstruction (ACLR) involves the preparation and restructuring of grafts through tunnels opened into the femur and tibia in order to restore ACL function in individuals with ACL insufficiency and to reduce the risk of future osteoarthritis and degeneration in other soft tissues of the knee joint (Beynnon et al., 2005; Salzler et al., 2015; Wilk et al., 1994).

ACL, which is the most important ligament that provides stability to the knee joint, is of great importance because it adjusts the stiffness of the quadriceps (Q) and hamstring (H) muscles in the agonist-antagonist structure of the knee joint (Genç and Güzel, 2022). It also provides safe reciprocal movements such as extension (Ex) and flexion (Flx) and performs a proprioceptive function (Koga et al., 2010). From this point of view, ACLR, which is very important for athletes, is one of the most frequently applied orthopedic surgical procedures in sports medicine (Nordenvall et al., 2012). ACL injuries typically occur as a result of sudden deceleration, change of direction, or hard blows to the knee (Pua et al., 2008; Wilk et al., 1994). Hamstring autograft (HT), one of the most frequently applied ACL methods, is the conventional method performed with semitendinosus/gracilis (ST/G) tendons (Middleton et al., 2014). While tendon allografts are preferred in 40% of primary ACLR performed in the United States, autografts from the patient's HT, patellar tendon (PT) or M. Quadriceps femoris tendon (QT) are preferred in 60% of the remaining reconstructions (Salzler et al., 2015).

The most objective data on the rehabilitation process and knee strength assessments for post-ACL return to sports (RTS) are provided by isokinetic dynamometers (Rivera-Brown et al., 2022; Ohji et al., 2021; Herbawi et al., 2022). In isokinetic dynamometers, in addition to the Ex and Flx peak torque force mutually applied by the knee, H/Q force ratios, which are defined as the unequal force between the right and left Q and H muscles are evaluated (Huang et al., 2017; Genç and Güzel, 2022). While this ratio is considered normal at 60° angular velocity in isokinetic

dynamometers, the ratio may vary between 50% and 80% as the angular velocity increases (Kellis and Baltzopoulos, 1995; Ermiş et al., 2019). In the literature, most of the studies examining the muscle strength of individuals who have undergone ACLR indicate that individuals have insufficient muscle strength even in the second year after the reconstruction, regardless of the graft type (Ageberg et al., 2009; Petersen et al., 2014). It is a known fact that individuals can return to their sports routines with a well-structured rehabilitation program following successful ACLR with PT or HT graft (Gobbi and Francisco, 2006)

There are many studies in the literature in which post-ACLR comparisons were made by researchers using isokinetic tests with different graft methods (Genç and Güzel, 2022; Martin Alguacil et al., 2018; Hunnicutt et al., 2019). When all this information is evaluated, the present study aims to evaluate the results of isokinetic knee strength in patients who underwent ACLR with different graft methods.

## 2. Material and Method

The study was conducted by using Google Academic, YÖK Thesis and Pub-Med databases. The studies to be included in the study were filtered as between 2010 and 2022. The keywords used in the literature review were 'ACL, Reconstruction, Isokinetics, Strength, Hamstring tendon graft, Quadriceps tendon graft, Patellar tendon graft'. Inclusion criteria were determined as studies in which participants had a diagnosis of isolated ACL rupture in only one knee without concomitant meniscal, chondral, or other ligamentous injuries, and underwent ACLR with HT, QT, or PT grafts, studies in which participants did not have other neuromuscular or musculoskeletal injury, and a history of contralateral knee surgery or injury and studies in which at least 3 months had passed since the ACLR. Studies in which any exercise program was applied to the participants were excluded from the study.

## 3. Results

**Table 1:** Review of literature researches evaluating isokinetic knee strength after ACLR

| Authors | Participant group | Comparison group | Isokinetic assessment | Follow up | Outcome |
|---|---|---|---|---|---|
| Genç and Güzel (2022) | 29 Male HT Mean age:24.65 Athletes | Contralateral limb | 60, 180, 240 °/s | 6 months | 6-month isokinetic knee strength gave high results on the non-operated side and when evaluated in terms of return to sports, the H/Q ratios of the operated side were sufficient. |
| Yosmao et al. (2002) | 40 Male HT Mean age: 24.65 | Contralateral limb | 60, 180 °/s | 12 months | H-Q muscle strength was insufficient. |

| | | | | | |
|---|---|---|---|---|---|
| Hunnicutt et al. (2019) | 7 Male, 8 Female PT Mean age: 18.0 | 12 Male, 3 Female QT Mean age: 25.0 | 60, 180 °/s | 8 months | Similar results were obtained when QT and PT autograft were compared. |
| Karasel et al. (2010) | 38 Male, 5 Female PT Mean age: 27.6 6 athletes, 37 sedentary individuals | Contralateral limb | 60, 180, 240 °/s | 16.2 months | Q muscle strength was significantly lower on the operated side only at angular velocity Ex 60º/sec. Flx/Ex muscle strength ratios on the operated side were significantly higher at all angular velocities. |
| Martin Alguacil et al. (2018) | 23 Male, 3 Female QT Mean age: 18.7 Athletes | 16 Male, 9 Female HT Mean age: 19.2 | 60, 180, 300 °/s | 3, 6, 12 months | An ACLR with a QT graft showed similar functional results in soccer players at 12-month follow-up, with a better isokinetic H/Q ratio compared to an ACLR with HT. |
| Fischer et al. (2018) | 34 Male, 247 Female QT Mean age: 21.7 | 47 Male, 16 Female HT Mean age: 21.5 | 60 °/s | 6 months | Graft type appeared to have an effect on extensor strength in the first months after ACLR; however, it has no effect on flexor strength. A higher H/Q ratio was found in patients with QT grafts in the first months after surgery. |
| Guney Deniz et al. (2018) | 18 Male, 4 Female HT Mean age: 26.7 17 Male, 5 Female QT Mean age: 27.8 17 Male, 4 Female TAA (tibialis anterior allograft) Mean age: 26.4 | 20 Controls | 60, 180 °/s | 13.3,13.1, 13.5 months | Compared with healthy controls, patients developed impaired muscle strength an average of 13.5 months after ACLR. |
| Ulusoy (2014) | 30 Male HT Mean age: 28.9 | 30 Male Mean age: 28.0 | 60, 180 °/s | 3 months | At week 12, a deficit of 22% was found in the knee Flx muscles at an angular velocity of 60˚/s, while a deficit of 14% was found in the knee Flx muscles and a deficit of 28% was found in the Ex muscles at an angular velocity of 180˚/s. |
| Baltacı et al. (2013) | 30 Volunteers Mean age: 29 | Contralateral limb | 60, 180 °/s | 3 months | In the Q muscle strength evaluation performed in the early postoperative period, Q muscle strength was found to be 36% at 60˚/s angular velocity and 32% at 180˚/s angular velocity. |

## 4. Discussion and Conclusion

There are many studies in the literature in which post-operative isokinetic strength assessment was performed in patients who underwent ACLR with different graft

methods. Peak torque is the most common force measurement obtained and used from isokinetic dynamometers, one of the methods used to evaluate post-ACLR RTS and physical activity, muscle strength and performance, and this value can usually be shown as a percentage by normalizing to body mass (Zvijac et al., 2014). Although the accelerated rehabilitation program after ACLR recommends starting exercises for movement, weight transfer and Q contraction as soon as possible, it takes time for knee extensor strength to return to normal, but sometimes it is not possible (Mattacola et al., 2002; Holsgaard-Larsen et al., 2014; Järvelä et al., 2022). Kvist et al. showed that the difference between the strength of the operated leg and the non-operated leg should be 15% at most for RTS after ACLR and also stated that one of the most important parameters for RTS after ACLR is the ratio of the operated leg to the non-operated leg (Kvist, 2004). In their systematic review, Abourezk et al. reported that there was a difference of more than 15% in the H muscle strength of the operated side compared to the non-operated side in 50% of their samples (Pai et al., 1997). Only 12-16% of individuals who undergo ACLR achieve 90% of the QF strength of the unaffected extremity within six months after surgery (Wilk et al., 1994). A study by Otzel showed that peak QF torques at 60°/s and 180°/s angular velocities were lower on the operated side compared to the non-operated side in the ACLR group (Otzel et al., 2015). It is stated that H muscle strength is adversely affected in both early and late periods in ACLR performed with HT graft (Altay, 2001; Wong et al., 2005; Feller and Webster 2003; Tow et al., 2005). In addition, many studies in the literature reported that individuals who underwent ACLR with HT grafting did not differ in terms of peak H muscle strength on the operated and non-operated sides at the post-operative 12th and 24th months (Adachi et al., 2003; Segawa et al., 2002; Maeda et al., 2002). Feller et al. showed that there was an 11% deficit in the Q muscle at an angular velocity of 60º/s and the patients reached normal muscle strength values in their measurements at the 12th month after ACLR (Feller and Webster, 2003). In the evaluation of Q muscle strength after ACLR, it was found to be 36% at 60˚/s angular velocity and 32% at 180˚/s angular velocity (Baltacı et al., 2013). While many studies in the literature reported that the Q force was low even 2 years after ACLR, Victor et al. reported that the Q force was low at 6 and 12 months after surgery, but could fully recover at 24 months (Wilk et al., 1994; Otzel et al., 2015; Kobayashi et al., 2014; Victor et al., 1997). Another study examining the effect of graft selection in ACLR reported an average of 10% insufficiency in the H and Q muscles two years after the operation, regardless of the graft method; however, it was observed that insufficiency in the H muscles was significantly more pronounced in individuals using HT grafts (Shaerf et al., 2014).

Due to the multiplicity and variety of studies in the literature, although there are controversial results about muscle strength in individuals after ACLR, and although it is seen that H and Q muscle strength improves in the late period after ACLR, there is a loss of strength when compared to healthy individuals. The fact that the muscle strength of individuals who have undergone ACLR is lower even in the long term after surgery

shows us that more importance should be given to gaining muscle strength in rehabilitation. Since most studies in the literature cannot evaluate pre-ACLR isokinetic muscle strength data, it does not include muscle strength differences between both extremities before ACLR and pre- and post-reconstruction comparisons; therefore, it is not possible to obtain a transparent result.

Muscle strength assessment before surgery in patients who are planned for ACLR is valuable in terms of shaping the treatment program correctly in the rehabilitation process awaiting the patient after the operation. H and Q muscle strength values, which are frequently evaluated after ACLR, are insufficient to determine the target and measure the benefit of the rehabilitation program in the absence of pre-reconstruction values. H and Q muscle strength losses, which are encountered in long-term follow-ups after reconstruction, have once again emphasized the place of these muscles, which have great importance in terms of lower extremity functions and balance of the patient in the rehabilitation program, in the treatment program.

**Conflict of Interest Statement**

The authors declare no conflicts of interest.

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