

QUADRICEPS AND HAMSTRINGS FORCE AND RATE-OF-FORCE DEVELOPMENT DEFICITS IN PEOPLE BEFORE ACL SURGERY

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Introduction

One of the most important aspects of return to sport assessments after an anterior cruciate ligament (ACL) reconstruction is the quadriceps and hamstrings strength [1]. The limb symmetry index (LSI) and the Hamstrings to Quadriceps ratio (H/Q ratio) are common metrics in return to sport evaluation, as achieving an LSI higher than 90% and a H/Q ratio of 50-80% decreases the chance of a second ACL injury [2].

A known problem with those metrics is that they overestimate the muscle force in the non-injured leg, as this measure decreases over the long period of rehabilitation after injury. Another important but less researched measure is the Rate-of-Force Development (RFD), assessing how fast one can recruit force. The gold standard for RFD assessment is an isokinetic chair, expensive and stationary equipment that limits its use mainly to research labs.

To address these issues, we used a handheld dynamometer in a public hospital environment and assessed the LSI and H/Q ratio of the force and RFD among people before an ACL surgery.

Methods

Sixteen recreational athletes, 14 males and two females, before an ACL reconstruction surgery (age 25.6 ± 7.1) and 23 healthy participants (age 28 ± 5.7 , 12 males and 11 females) signed informed consent and were recruited to this study.

Using a Microfet2 handheld dynamometer attached to a belt, the participants' quadriceps force, hamstrings force, and RFD were measured while sitting at the end of a treatment bed with their hip flat on the bed and their knee at 90 degrees. The dynamometer was placed 5cm above the lateral malleolus. After familiarization and a warm-up session, each participant was asked to push as hard and fast as possible for three repetitions with one-minute rest between reps, assessing the quadriceps.

The same routine was repeated for the hamstrings, with the assessor holding the dynamometer between his hand and a wall to stabilize it. Those methods are reliable, with an ICC of 0.83-0.93 [3,4]. Two RFD phases were measured, early and late (0-100ms and 0-200ms, respectively),

The LSI was calculated as the ratio between the injured leg value and the uninjured leg value and as the ratio between the left and right leg for the healthy participants.

Results

As shown in Table 1, the peak force LSI of the quadriceps is more affected than the hamstring's LSI. Further, the LSI of the RFD shows higher deficits in both muscle groups. All of the LSI values among non-injured participants are within the normal range [2].

Quadriceps LSI (%)	Injured (n=14)	Non-Injured (n=23)
Peak Force	80± 19.6	98.4± 10.9
RFD100	69.6± 29.1	91.3± 17.1
RFD200	69.7± 21.9	97.5± 18.7
Hamstring LSI (%)		
Peak Force	92.1± 29.1	102± 16.4
RFD100	90.8± 42.2	102± 25.6
RFD200	83.4± 39.6	107± 27.7

Table 1: limb Symmetry Index of the quadriceps and hamstring muscles force and rate of force development among injured and non-injured participants

The H/Q ratio among the injured participants was $59.3\% \pm 17.7$ for peak force, $48.9\% \pm 25.7$ for early RFD, and $52\% \pm 28.2$ for late RFD.

In comparison, the H/Q ratio among the non-injured participants was $58.2\% \pm 11.3$ for peak force, $41.6\% \pm 15$ for early RFD, and $48.9\% \pm 15$ for late RFD.

Discussion

While the most common use of LSI in return to sport decision after an ACL injury is the peak force, we have found that early and late RFD are more affected among people before an ACL reconstruction. The H/Q ratio, on the other hand, presented as similar when comparing the injured and non-injured groups.

These findings show the importance of comparing not only to the injured leg but to a healthy cohort, as differences that might seem important could turn out to be less relevant.

As it is now possible to measure RFD with portable and inexpensive equipment, healthcare practitioners will be able to assess not only the peak force but also the LSI and H/Q ratio of the quadriceps and hamstring RFD.

References

1. Do Kyung et al, Sci Rep, 12(1): 5830, 2022
2. Lynch et al, Br J Sports Med, 49: 335–342, 2015
3. Mentiplay et al, PLoS One, 10: 0140822, 2015
4. Yona et al, Mendeley Data, 2022

