

# Quadriceps Strength Symmetry is Associated With Jump Landing Symmetry at Clearance for Return to Sport after ACL Reconstruction

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## Summary

Isokinetic quadriceps strength testing and jump landing biomechanics are common components of return to sport testing after anterior cruciate ligament reconstruction (ACLR). This study aimed to provide insight on the longitudinal association between strength and biomechanical measures across rehabilitation stages. Patients from an ongoing point of care study completed testing during the mid-rehabilitation phase and a second visit during the late-rehabilitation phase. At both visits, patients completed quadriceps strength testing. Jump landing performance data was collected during the late-rehabilitation visit. The results indicated a positive association between quadriceps strength symmetry and landing symmetry longitudinally and cross-sectionally.

## Introduction

Isokinetic quadriceps strength and jump landing assessments are functional tasks used to determine physical readiness for sport participation after ACLR. Despite the popularity of these assessments, the longitudinal association between quadriceps strength limb symmetry index (LSI) and jump landing peak impact force (PIF) LSI is poorly understood. Quadriceps strength assessments can be completed throughout all stages of rehabilitation. However, jump landing is not typically performed until late-rehabilitation. Understanding the relationship between early and late rehabilitation performance may allow clinicians to monitor the patients' return to sport trajectory. Therefore, the purpose of this study was to assess the longitudinal and cross-sectional relationship between quadriceps LSI and jump landing performance LSI in ACLR patients. It was hypothesized that there would be a positive relationship between quadriceps LSI and PIF LSI both longitudinally and cross-sectionally. A secondary purpose was to investigate the role of sex in the longitudinal analysis.

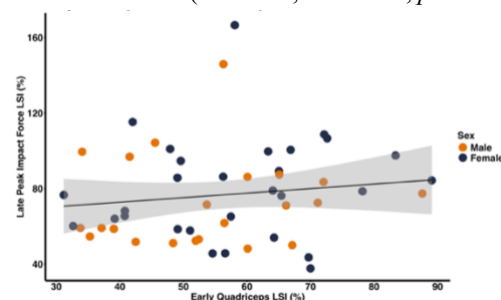
## Methods

Longitudinal data were obtained from a larger ongoing point of care study. Data from 50 (21 females, age =  $22.7 \pm 10.4$  years) patients with primary unilateral ACLR were included in the analysis. Testing was completed during mid- ( $4.0 \pm 0.3$  months post-ACLR) and late rehabilitation ( $8.3 \pm 1.8$  months post-ACLR). Patients performed bilateral isokinetic concentric knee extension strength assessments at 60 deg/s at both testing visits. Peak torque (PT) was recorded and normalized to body mass ( $\text{Nm} \cdot \text{kg}^{-1}$ ). Additionally, patients completed a jump landing assessment while wearing force sensor insoles at the late rehabilitation visit. PIF data (N) were collected at 200Hz and each patient completed 3 trials deemed to have good quality data. Peak PIF was measured using a custom script and then normalized to body weight. The bilateral PT and PIF data were used to calculate LSI by dividing values from

the injured limb by the values obtained from the contralateral limb. Linear regression models controlling for the difference in time since surgery between visits were utilized to assess the association between PT LSI and PIF LSI. The association was evaluated longitudinally from the mid- to the late-rehabilitation visit as well as cross-sectionally at the late rehabilitation visit. Separate exploratory regression models were created for male and female patients.

## Results and Discussion

The results of the longitudinal linear model indicated a significant association between quadriceps PT LSI at the mid visit and PIF LSI at the late visit (Figure 1). Additionally, the cross-sectional model indicated a significant association between PT LSI and PIF LSI at the late-rehabilitation visit ( $B = 0.60$ ,  $R^2 = 0.45$ ,  $p < 0.001$ ).



**Figure 1.** Scatter plot representation of PT LSI (%) at the mid-rehabilitation visit and PIF LSI (%) at the later visit ( $B = 0.35$ ,  $R^2 = 0.18$ ,  $p = 0.007$ ). There was not a significant effect of sex ( $B = -7.35$ ,  $p = 0.80$ ). The grey area is representative of standard error.

## Conclusions

There was a positive association between quadriceps strength LSI and peak jump landing impact force LSI longitudinally and cross-sectionally. The findings highlight the importance of monitoring quadriceps symmetry throughout rehabilitation as it may serve as an indication of performance during sport-specific tasks such as jump landing.

## References

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