Atypical leg biomechanics during stair-descent persist throughout rehabilitation following ACL reconstruction

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Summary

Poor motor control of the leg often accompanies anterior cruciate ligament (ACL) injuries, typically occurring during loading in non or indirect contact situations. During rehabilitation longitudinal analysis of leg loading may be crucial to provide insight into motor control and biomechanics supporting intervention development. We analyzed leg movement control longitudinally during weight acceptance of a stair-descent task three times during rehabilitation (~1 year) of 27 individuals post-ACL reconstruction compared to 27 asymptomatic controls. Functional Data Analysis was used to statistically compare leg sagittal plane time-series biomechanical data. We found persistent movement deviations at the hip and knee joints for both the injured and non-injured leg that did not normalize with time. We interpreted this as a retained protective movement pattern, suggesting central neural changes post-injury.

Introduction

Anterior cruciate ligament (ACL) injury often occurs during the loading phase of non or indirect contact situations linked to deficient lower limb control [1,2]. Thus, highlighting the need for studying movement control and particularly the loading phase following injury. Moreover, there is a specific need for longitudinal studies to guide early interventions and support routine evaluations after ACL reconstruction (ACLR). In this study, we evaluated if movement patterns change longitudinally throughout rehabilitation following ACLR during weight acceptance of a stair-descent task, in comparison to asymptomatic controls.

Methods

Participants descended two body-height normalized steps and continued walking forward. Time-normalized time-series data of hip, knee and ankle angles, moments and powers in the sagittal plane were obtained during the weight acceptance phase using 3D motion capture and force plates. Individuals following ACLR were tested on three occasions post-surgery (ongoing data collection): 1. Early-rehabilitation (n=27, mean [SD] 2.9 [1.3] months), 2. Mid-rehabilitation (n=27, 8.8 [2.9] months), and 3. End-of-rehabilitation (n=25, 13 [3.5] months). Time-series data for the ACLR group were longitudinally compared between the test sessions and cross-sectionally to 27 asymptomatic controls (tested once) using functional data analysis methods.

Results and Discussion

The injured and the non-injured leg demonstrated persistent movement alterations throughout rehabilitation that did not resolve over time. Both legs continuously exhibited atypically greater hip flexion angles and knee flexion angles and moments at all test sessions and when compared to controls. The injured leg also revealed greater hip flexion moment and ankle dorsiflexion angle and lower ankle power absorption at early-rehabilitation, though these normalized as rehabilitation progressed (Figure 1). This was interpreted as a protective movement pattern, where hip, knee and ankle flexion help stabilize and control knee loading. With rehabilitation, this protective pattern diminished but did not disappear.

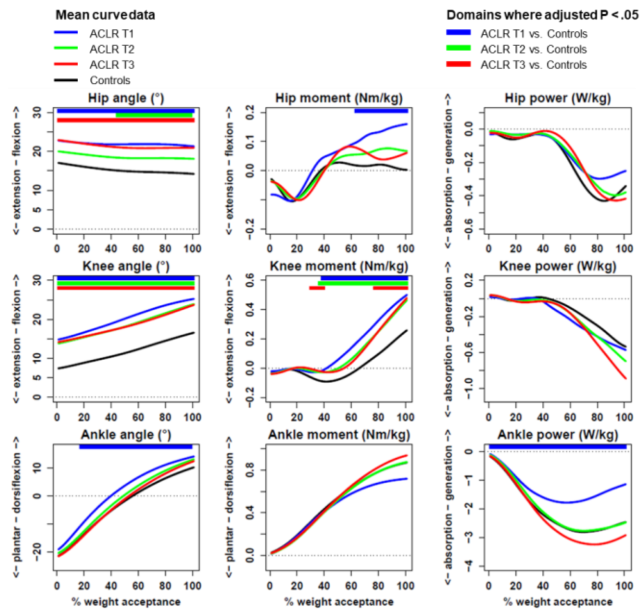

Figure 1: Time-series data of the ACLR leg and controls during weight acceptance. The thick bars above the plots indicate time domains with statistically significant differences between groups.

Conclusions

Early following ACLR, individuals exhibit a stiffer leg loading during stair descend that becomes less rigid with time. Yet, the persistency and bilateral symmetry of the alterations at the hip and knee in a daily task, such as stair-descent, suggest central neural changes may affect lower limb motor control post-ACLR.

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References

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