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Anterior Cruciate Ligament Reconstruction May Alter Muscle Activation Patterns of Knee Flexors

Kristin Briem, PhD, PT, ICELAND
Stefan Magni Arnason, PT, ICELAND
Bjartmar Birnir, BSc, PT, ICELAND
Tomas Emil Gudmundsson, PT, ICELAND
Gardar Gudnason, PT, ICELAND

University of Iceland
Reykjavik, ICELAND

Summary:
Reconstructing the ACL by using a graft from the hamstrings muscle group may impact the firing patterns of the ipsilateral knee flexors, as indicated by surface EMG recordings during open- and closed-chain exercises in athletes with a history of ACL reconstruction compared to healthy age- and gender-matched controls.

Abstract:
Background and Objective:
One of two commonly used autografts for reconstructing a torn anterior cruciate ligament (ACL) involves a graft from the hamstrings tendon. The impact of using part of the hamstrings muscle for ACL reconstruction (ACLR) has not been fully elucidated. Pre- and post-operative muscle strength of the knee flexors has been given considerable attention, whereas muscle activation patterns during functional activities have not. The purpose of this study was therefore to assess muscle activity of the main muscles involved in knee joint flexion during functional activities after ACLR using a hamstrings graft.

Methods:
Participants included 36 athletes (16 men, 20 women); 18 with a history of ACLR with hamstrings grafts (1-6 years post-injury) and 18 healthy controls, matched for age, gender, and BMI. All competed with teams in the Icelandic men's and women's premier soccer league and each participated in a single data collection during the pre-season period. Surface electromyography (EMG) was used to monitor muscle activity of medial and lateral hamstrings (MH and LH, respectively) and medial and lateral gastrocnemius (MG and LG, respectively) during the performance of closed chain ('Nordic hamstring') and open chain (using TRX® straps) exercises. The signal was sampled at 1600 Hz, filtered and normalized to the signal obtained during a maximal voluntary isometric contraction. Peak muscle activation of each muscle group during the eccentric phase of the exercises was used for analysis. ANOVA analyses were used to determine statistical significance of muscle activation differences found in within-subjects factors (limb and exercise), between groups (ACLR vs. healthy). Alpha was set at 0.05.

Results:
There was a general main effect of limb across all subjects, who seemed to favor one limb over the other during exercise performance ($p<0.001$). A significant 3-way interaction was found for limb by exercise by group ($p=0.02$) where interlimb muscle activation patterns remained unchanged across exercises in controls while interlimb differences in MH peak muscle activation were altered between exercises in the ACLR group. Moreover, a significant interaction between relative LH/LG activity of limb by group was observed ($p<0.05$), where LH activation was greater than LG for both limbs of controls as well as on the sound side of the ACLR group, but reversed (LG>LH) in the surgical limb.

Discussion:
Knee flexor muscle activation patterns observed in athletes that had undergone ACLR with a hamstrings graft

indicate that the surgery may affect not just muscle morphology, but also lead to adaptive changes in muscle firing patterns within the knee flexor muscles. Further research should assess post-operative rehabilitation within the context of hamstring injury prevention and risk of re-injury to the knee.