Muscle activity of experienced skiers with and without ACL reconstruction during jump landings

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Summary

When landing from a jump in ski boots, the restricted range of motion at the ankle alters leg muscle activity. This activity may be affected by anterior cruciate ligament reconstruction (ACLR), as EMG recordings demonstrated a faster onset of activity following landing. In nearly all landing conditions, it took more than 200 ms for muscles to activate, while ACLR skiers had a faster onset of activity. ACLR skiers also trended toward more quadriceps-dominant landings. These findings suggest that the biceps femoris and vastus medialis may not activate in time to help prevent a backwards fall on the slopes.

Introduction

A frequent mechanism of ACL injury in experienced skiers occurs during posterior displacement of the center of mass when landing from a jump, which can be limited through co-contraction of the hamstring and quadriceps muscles to prevent excessive knee flexion [1]. Risk of injury from this mechanism is heightened at the end of a race when fatigue is present [2]. In previous literature, the ACLR limb of elite skiers displayed increased hamstring activity [3]. The purpose of this ongoing study is to investigate the muscle activation patterns of experienced skiers with and without a previous ACLR while restricting the ankle's range of motion (ROM).

Methods

3 ACLR skiers (age = 32.0 ± 4.4 yr, skiing exp. = 20.3 ± 12.9 yr) and 5 control skiers (age = 26.6 ± 5.4 yr, skiing exp. = 16.8 ± 4.1 yr) were recruited from Los Angeles. All skiers performed the following landings in the laboratory while wearing walking boots on both legs: bilateral drop landing (BDL), single-leg drop landing (SDL), and broad jump (Bro). Following a fatigue protocol, the three landings were performed again [4]. EMG data was collected using two Delsys electrodes (Delsys Incorporated, Natick, MA, USA) for the vastus medialis (VM) and biceps femoris (BF) of each leg at 2000 Hz. All data were analyzed using MATLAB R2024a. Independent samples t-tests were used to compare EMG outcomes between groups and a paired samples t-test was used to compare outcomes between conditions.

Results and Discussion

The ACLR skiers had faster mean muscle activation after landing in nearly every condition compared to the control skiers (Table 1). This could be a preventative mechanism to ensure knee joint stability during a landing. For all skiers, the onset of activity for both muscles was almost always greater than the 200 ms stabilization phase after landing, indicating that a fixed ankle joint in a ski boot may promote longer electromechanical delays in leg muscle activity (Figure 1) [4].

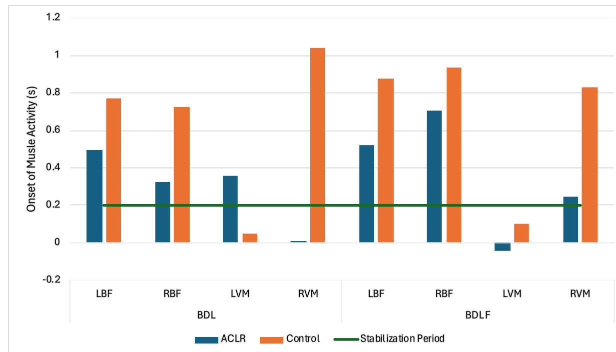

Figure 1: Mean onset of muscle activity (5% of MVIC) after landing for all muscles in each condition. Landing occurred at 0 s.

The control skiers trended toward more hamstring-dominant landings after fatigue, while ACLR skiers trended toward more quadriceps-dominant landings, though the results were insignificant. This result is in opposition to recent work indicating that following ACLR athletes across various sports trend towards more hamstring-dominant landings, again highlighting the role of ski boots in affecting jump landing mechanics [5].

Conclusions

Skiers with an ACLR had shorter leg muscle onset times during a jump landing and trended toward more quadriceps-dominant landings. Restricting ankle ROM through a ski boot may introduce longer electromechanical delays during jump landings, which may reduce a skier's ability to control knee flexion during landings.

References

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Table 1: Significant onset timing differences between ACLR and control participants, as well as between pre- and post- fatigue conditions **$* = p < 0.05$**

	Onset RVM BDL (s)		Onset RVM Bro (s)		Onset DVM SDL (s)		Onset RBF Bro (s)	
Condition	ACLR	Control	ACLR	Control	Pre-Fatigue	Post-Fatigue	Pre-Fatigue	Post-Fatigue
Onset after Landing	.005*	1.037	-.372*	-.010	.762*	.552	.151*	-.095