Effect of ACL reconstruction on multi-joint coordination in dancers

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INTRODUCTION
Both semitendinosus-gracilis (STG) and patella tendon bone (PTB) are frequently selected grafts for anterior cruciate ligament (ACL) reconstruction in dancers. Although STG and PTB reconstruction outcomes appear to be outwardly similar when assessing the knee joint in isolation, it is unclear whether there are limitations in multi-joint control following these procedures. Kinematic and kinetic analysis of locomotion activities following PTB reconstruction suggest ‘normalization’ of kinematic patterns (Ciccotti et al., 1994; Devita et al., 1997). Similar studies have not been conducted with subjects following STG ACL reconstruction, with dancers following ACL injury and reconstruction, or with domain-specific complex movements.

METHODS
The present study examined the movement patterns of male and female professional dancers following two types of ACL reconstruction compared to controls. Two-dimensional kinematic analysis was conducted at 60 Hz, with 12 reflective markers, in the frontal plane. Eighteen subjects: six control dancers, six dancers with STG, and six dancers with PTB ACL reconstruction performed the passé to a metronome for 12 trials per limb. All dancers had returned to all dancing activities including performance with no visible asymmetries in their dancing.

RESULTS
The tangential velocity profile of a representative control subject was smooth and bell-shaped (Fig. 2A). In contrast, the profile of a representative STG subject was multi-modal (Fig. 2B). ACL subjects displayed a greater number of acceleration crossings at the knee (representing number of velocity peaks) on both involved and non-involved limbs compared to controls. Knee and ankle peak tangential velocities were slower on the involved limb of subjects in the STG and PTB groups compared to controls (P<0.05). Control subjects had faster hip and knee peak angular velocities (P<0.05) than subjects in both ACL groups. There were bilateral adaptations measured in delayed movement onset and completion times, longer acceleration times, and greater variability in the ACL groups. Control subjects spent a greater percentage of the ascent phase of the passé in deceleration compared to STG and PTB subjects, regardless of limb (P<0.05).

Figure 1. Passé sequence. A) First position (initial and final posture). B) Passé position.
DISCUSSION
These findings suggest that injury to a single peripheral joint can affect multiple joints of both involved and non-involved lower extremities. The altered movement patterns found in dancers with both types of ACL reconstruction suggest that their control of complex movements may not return to pre-injury status and may be adaptive in nature. These differences represent compensatory strategies employed by dancers with ACL reconstruction which have not been previously documented. To optimize function in this population, additional quadriceps strengthening and training with multi-joint non-weightbearing movements may be warranted. Furthermore, development and use of a dance specific outcomes measure might assist in ascertaining as well as maximizing functional outcomes in this population.

REFERENCES

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