QUADRICEPS FEMORIS MUSCLE FATIGUE AND PERCEIVED EXERTION IN ACL-RECONSTRUCTED INDIVIDUALS

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INTRODUCTION

Injury to the anterior cruciate ligament (ACL) is a common and debilitating occurrence that yields residual strength deficits following surgical reconstruction (Rosenberg et al, 1992). A higher rating of perceived exertion was shown in individuals with a uni-lateral ACL-deficient knee during a sustained isometric quadriceps femoris (QF) contraction to failure while the rate of increase in EMG activity was not found to be significantly different between the superficial QF components (Tho et al, 1997). The purpose of this study was to examine muscle fatigue and perceived exertion in healthy individuals with a uni-lateral ACL-reconstructed knee.

METHODS

Subjects included 10 healthy volunteers (5 females, 5 males, mean age=29.1 ± 6.9 years, mean height=171.2 ± 10.2 cm, mean mass=68.5 ± 14.2) that had undergone a uni-lateral ACL reconstruction (central 1/3 patellar tendon augmentation). Subjects self-reported as functional, via the Cincinnati Knee Rating System (mean score = 8.8 out of 10, range = 7-10). Following a 5 min period of sub-maximal cycling, subjects were evaluated for 5 maximum voluntary isometric contractions (MVC), performed 2 min apart. Approximately 2 min following the establishment of the 5 MVCs, subjects then performed an isometric contraction equivalent to 80% of the 3 averaged highest MVCs, to the point of failure, during which time the subjects’ ratings of perceived exertion was recorded. Perceived exertion was measured with the Borg category-ratio (CR-10) scale. Both legs of each subject were assessed in a random order.

Muscle activity was assessed, via EMG, for the vastus medialis (VM), vastus lateralis (VL), and rectus femoris (RF) muscles during all contractions. Pre-amplified bipolar circular surface electrodes (Ag/AgCl; 0.8 cm diameter) were placed on each muscle with a fixed interelectrode distance (center to center) of 2 cm. The raw EMG signals were full-wave rectified and integrated (IEMG) every 10% during the 80% MVC. Each IEMG value was expressed as a 1 sec avg and then normalised to a 1 sec avg of the activity during the 3 averaged MVCs.

RESULTS AND DISCUSSION

The results demonstrated no significant differences (t9=1.47, p=0.18) for peak torque (PT) between the involved (mean PT=221.96 ± 90.43 N•m) and non-involved (mean PT=238.23 ± 79.81 N•m) limbs. The results also showed no significant differences (t9=0.96, p=0.36) for 80% MVC endurance time between the involved (mean time=21.4 ± 5.7 sec) and non-involved (mean time=19.7 ± 6.5 sec) limbs.
The results demonstrated significant muscle (F2,18=13.27, p<0.05) and time (F9,81=15.83, p<0.05) main effects for normalized EMG activity. There was no significant limb main effect, nor any 2- or 3-way interactions. These results showed that during the 80% MVC, a significant increase in EMG activity occurred for all muscles in a parallel manner within the first part of the contraction (Figures 1 and 2).

The perceived exertion response was found to increase significantly (F2,18=35.06, p<0.05) during the 80% MVC in both involved and non-involved limbs (Figure 3). There were no significant differences between the limbs.

Figure 1: Normalized EMG activity of the VM, VL and RF muscles of the involved limb during a sustained 80% MVC.

Figure 2: Normalized EMG activity of the VM, VL and RF muscles of the non-involved limb during a sustained 80% MVC.

These results also demonstrate that overall activation of the VM was significantly lower than the VL and RF muscles. Overall activation of the VL and RF muscles were not significantly different.

SUMMARY

These findings suggest that individuals with a uni-lateral ACL-reconstructed knee who self-report as highly functional demonstrate minimal bi-lateral QF strength, muscle activation and endurance, and perceived exertion deficits. The results also support previous findings of a parallel increase in QF muscle activation during fatigue (Pincivero and Gear, 2000; Tho et al, 1997) while the VM remains activated to a lower level than the VL and RF muscles (Pincivero and Gear, 2000).

REFERENCES