INTRODUCTION

The quadriceps femoris (QF) is a unique group of 4 anatomically distinct muscles that share a common nerve and function. Previous studies have demonstrated different electromyographic (EMG) patterns between the superficial portions of the QF during constant force contractions (Alkner et al, 2000; Pincivero and Coelho, 2000; Pincivero et al, 2001). Few investigations, however, have addressed the EMG signal of these muscles under constant effort contractions. The purpose of this study was to examine the effects of perceived voluntary contraction effort on inter-muscle and inter-gender EMG median frequency (f_med) differences.

METHODS

Fifteen healthy male (mean age = 24.6 ± 4.1 years, mean height = 178 ± 9.8 cm, mean mass = 77.8 ± 11.2 kg) and 15 healthy female (mean age = 24.3 ± 5.2 years, mean height = 167 ± 6.9 cm, mean mass = 60.5 ± 6.2 kg) volunteers participated. Subjects performed an active warm-up involving 5 min of sub-maximal cycling, followed by 3-4 sub-maximal and maximal effort isometric QF contractions. For the isometric contractions, subjects sat in an upright position and were stabilized with thigh, pelvic and torso straps on the Biodex System II isokinetic dynamometer. Subjects then performed 5 isometric maximal voluntary contractions (MVC) with their knee AT 60 deg flexion. The MVCs were performed for 5 sec, with 2 min rest in between each contraction. Immediately following each MVC, the perceptual range was anchored by having the subject assign a rating of “10” to their feelings during the contraction, by observing a 10-point scale. Following a 2 min period of rest, subjects were instructed to sit quietly and to assign a rating of “0” to the feelings in their QF muscle. Sub-maximal isometric contractions were then separately performed at the following perceived effort levels on the 10-point scale: 1, 2, 3, 4, 5, 6, 7, 8 and 9, in a random order. Subjects were instructed to maintain the contraction at each perceived effort level for 5 sec.

Surface EMG for the vastus medialis (VM), vastus lateralis (VL), and rectus femoris (RF) muscles was recorded with pre-amplified bi-polar circular electrodes (Ag/AgCl) that were placed on predetermined areas of each muscle with a fixed inter-electrode distance (center to center) of 2 cm. The reference electrode was placed over the medial shaft of the tibia. EMG activity was collected at 1000 Hertz (CMRR=87 dB at 60 Hertz, input impedance >25 Mohms at dc) with a gain of 10K. Median frequency of the 3 muscles was assessed through a power spectral analysis performed over 11 consecutive, 512
msec epochs overlapping each other by half their length (256 msec) during the middle 3 sec of each contraction. The $f_{\text{med}}$ for each of the 11 epochs was then determined for each muscle, followed by calculation of the mean and normalized coefficient of variation ([standard deviation/mean] x 100%) for each contraction.

**RESULTS AND DISCUSSION**

The results demonstrated that the mean VL $f_{\text{med}}$ was significantly greater than the other 2 muscles, and RF $f_{\text{med}}$ was significantly greater than the VM (Figure 1).

![Figure 1: Median frequency for VM, VL and RF muscles across perceived voluntary contraction levels 1 to 9.](image)

The VL demonstrated a significant increase in mean $f_{\text{med}}$ across the contraction efforts, as compared to the VM and RF that displayed a significant decrease. Males displayed significantly higher VM $f_{\text{med}}$ values than the females, as well as experiencing a greater increase across the contraction efforts for the VL than the females (Figure 2). Median frequency variability was shown to be significantly highest for the VM, as compared to the VL and RF.

![Figure 2: Median frequency for the VL in males and females across perceived voluntary contraction levels 1 to 9.](image)

**SUMMARY**

The findings of the present study appear to corroborate our previous investigation (Pincivero et al, 2001) regarding contraction effort and gender effects on the VL muscle. The current findings also suggest that sensitivity of the EMG $f_{\text{med}}$ to an increase in contraction intensity is muscle specific, as shown by the lack of an effort effect on the VM and RF muscles. Such findings may be reflective of differential muscle fiber type proportions that may exist between the superficial QF muscles.

**REFERENCES**


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