THE CHANGES IN EMG AND STEADINESS WITH VARIATION IN MOVEMENT SPEED DIFFER FOR CONCENTRIC AND ECCENTRIC CONTRACTIONS

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INTRODUCTION

The activation of muscle by the nervous system differs for concentric and eccentric contractions (Enoka & Fuglevand, 2001). These differences appear to involve both the descending command (Aagaard et al. 2000; Semmler et al. 2000) and movement-related sensory feedback (Burke et al. 1978; Schieber & Thach, 1985). Because the relative contribution of sensory feedback declines with movement speed, fast contractions are largely determined by the descending command. We asked the question, does the difference in muscle activation between concentric and eccentric contractions change with movement speed? The purpose of the study was to compare the changes in muscle activation and steadiness with variation in the speed of movement for concentric and eccentric contractions.

PROCEDURES

Ten healthy and active young individuals (30.4 ± 1.4 years, 6 males and 4 females) were recruited for this study. Each subject attended one testing session and performed the following tasks with the index finger of the left hand: (1) maximum load lifted in one repetition (1RM) and (2) position-tracking trials. The position-tracking trials were performed with a load equal to 15% of 1-RM within a 10^{o} range of motion in the abduction-adduction plane. The weight was attached to the index finger at the proximal interphalangeal joint to provide a load in the adduction direction. Each subject raised (concentric contraction) and lowered (eccentric contraction) the load at six different velocities (1.7, 3.3, 6.7, 16.7, 33.3, and 66.7 ^{o}/s). Prior to movement, each subject supported the load with an isometric contraction; thus, each anisometric contraction was preceded by an isometric contraction. For the position-tracking task, each participant was instructed to match a line displayed on an oscilloscope by controlling movement speed of the index finger. To familiarize the participants with each velocity, several practice trials (< 10) were given prior to data collection. In addition to verbal feedback, subjects received visual feedback for the first few practice trials. To eliminate the effect of visual feedback during data collection trials, subjects were given visual feedback only after the trial was completed. Data were collected until the subjects matched the slope of the target line three times. A rest period of 10 seconds was given between data collection trials and 120 seconds between target velocities. The order of target velocities and contractions were assigned randomly for each subject.

Position of the index finger was detected with a linear variable displacement transducer. Steadiness of the movement in the horizontal plane (abduction-adduction plane) was measured by a piezoresistive accelerometer attached to the proximal interphalangeal joint of the index finger. The muscle activation (EMG) of the first dorsal interosseus, which is the only muscle that abducts the index finger, was measured with 4 mm silver-silver chloride surface electrodes. For both contractions at each velocity, average rectified EMG (AEMG) and standard deviation (SD) of acceleration were computed from the middle one-third of the trial.

RESULTS AND DISCUSSION

The mean AEMG of the first dorsal interosseus was greater during concentric contractions ($p<0.05$). There was a contraction x velocity interaction ($p<0.05$) due to the increases in AEMG with velocity during the concentric but not the eccentric contractions (Figure 1).

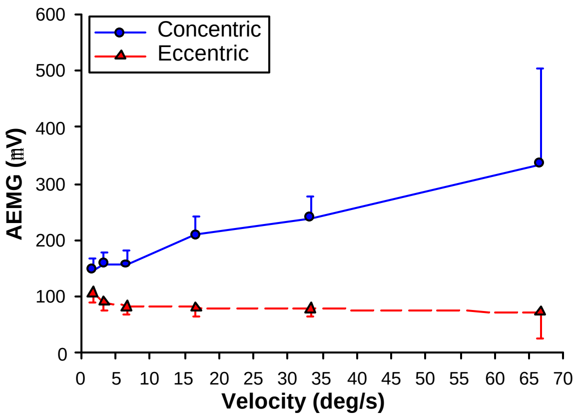

Figure 1. Average EMG increased with movement velocity for concentric but not eccentric contractions.

In contrast to the EMG findings, the standard deviation of acceleration was greater during eccentric contractions compared with concentric contractions ($p<0.05$). Furthermore, there was a contraction x velocity interaction ($p<0.05$) due to the greater increase in the SD of acceleration with movement velocity for the eccentric contractions compared with the concentric contractions (Figure 2).

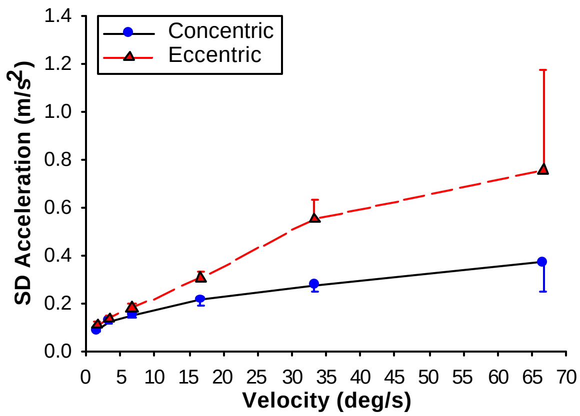

Figure 2. SD of acceleration increased more for eccentric than for concentric contractions with movement velocity.

Differences in muscle activation between concentric and eccentric contractions were augmented with increases in movement speed. This finding suggests that the descending control of muscle action, at least for fast movements, differs for concentric and eccentric contractions. Furthermore, this difference in activation of the muscle impairs the ability of the subjects to perform steady eccentric contractions.

SUMMARY

The results of this study indicate that increases in movement speed were accomplished with less AEMG and reduced steadiness for eccentric contractions compared with concentric contractions.

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