MECHANOMYOGRAPHY AND FORCE RELATIONSHIP DURING CONCENTRIC AND ECCENTRIC CONTRACTIONS OF THE VASTUS LATERALIS IN THE SPRINTERS

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INTRODUCTION

It has been investigated the mechanomyographic (MMG) signal may respond linear [1] or non-linear [3] relationship with force development Different relationship depends on contraction types, force levels, angular velocities and the muscles studied [1, 3]. Studies suggested that the MMG properties may also differentiate muscle fiber types [5]. The purpose of this study was to investigate the MMG and EMG (electromyographic) amplitude responses of vastus lateralis to different force levels during concentric and eccentric contractions in the sprinters.

METHODS

Subjects. Six male sprinters (26.1 ± 1.6 yrs) were recruited for this study.

Experimental procedures. Subjects were in seated position with belt over the hip and chair of leg extension machine, then randomly performed 30%, 50%, 70% and 85% MVC leg extension each 5 tests with starting knee angle 90° and extending to 180° at the speed of 1.5s up and 1.5s down controlled by beat metronome (40bpm, 1beat up, 1 beat down). Each subject practiced the speed control 2 times on nonconsecutive days one week ahead.

Signal processing. The MMG and EMG signals from vastus lateralis of nondominant leg were detected by biaxial accelerometer (acceleration range ± 2g, Biovision), and surface electrodes (Biovision) respectively with both sample rate 1000Hz and bandpass filtering (2nd order Butterworth) 5-100Hz for MMG and 5-500Hz for EMG. The concentric and eccentric phases were separated by goniometer signal, and the middle 0.5s of each 1.5s recording was used to avoid initial burst [6]. The mean root mean square (time constant 100ms) of MMG (rmsMMG) and EMG (rmsEMG) for middle 3 of 5 tests were calculated.

Statistical analysis. The relationship between concentric and eccentric rmsMMG/rmsEMG with force and the difference between two phases of two signals were examined by linear regression model (y = a + bx, x: force, y: rmsMMG or rmsEMG) and two-way ANOVA respectively.

RESULTS AND DISCUSSION

MMG signal. The rmsMMG showed positive linear relationship with increasing force level for both concentric (r^2= 0.45, regression coefficient b=0.67, P<.001) and eccentric (r^2= 0.64, b=0.80, P<.001) contractions. The eccentric rmsMMG was greater than concentric rmsMMG for all levels of force (P<.05).

EMG signal. The rmsEMG also showed linear relation with increasing force for concentric (r^2= 0.71, b=0.84, P<.001) and eccentric (r^2= 0.54, b=0.73, P<.001) contractions. Contrary to MMG, all levels of concentric rmsEMG were significantly greater than eccentric rmsEMG (P<.05).

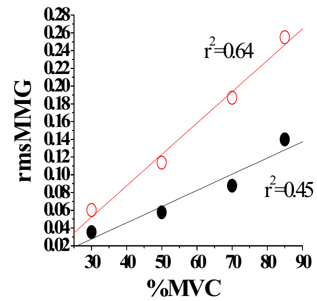

Figure 1

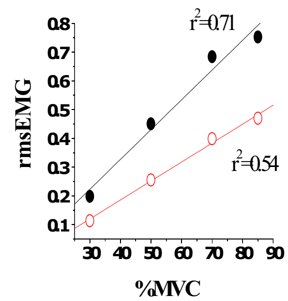

Figure 2

Figure 1:MMG-force relationship during concentric (●) and eccentric (○) contractions.

Figure 2: EMG-force relationship during concentric (●) and eccentric (○) contractions.

Discussion. The results of linear relationship of MMG/EMG amplitude and force during concentric and eccentric contractions conformed to previous study [1]. The lower EMG activity demonstrated decreased active motor units during eccentric phase [4]. The greater MMG activity during eccentric contraction of this study disagreed with the previous investigations of no difference [1] or lower activity [3] may result from faster speed of our experiment and fast-twitch fiber type subjects. Studies reported at higher velocities muscle sounds were from more superficially located fast-twitch fibers [2] and were less damped by surrounding tissues may result in greater MMG amplitude [7], and these may account for our study result.

CONCLUSIONS

The MMG signal may detect the active motor units recruitment during isotonic concentric and eccentric contractions and also response the selectively activated fast-twitch fibers at faster velocity and with fast fiber type muscle during eccentric contraction.

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