RELATIONSHIPS BETWEEN EMG FREQUENCY SPECTRUM AND RATE OF FORCE DEVELOPMENT CHANGES

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INTRODUCTION

Controversy exists as to whether or not the EMG frequency spectrum is related to isometric rate of force development (RFD). In the elbow flexor muscles, significant correlations exist between mean power frequency and maximal RFD (Bilodeau et al. 2002; Gabriel et al. 2001). To the authors' knowledge, these results have not been reproduced in knee extensor muscles.

While maximal RFD is commonly used to assess explosive strength, our previous work suggests this may not be the most robust variable for the rise of the force-time curve (Chiu et al. in press). As such, the different parameters describing this portion of the force-time curve may illustrate distinct aspects of explosive strength performance.

Additionally, we have found relationships between change scores for RFD and myosin heavy chain parameters following fatiguing exercise (Chiu et al. in press). These data indicate that factors contributing to explosive strength performance may be best elucidated following an exercise protocol.

The research purpose was to determine the relationship between RFD parameters and the EMG frequency spectrum before and after an overreaching training protocol.

METHODS

Recreationally trained male subjects performed a one-week phase of high volume, high power resistance exercise designed to induce overreaching. The details of the training protocol have been reported elsewhere (Chiu et al. 2003).

Subjects performed isometric knee extensor tests before (PRE) and after the week of training (HPT). Force was obtained via a load cell. Isometric force-time curves were analyzed for peak force, peak RFD and average RFD. EMG was obtained using a Ag-AgCl bipolar electrode on the vastus lateralis muscle. Mean (MPF) and median frequency of the power spectrum were determined for the time from the onset of the EMG signal to peak force.

Significance of differences was calculated using paired t-tests. Correlations were determined between RFD and EMG parameters. RFD parameters were normalized to body mass. Additionally, correlations were determined between the change scores for RFD and EMG parameters from PRE to HPT.

RESULTS

PRE and HPT RFD and EMG parameters are presented in Table 1. Peak force was significantly impaired following training ($p=0.02$). No significant differences existed for the group from PRE to HPT. No significant correlations were found between RFD and EMG parameters. A significant correlation existed between the change in average RFD and change in MPF from PRE to HPT (Figure 1; r=0.70; p=0.02).

Table 1: RFD and EMG parameters before and after training. Mean ± S.D. * denotes significantly different from PRE.

Measure	PRE	HPT
MPF (Hz)	59 ± 16	54 ± 16
MDPF (Hz)	45 ± 21	40 ± 19
Peak Force (N)	668 ± 122	*577 ± 150
Average RFD ($N \cdot s^{-1}$)	1717 ± 608	1800 ± 681

DISCUSSION

Contrary to earlier reports for the elbow flexor muscles, no relationship existed between knee extensor RFD and the EMG frequency spectrum. A limitation of this investigation is measuring only the vastus lateralis EMG. However, Gabriel et al. (2001) measured only biceps brachii and Bilodeau et al. (2002) measured biceps brachii and brachioradialis – neither collected from brachialis muscle. Further investigation is required to determine the variability of the frequency spectrums of the different knee extensor muscles.

Similar to our previous findings (Chiu et al. in press), the current investigation found a significant correlation between two change scores. The positive relationship between the change scores for RFD and MPF indicates that a decrease in EMG frequency is associated with a decrease in RFD and an increase in EMG frequency is associated with an increase in RFD.

Decreased MPF may result in decreased activation of high threshold motor units. High threshold motor units contain muscle fibers with MHC IIa which is positively correlated to RFD (Chiu et al. in press). Thus, decreased recruitment of high threshold motor units would result in decreased RFD. Similarly, increased recruitment of high threshold motor units would result in increased RFD. Gabriel et al. (2001) also proposed increased MPF enhanced motor unit rate coding, also consistent with increased RFD.

In summary, prior to exercise, no relationships exist between RFD and EMG frequency spectrum parameters. However, the change in average RFD and MPF following a period of training are related. This relationship may be a result of altered motor unit recruitment patterns.

REFERENCES

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Figure 1: Correlation between change in RFD and mean power frequency.