

IMPAIRMENT IN GROSS SARCOLEMMA FUNCTION DURING HIGH FORCE ISOMETRIC CONTRACTIONS AFTER ECCENTRIC ELBOW FLEXOR EXERCISE

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INTRODUCTION

Repeated eccentric contractions are known to cause exercise-induced muscle damage (EIMD), which is characterised by a prolonged loss of muscle force production [1], and seems to be related to failure of excitation-contraction coupling [2].

In addition, direct morphological evidence suggests that predominantly fast twitch fibres are prone to sarcolemmal disruption in EIMD [3]. However, it remains unclear if the function of the sarcolemma of these fibers is affected or not. Therefore, the purpose of the current experiment was to examine the gross sarcolemmal function of m. biceps brachii (BB) after eccentric elbow flexor exercise. This was studied at wide range of isometric contraction levels with high-density surface electromyography (sEMG).

METHODS

Nine subjects were measured before (BEF) maximal eccentric elbow flexor exercise (50 repetitions, 20 s intervals), and the follow-up measurements were performed two hours (2H), two days (2D) and four days (4D) after the exercise.

sEMG signals were recorded with a grid of 64 electrodes (8 mm IED). This grid consisted of 13 circular electrodes in each of its five columns, except in the first column, which consisted of 12 electrodes.

Root mean square (RMS), mean power frequency (MNF) and mean muscle fiber conduction velocity (CV) [4] were calculated during sub- and maximal isometric voluntary contractions and during maximal peripheral nerve stimulation (maximal M-wave).

RESULTS

Maximal isometric voluntary (MVC) force decreased by 21.3 ± 5.6 % at 2H ($p < 0.001$) and by 12.6 ± 11.1 % at 2D

($p < 0.01$). Similarly passive twitch amplitude decreased from an initial level of 69.7 ± 19.2 N to 33.8 ± 10.0 N at 2H ($p < 0.01$) and to 46.1 ± 9.4 N at 2D ($p < 0.05$) post-exercise, but recovered to 56.0 ± 7.5 N at 4D.

CV and MNF decreased both during MVC (CV from 4.1 ± 0.3 m/s to 3.8 ± 0.4 m/s, $p < 0.01$ and MNF from 92.6 ± 10 Hz to 85.2 ± 11 Hz, $p < 0.05$) and during electrically evoked maximal M-wave (CV from 4.1 ± 0.3 m/s to 3.0 ± 0.5 m/s, $p < 0.05$ and MNF from 97.1 ± 27.2 Hz to 78.0 ± 24.4 Hz, $p < 0.05$) two-hours post-exercise. Furthermore, at submaximal isometric force levels, CV and MNF decreased only at higher contraction levels (40%, 50% and 75% of MVC) two-hours post-exercise (Fig. 1).

CONCLUSIONS

It appears that intensive exercise can temporarily impair gross sarcolemmal function of the elbow flexor muscles. In addition, since this only occurred at high force levels (Fig 1.), it seems that the higher threshold motor units were predominantly affected. According to Henneman's size principle, these are the motor units with larger and faster fibers. Therefore, these findings are in line with the morphological evidence of predominant damage of membrane systems of the fast twitch fibers after eccentric contractions.

REFERENCES

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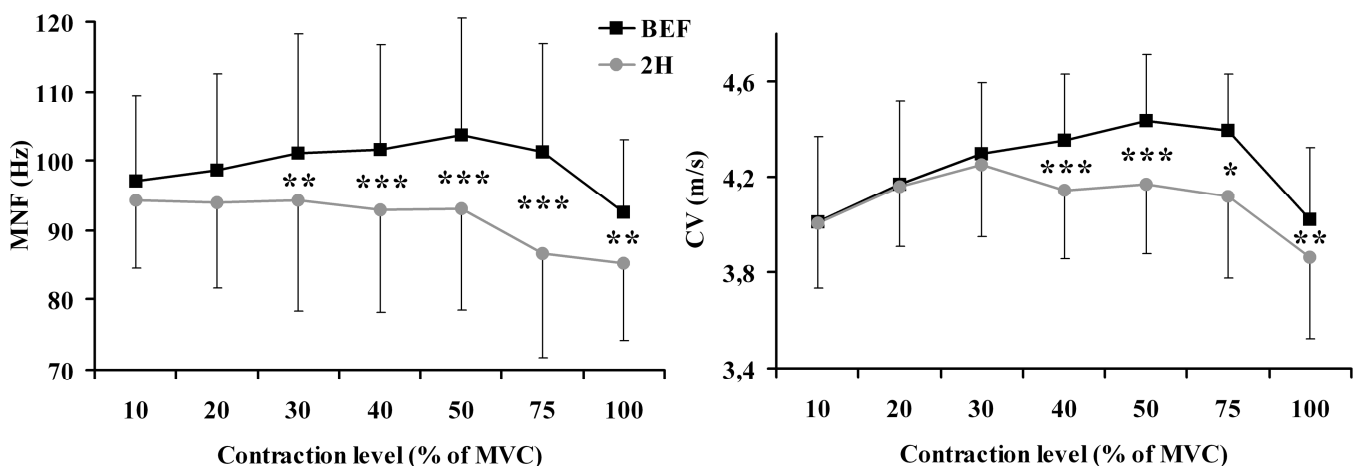


Figure 1: Mean power frequency (MNF) and mean muscle fiber conduction velocity (CV) during different isometric contraction levels. *** $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$ between the before (BEF) exercise and two hours (2H) post-exercise values.