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Changes in the EMG Median Frequency during Voluntary Muscle Activity of Different Intensity in Relation to Blood Chemical Parameters

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CHANGES IN THE EMG MEDIAN FREQUENCY DURING VOLUNTARY MUSCLE ACTIVITY OF DIFFERENT INTENSITY IN RELATION TO BLOOD CHEMICAL PARAMETERS

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INTRODUCTION

The reduction of muscle AP propagation velocity (CV) is often discussed as the major cause of the alterations in the EMG spectrum during sustained muscle contraction, since both effects have been found to show a close correlation (Lindstrom et al., 1970; Stulen & De Luca, 1981; Kranz et al., 1983; Merletti et al., 1990). As causes for the decrease in CV, an elevation of extracellular potassium (Bigland-Ritchie et al., 1979, Petrofsky 1981; Moxham et al., 1982, Kössler et al., 1990) as well as a decrease in muscle pH (Lindström et al., 1977, Mortimer et al., 1970) are under consideration. We examined the effects of exercise-induced changes in pH and electrolyte concentration on muscle electrical activity during voluntary exercise.

METHODS

9 subjects performed handgrip exercises with a hand-ergometer. The tests consisted of the 15 min warm-up phase und six 1 min static exercise periods separated by a 4 min rest. During the exercise bouts, the subjects had to lift weights and to keep them at a constant level. The weights were varied randomly between 5 and 30 kg, with steps of 5 kg. Blood was taken from a cubital vein. Acid-base-state, plasma electrolytes Na+ and K+ and [Lac-] were determined. For the recording of EMG the differential recording was used. M-wave and EMG was recorded from flexor muscles of the forearm. Muscle power, median frequency (MF) and RMS were calculated.

RESULTS

We observed distinct changes of MF during the exercise bouts (Fig. 1). During the exercise bouts, the shift of MF towards low frequencies correlated with the increase of weight ($r=-0.73$, $P<0.001$) or $[K^+]_v$ ($r=-0.76$, $P<0.001$), but not with the changes in pH. The range of the CV changes was from +4 % at 5 kg to –2 % at 30 kg. CV did not correlate neither with changes in venous pH and [K+] nor in MF.

DISCUSSION

Our data contradict the results of other studies, which have shown a relation between MF and CV (Lindstrom et al., 1970; Stulen & De Luca, 1981; Kranz et al., 1983; Merletti et al., 1990). Also the significance of extracellular potassium elevation or decrease in pH for the changes in MF was not shown. For in vivo studies, the reason for these discrepancies might be found in the different activation mechanisms in voluntary and evoked muscle exercise. Some in vitro experiments were performed under non-physiological conditions. During voluntary exercise Bigland-Ritchie et al. (1981) also did not find a relation between changes in MF and CV.

CONCLUSION

Under the conditions of our experiment: 1) the decrease in the CV was not the cause of the decrease in muscle force, 2) the effects of changes in electrolyte concentration and in pH on the CV may compensate each other or may be counterbalanced by other effects (e.g. increased T°). It can be concluded that changes in CV are not the only cause and, maybe, are not the main cause of MF shifts. We mean that in our study these shifts might be caused by the changes in the recruitment of different muscle fiber types.

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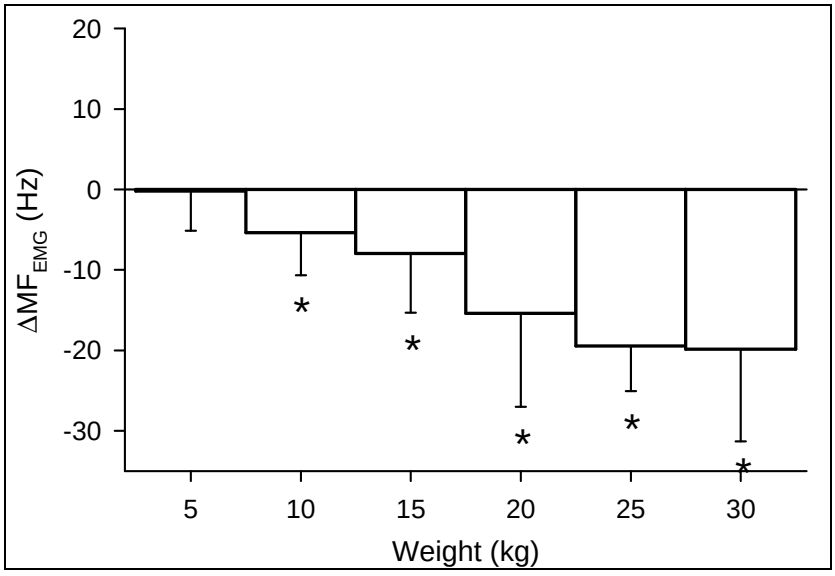

Fig. 1: Changes of MF during the exercise. Means ± SD. *P<0.02.