Muscle metabolism and acid-base status during exercise in work-related forearm myalgia measured with 31P-MRS

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Introduction

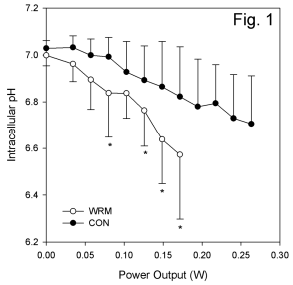
Repetitive strain injuries (RSI) represent a major component of worker disability and discomfort. Approximately 44% of workers involved in repetitive upper limb tasks have reported muscle pain and tenderness which may be classified as forearm work-related myalgia*[1]. Based on epidemiologic studies, it is known that work-related myalgia (WRM) is specific to muscles engaged in tasks that require stereotyped isometric or near isometric contraction, varying force levels, performed chronically over a sustained period[1]. However, while there are indications to suggest that abnormalities in forearm muscle blood flow[2,3,4,5,6] may represent a significant part of the etiology, the existence of cellular abnormalities is forearm WRM currently unclear.

Purpose

The aim of the present study was to study the metabolic and acid-base status during incremental wrist extension exercise in the forearm of individuals with work-related myalgia (WRM) using ^{31}phosphorus magnetic resonance spectroscopy (^{31}P-MRS).

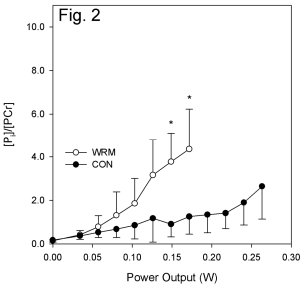
Methods

Twelve persons with WRM and 12 healthy matched control participants (CON) were recruited in this cross-sectional study. ^{31}P-MRS was used to non-invasively monitor the intracellular concentrations of phosphocreatine ([PCr]), inorganic phosphate ([P_i]), as well as intracellular pH status (pH_i) during an incremental wrist extension exercise protocol. The biphasic parameters related to the onset of a rapid decrease in pH_i and the onset of rapid increases in [P_i]/[PCr] were determined using piecewise linear regression analysis. Data were analyzed for main group time/power, and interaction effects by two-way repeated measures ANOVA. Significance was set at $P<0.05$. Data are presented as mean (SD).



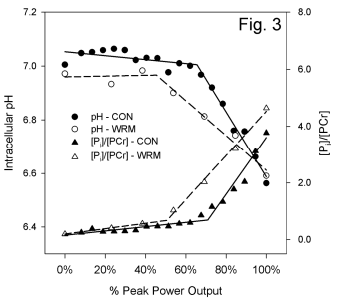
Results

We observed ~ 33 % decreased work capacity in WRM compared to CON (0.18 W (SD 0.04) vs. 0.27 W (SD 0.09) respectively, $P<0.05$), as well as a significantly lower pH_i (Fig. 1, $P<0.05$) and significantly greater [P_i]/[PCr] (Fig. 2, $P<0.05$) in WRM vs. CON at equivalent power output/ATP demands. Furthermore, the onset of a faster decrease in pH_i (i.e. pH threshold, pHT) and the onset of a faster increase in [P_i]/[PCr] (i.e. phosphorylation threshold, PT) occurred at a significantly lower relative power output in WRM (pHT: 51.3 % (SD 9.8) vs. 59.0 % (SD 5.9), $P<0.05$; pT: 52.4 % (SD 9.5) vs. 59.6 % (SD 6.6), $P<0.05$; % of peak power output, CON vs. WRM respectively). Representative WRM and CON participant shown in Fig. 3. Mono-exponential modelling of the data collected during the recovery from exercise showed no difference in the time constant (τ) of PCr resynthesis (WRM: 64 s (SD 12) vs. CON: 59 s (SD 14), $P>0.05$), but did show a slower rate of restoration for pH_i (WRM: 348 s (SD 160) vs. CON: 195 (SD 64), $P<0.05$).



Conclusion

In summary, for the first time using ^{31}P-MRS we have described the dynamics of muscle metabolic and acid-base status during exercise in individuals with work-related forearm myalgia. The salient features of this study were a greater reliance on substrate-level phosphorylation combined with a greater accumulation and earlier onset of intracellular acidosis during incremental exercise. Together, these observations suggest a reduced contribution of aerobic metabolism and increased reliance on anaerobic metabolism. The observation of a slower recovery of intracellular pH in work-related forearm myalgia suggests a possible mechanism of a reduction in local muscle blood flow and perfusion in this condition.



References

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* Forearm work-related myalgia was called RSI before a 1987 moratorium banned the use of this term, considering it to be a reversible neurosis. See chapter 1, Ranney DA, *Chronic Musculoskeletal Injuries in the Workplace.* WB Saunders, Philadelphia, 1997