Reliability of an incremental wrist extension exercise protocol using 31P-MRS for measuring metabolic and acid-base changes in the ECRB muscle

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Introduction

The extensor carpi radialis brevis muscle (ECRB) is a wrist extensor muscle commonly used in daily living and occupational tasks. Individuals performing repeated manual tasks involving wrist extension are at risk of developing a repetitive strain injury (RSI) causing work related myalgia (WRM), a general term used to describe pain and discomfort that result from repetitive movements*. In 2000/01, one in ten Canadians aged 20 or older, or an estimated 2.3 million people, reported WRM that was serious enough to limit their normal activities[1]. Currently, there exists no data describing the normal physiological response to exercise in the ECRB muscle. Because it is essential to understand the normal physiology of this muscle group before we can assess the impact of WRM, we sought in this study to devise a protocol for measuring the intracellular acid-base and metabolic status of the ECRB.

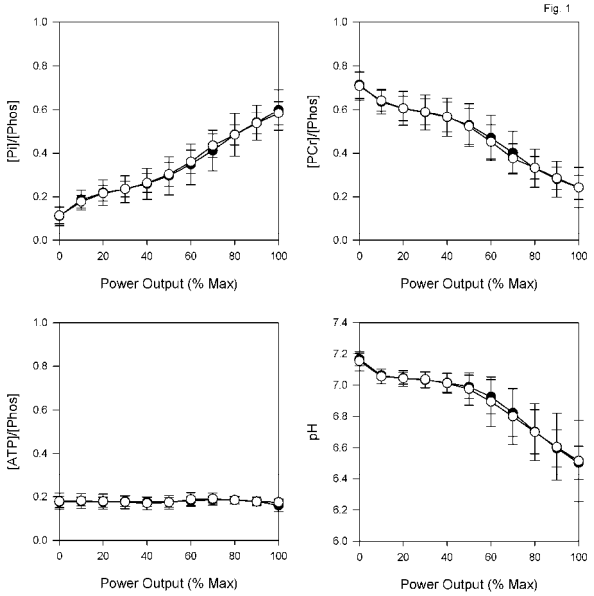
Purpose

The aim of the present study was to assess the reliability of metabolic and acid-base measurements made in the ECRB muscle using ^{31}phosphorus magnetic resonance spectroscopy (^{31}P-MRS) and an incremental wrist extension exercise protocol.

Methods

Nine healthy female participants performed two identical incremental wrist extension exercise tests on separate days (DAY1; DAY2). ^{31}P-MRS was used to measure the intracellular concentrations of phosphocreatine ([PCr]), inorganic phosphate ([P_i]), adenosine triphosphate ([ATP]), and intracellular pH (pH_i). 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 using a two-way repeated measures ANOVA and compared using Pearson correlation coefficients. The coefficient of variability (CV) and the 95% confidence intervals of the CV were calculated between DAY1 and DAY2[2]. Significance was set at $P<0.05$. Data are presented as mean (SD).

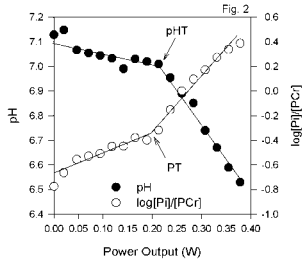
Fig. 1



Results

In the incremental exercise test, peak power output (PPO) was 0.29 W (SD 0.11) and 0.30 W (SD 0.10) on each of two trials respectively [CV = 3.8% (95% CI 2.6-7.4%)]. No differences between [ATP], [PCr], [P_i], or pH_i were detected between DAY1 and DAY2 (Fig. 1). An onset of a rapid decrease in pH_i was observed in the ECRB at 49.6 % of PPO (SD 6.8) on DAY1 and 46.8 % of PPO (SD 6.3) on DAY2 [CV = 4.3% (95% CI 2.9-8.5%)]. A coincident onset of a rapid increase in [P_i]/[PCr] in the ECRB occurred at 50.8 % of PPO (SD 7.4) on DAY1 and 47.6 % of PPO (SD 5.5) on DAY2 [CV = 6.3% (95% CI 4.2-12.5%)]. A representative participant is shown in Fig. 2.

Fig. 2



Conclusion

We conclude that an incremental wrist extension exercise protocol provides a reliable measure of the metabolic and acid-base status in the extensor carpi radialis brevis muscle (ECRB). This finding is important to those interested in studying the pathophysiology of the ECRB and in particular work-related forearm myalgia, because for the first time we have provided data describing the normal response to increasing workload in this muscle. Our results demonstrate exercise tolerance (i.e. peak power output) of the incremental wrist extension protocol had a CV of 3.8%, a reliable and acceptable amount of variability that is comparable to the CV of repeated 1-hr cycling time trial protocols[3]. We also found that there was a strong significant test-retest correlation for the onset of more rapid decreases in pH_i (pHT) and in the onset of more rapid increases in log[P_i]/[PCr] (PT), with CV = 4.3% and 6.3% respectively.

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