EFFECT OF RESISTANCE EXERCISE LOAD ON NEAR-INFRARED SPECTROSCOPY MEASUREMENT OF SKELETAL MUSCLE MITOCHONDRIAL CAPACITY

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Introduction

- Traditionally, muscle biopsies have evaluated mitochondrial density and oxidative enzyme activity to quantify muscle oxidative capacity (MOC). Biopsy studies have shown that MOC is an important aspect of resistance exercise recovery and repeated sprints. However, muscle biopsies are an invasive technique and may not be practical for many endurance athletes.
- NIRS measurement of muscle oxygen uptake (mVO_2) during brief arterial occlusions has shown to be a valid, reliable indicator of MOC.
- Changes in deoxyhemoglobin (HHb) during a series of multiple transient arterial occlusions following exercise measure muscle oxygen uptake (mVO_2). Recovery mVO_2 is related to phosphagen recovery kinetics and is an indirect measure of MOC, in that the faster muscle oxygen uptake returns to a resting level the greater MOC.
- Studies have shown that MOC as measured by NIRS is lower following higher-intensity aerobic exercise suggesting that the intensity of exercise before the measurement affects the measurement.
- Typically, low-intensity movements performed as fast as possible is the exercise that is used to increase the demand the muscle oxygen uptake before the MOC measurement with NIRS. However, it is unknown how resistance exercise may affect the MOC measurement.

Purpose

The purpose of this study was to examine the effect of resistance exercise load on the NIRS measurement of MOC.

Subject Characteristics

- Seven participants (M = 3; F = 4) completed the study (21.2 ± 0.5 yrs, 170.0 ± 8.2 cm, 71.0 ± 6.8 kg)

Predicted 1 RM* (lbs)	High Load 80% 1 RM (lbs)	Low Load 40% 1 RM (lbs)
204.3 ± 97.7	165.5 ± 78.2	82.7 ± 39.1

Data presented as mean ± SD. * The first visit was used to assess the participant's predicted one-repetition maximal (1-RM) on the barbell back squat.

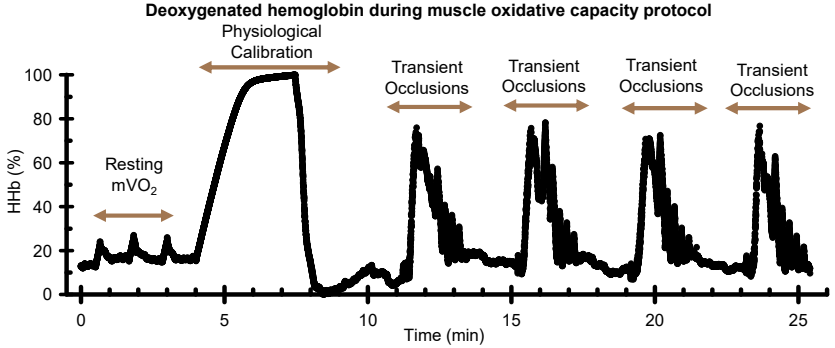
Experimental Conditions

- There were three experimental conditions the participants were required to complete and were performed in a randomized order.
- Each experimental condition commenced with an aerobic warm-up on the cycle ergometer at a self-selected intensity followed by the MOC protocol.
- MOC was assessed using a similar protocol described by Ryan et al. (2013). The only difference between conditions was the exercise (i.e. body weight, low-load, or high-load) completed immediately before the transient occlusions.
- **Body weight** – body weight squats were performed as fast as possible.
- **Low Load** – approximately 16 repetitions of barbell back squats set at 40% 1 RM were performed (metronome set at 96 bpm).
- **High load** – approximately 8 repetitions of barbell back squats set at 80% 1 RM were performed (metronome set at 48 bpm).

Muscle Oxidative Capacity

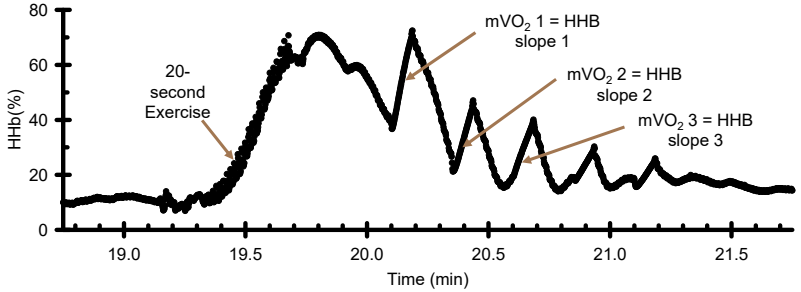
- Muscle oxidative capacity was assessed using the data collected by the NIRS and a 12D Hokinson blood pressure cuff was positioned superior to the quadricep muscles and adjusted to a pressure of 300 mmHg40 mm chan.
- A continuous wave Portamon NIRS system was placed on the vastus lateralis and tightly taped to the skin.
- HHb was collected continuously at 10 Hz using the 30-,35-, and 40-mm channels using Oxysoft software.

Deoxygenated hemoglobin during muscle oxidative capacity protocol



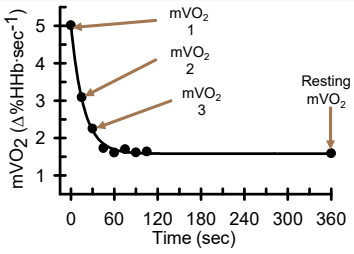
- Resting mVO_2 was calculated using three 10-second occlusions without exercise
- A physiological calibration was done to normalize HHb.
- Immediately before transient occlusions, subjects performed the 20-second exercise bout.
- Followed by eight 5-second occlusions occurring with 10 seconds of rest in the seat position.
- The exercise with transient occlusions was repeated four times.

Deoxygenated hemoglobin during transient occlusions(5-seconds on, 10 seconds off)

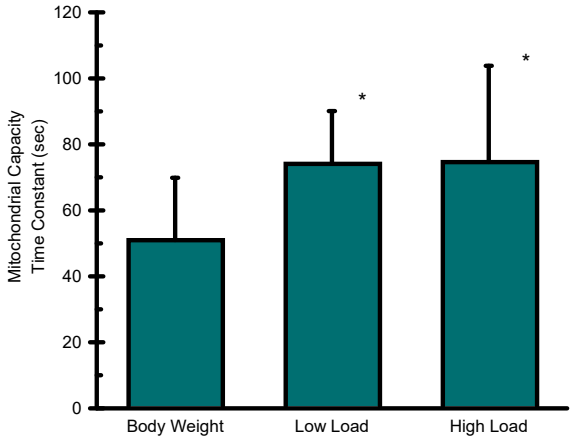


Data Analysis

- HHb was corrected for changes in blood volume using methods described by Ryan et al (2012) and ln each channel, the slope of change in HHb during the first 3 seconds of each transient occlusion was the mVO_2.
- The four mVO_2 at each time point were averaged and was plotted against time. Resting mVO_2 was the final data point.
- A mono exponential curve using the following equation: $y(t)=\text{End}-\Delta*e^{-k\cdot t}$ was fitted and the time constant (k) was calculated.
- The time constant found in each channel was averaged to determine MOC.



Results



Data are mean ± SD. * = different from body weight p<0.05).

Conclusions/Practical Applications

- Utilizing near-infrared spectroscopy (NIRS) allows for non-invasive assessment of MOC in resistance athletes, which can give insight into recovery kinetics in this population.
- However, conducting MOC assessment after a loaded resistance exercise, as opposed to an unloaded (i.e., body weight) exercise, may prolong the assessment duration. This could be due to low oxygen availability after resistance exercise.
- This could show that NIRS measures of MOC following resistance exercise are a non-invasive alternative to a muscle biopsy when measuring MOC, but resistance exercise load and oxygen availability should be controlled.

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Acknowledgments

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