Validation of a New NIRS Method for Measuring Muscle Oxygenation During Rhythmic Handgrip Exercise

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Near infrared spectroscopy (NIRS) is commonly used to measure muscle oxygenation during exercise and recovery. Current NIRS algorithms do not account for variation in water content and optical pathlength during exercise. **PURPOSE:** Validate a newly developed NIRS algorithm during rhythmic handgrip exercise and recovery. **METHODS:** Six female subjects, average age 28 ± 6 yrs, participated in the study. A venous catheter was placed in the retrograde direction in the antecubital space. A NIRS sensor with 30 mm source-detector separation was placed on the *flexor digitorum profundus*. Subjects performed two 5-min bouts of rhythmic handgrip exercise (2s contraction/1 s relaxation) at 15% and 30% of maximal voluntary contraction. Venous blood was sampled before each bout, during the last minute of exercise, and after 5 minutes of recovery. Venous oxygen saturation (SvO2) was measured with a I-Stat CG-4+ cartridge. Spectra were collected between 700 – 900 nm. A modified Beer's Law formula was used to calculate the absolute concentration of oxyhemoglobin (HbO2), deoxyhemoglobin (Hb) and water, as well as effective pathlength for each spectrum. Muscle oxygen saturation (SmO2) was calculated from the HbO2 and Hb results. The correlation between SvO2 and SmO2 was determined. **RESULTS:** Optical pathlength and water varied significantly during each exercise bout, with pathlength increasing approximately 20% and water increasing about 2%. R2 between blood and muscle SO2 was found to be 0.74, the figure shows the relationship over SvO2 values between 22% and 82%. The NIRS measurement was, on average, 6% lower than the blood measurement. **CONCLUSIONS:** Pathlength changes during exercise because muscle contraction causes variation in optical scattering. Water concentration also changes, but only slightly. A new NIRS algorithm which accounts for exercise-induced variation in water and pathlength provided an accurate assessment of muscle oxygen saturation before, during and after exercise. Funded by the National Space Biomedical Research Institute through NASA NCC 9-58.