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FEASIBILITY OF USING NEAR INFRARED SPECTROSCOPY IN DETERMINING VO2 FOR PREOPERATIVE RISK ASSESSMENT

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ABSTRACT

Cardiopulmonary exercise testing (CPX) has been used to identify elderly patients at high risk for mortality during major surgery. Older demonstrated that postoperative cardiovascular-related deaths were predicted by an anerobic threshold (AT) < 11 ml/min/kg. This methodology is limited by the uncomfortable and claustrophobic facemask used for standard CPX. During cycling, pulmonary-derived oxygen consumption (VO2) is equivalent to muscle VO2. Our research group has developed novel methods of using near infrared spectroscopy (NIRS) to determine muscle oxygen saturation (SmO2), muscle pH and hematocrit (Hct). Hypothesis: NIRS parameters, in combination with heart rate (HR) monitoring, may be used to estimate VO2.

METHODS

Ten healthy subjects (SMF) performed CPX. Whole-body VO2 was determined with a metabolic cart (True One 2400, Parvo Medics, Salt Lake City, UT) in combination with heart rate (HR) monitoring.Stroke volume estimates for three subjects were plotted versus HR and the resulting best fit equation was obtained. Using NIRS is a feasible method of measuring VO2 up to the AT in young and untrained subjects, and SV found to be related to HR.

INTRODUCTION

Postoperative morbidity and mortality may be reduced by identifying high risk individuals before surgery. Among the parameters identified by cardiopulmonary exercise testing (CPX) is the anaerobic threshold (AT), a point readily obtained by measuring oxygen consumption (VO2). Older has shown that postoperative cardiovascular-related deaths are restricted to patients with an AT of <11 ml/min/kg. He used these preoperative measurements as a means to appropriately triage patients postoperatively (i.e., ICU vs. ward admission). However, restrictive and claustrophobic masks during CPX VO2 analysis may deter some patients.

Grasso has shown that the response of pulmonary-derived whole body and two times the invasively-measured muscle VO2 during cycling exercise are similar1. Our group has used noninvasive near infrared spectroscopy (NIRS) to measure hemodynamic parameters such as pH, Hct, and capillary oxygen saturation (denoted SmO2, as the sensor does not differentiate myoglobin and hemoglobin oxygen saturation)2. These NIRS-derived parameters may be used for screening of patients with low AT during exercise in a manner which is more comfortable to the subject.

HYPOTHESIS

Near infrared spectroscopy (NIRS), in combination with heart rate monitoring, may be used to determine VO2 at the anaerobic threshold.

RESULTS

- The best fit equation to estimate SV was found to be an exponential with offset multiplier. The multiplier ‘C’ is effectively the stroke volume at the uncomfortable and claustrophobic facemask used for standard CPX. During cycling, pulmonary-derived oxygen consumption (VO2) is equivalent to muscle VO2. The Fick equation assumes we measure SvO2, but for VO2 > AT, myoglobin desaturation may contribute substantially to SmO2, thereby overestimating VO2 with the NIRS method.

- Additional work is required to determine whether the limits of agreement between the two methods of measuring VO2 are small enough to be of clinical value.

- The SV values were estimated on the basis of HR response for three subjects, and this model may not be accurate for all individuals.

DISCUSSION

- Using NIRS is a feasible method of measuring VO2 up to the AT in young active subjects, but this method must be validated in the target population.

- The accuracy of this technique might be improved if myoglobin desaturation is accounted for and better estimates of VO2 during exercise are obtained (work on-going).

- Ultimately, NIRS monitoring may prove to be useful alternative to the more involved and potentially uncomfortable technique of measuring VO2 using a metabolic cart.

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