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

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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 (VO2max). Yale has shown that postoperative cardiovascular-related deaths are restricted to patients with an AT of <11 ml/kg/min1. 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.

Grassin has showed that the response of pulmonary-derived whole body and two times the invasively-measured muscle VO2 during cycling exercise are similar2. Our group has used noninvasive near infrared spectroscopy (NIRS) to measure hemodynamic parameters such as pH, HR, and capillary oxygen saturation (determined SmO2, as the sensor does not differentiate myoglobin and hemoglobin oxygen saturation). 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.

METHODS

Ten healthy subjects (SMIF) performed CPX. Whole-body VO2 was determined with a metabolic cart simultaneously with NIRS measures from the thigh. Muscle VO2 was calculated using the Fick equation (VO2 = SV x HR x C(a-v)O2) where stroke volume was estimated from HR. Oxygen content difference was calculated from Hct and SmO2 obtained with NIRS. VO2 from pulmonary measures and NIRS VO2 were compared by Bland-Altman analysis. VO2 was calculated using the Fick equation

\[ SV = C \left( 1 - e^{-0.132(RR-27.45)} \right) \]

where \( C \) is the exponential with offset multiplier. The multiplier 'C' is exponentially the stroke volume at maximum VO2 for the test.

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 maximum VO2 for the test.
• The equation was applied to all subjects, and C was varied until the best fit was obtained for each subject.
• C was found to have one value for male and a different value for female subjects.

Jason data

- Pulmonary-derived VO2 and NIRS-derived muscle VO2 are well-correlated up to the AT (R² = 0.89).
- Larger differences between the two measurements are seen after the AT.

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REFERENCES


DISCUSSION

• NIRS-derived muscle VO2 and whole body VO2 are strongly correlated for exercise up to the AT.
• After the AT, larger errors may be attributed to differences between SmO2 and SmVo2.
• 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.

Limitations

• This study utilized a small sample of young, healthy subjects. whose responses may not be representative of the elderly population who might benefit most from preoperative risk assessment.
• The SV values were estimated based on HR response for three subjects, and this model may not be accurate for all individuals.