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

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ABSTRACT

Introduction: 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 anesthesiologist threshold (AT) < 11 ml/kg/min). This methodology is limited by the uncomfortable and claustrophobic facemask used for standard CPX. During cycling, pulmonary-derived oxygen consumption (VO₂) is equivalent to invasively measured VO₂. Our research group has developed novel methods of using near infrared spectroscopy (NIRS) to determine muscle oxygen saturation (SmO₂) in healthy elderly subjects. Hypothesis: NIRS parameters, in combination with heart rate (HR) monitoring, may be used to estimate VO₂.

METHODS

Ten healthy subjects (SM¢) 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 using Bland-Altman analysis. AT was identified from spectrally determined pH. Results: SV was gender specific and a mathematical equation was developed to calculate SV from HR during exercise. Using the gender specific equation for SV, NIRS VO₂ closely approximated whole-body VO₂ up to the AT. The mean bias between VO₂ from pulmonary and NIRS VO₂ was -0.05 L/min, and the limits of agreement were -0.6 and +0.7 L/min (R² = 0.89). Larger errors were observed for VO₂ > AT. Conclusion: Our results demonstrate the feasibility of using NIRS-derived parameters and HR during exercise to estimate VO₂ for preoperative risk assessment.

INTRODUCTION

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

Grassie has shown that the response of pulmonary-derived whole body and two times the invasively-measured muscle VO₂ during cycling exercise are similar. 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). 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 maximum VO₂ for the task.
• 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.

HYPOTHESIS

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 task.

Data Analysis

• NIRS-measured muscle VO₂ plotted versus pulmonary VO₂ up to AT
• The two methods of measurement compared with Bland-Altman analysis and correlation coefficient.

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.

• Larger differences between the two measurements are seen after the AT.

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REFERENCES