Validity and reliability of a clinical non-exercise method for assessment of cardiorespiratory fitness using seismocardiography

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Introduction: Low cardiorespiratory fitness expressed as a low maximal oxygen consumption (V̇O2max) is associated with cardiovascular disease and all-cause mortality (1). Thus, V̇O2max is recognised as an important clinical tool in the assessment of patients (1,2). However, assessment of V̇O2max by exercise testing is both physically demanding and methodologically challenging and hence the clinical applicability is limited.

Purpose: Therefore, the aim of this study was to investigate the accuracy and precision of a clinical non-exercise method for assessment of V̇O2max.

Methods: On three separate days 20 healthy men (n=10) and women (n=10) with varying age (22–72 years) and fitness levels performed two tests for determination of V̇O2max; (a) a non-exercise test using seismocardiography (SCG V̇O2max) and (b) a graded exercise test to voluntary exhaustion on a cycle ergometer based on indirect calorimetry (IC V̇O2max). These tests were performed in order to examine the day-to-day reliability and the validity of SCG V̇O2max, respectively. Furthermore, SCG V̇O2max was assessed twice on each test day to investigate test-retest reliability. The SCG V̇O2max was performed in prone position following a short resting period by placing the SCG recording device on the xiphisternal joint with double adhesive tape. V̇O2max was assessed during a 5-minute recording of the sternal movement using SCG in combination with demographic data of the participants (3). In addition, body composition was measured and a resting blood sample collected each test day.

Results: On average SCG V̇O2max was 3.3±2.4 ml/min/kg (mean ± 95% CI) lower than IC V̇O2max (p=0.013, SCG V̇O2max: 36.6±3.3 ml/min/kg, IC V̇O2max: 39.9±3.0 ml/min/kg). A significant positive correlation was found between SCG V̇O2max and IC V̇O2max (Pearson, r=0.72, $p<0.001$). Both SCG V̇O2max and IC V̇O2max was similar between test days (p=0.972) and the intra-individual coefficient of variation was 4.5±2.9% and 4.0±2.5%, respectively.

Within each test day SCG V̇O2max was highly correlated (r=0.99, $p<0.0001$) and no difference was observed between tests (p=0.993).

Conclusions: The accuracy of the current non-exercise assessment of cardiorespiratory fitness based on seismocardiography is not optimal as SCG V̇O2max was systematically lower than the gold standard assessment applying indirect calorimetry during a graded exercise test. Despite the abovementioned difference, SCG V̇O2max and IC V̇O2max were highly correlated. Furthermore, the precision of SCG V̇O2max is very high as both day-to-day and test-retest reliability were high.