BREATHING ANALYSIS DURING EXERCISE: COMPARISON BETWEEN OPTOELECTRONIC SYSTEM AND BREATH-BY-BREATH ANALYZER

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Introduction

Optoelectronic systems (OS) usually used for motion capture can be used to measure tidal volumes and volume changes, in addition to evaluating ventilatory mechanics [1]. In contrast to spirometry, OS indirectly measures volumes by the evaluation of the chest wall displacement using infrared cameras, reflective markers and *ad-hoc* designed algorithms. OS has the advantage that it can additionally provide information regarding chest wall mechanics, and how the interactions between chest wall compartments affect tidal volume (V_T). The use of OS may be beneficial when measuring breathing biomechanics because studies have shown that the spirometer mouthpiece may alter subject's natural breathing frequency and V_T by creating awareness of respiration [2] and potentially altering rest and exercise ventilation [3]. However, during certain activities the volumes measured by OS may be significantly different from those measured by spirometry [4,5]. The aim of this work was to verify if V_T measured by OS and breath-by-breath analyzer (BbB) is similar.

Methods

Five subjects (5 males; 31.2±5.6 yrs) free from airway disease completed the study protocol. They performed a submaximal exercise test in two conditions (hunched shoulders and normal shoulder position) while undergoing simultaneous BbB and OS data collection. Arms were positioned on supports at 90° to the torso in the scapular plane. Ten infrared cameras (Qualisys AB) were set up in a circular pattern over 360°, approximately 3 meters from the subject to capture the chest wall motion during breathing. 89 IR-reflective markers were positioned on the chest, abdomen and back as described in [1]. An additional marker was placed on C7. The main outcome measure analyzed was V_T (L). Equal numbers of breaths from the OS data collection and from the metabolic data collection were analyzed for each subject.

The raw difference between V_T measurements was calculated for each subject as an absolute of V_T by BbB – V_T by OS. This absolute raw difference is then plotted against the average V_T of the two measurements and can be displayed in the Bland-Altman chart The mean discrepancy demonstrated as a percentage of the volume between OS and BbB was calculated as in (1).

$$\%\text{Discrepancy} = \frac{V_T\,\text{BbB} - V_T\,\text{OS}}{V_T\,\text{BbB}} \cdot 100 \qquad (1)$$

The association between the V_T measured by OS and the V_T measured by BbB was evaluated by linear regression.

Results

The average raw difference between OS and BbB was 0.09±0.25L (mean±SD) in the hunch position and was 0.01±0.24L in normal position (Fig. 1). When comparing the difference in measurements to the size of the V_T, OS and BbB had a discrepancy of 2.5±10.1% in hunch position and 0.6±9.9% in normal position, demonstrating that OS reports slightly lower than BbB. There was a strong correlation between OS and BbB V_T in both positions assumed by the athlete (R=0.96 and R=0.97 in the hunch and normal positions, respectively).

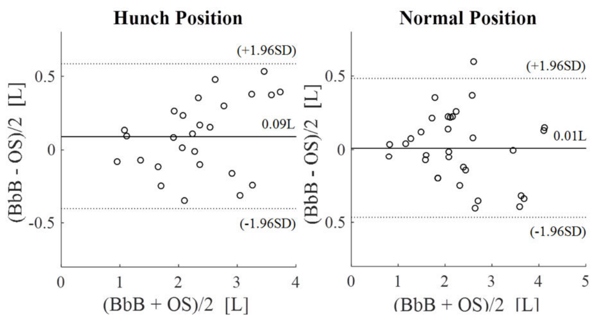

Figure 1: Results for Bland-Altman analysis during cycling exercise in hunch and normal position.

Discussion

This study demonstrated the average measurement difference of V_T between OS and BbB to be 0.09 L, which is comparable to previously reported results [5], and a small amount in the context of an average exercise V_T. The agreement is high for both normal and abnormal breathing positions meaning that differences in chest compartment contributions with position can be analysed using OS. In conclusion, OS can be used in during exercise to analyze chest wall volume changes and the biomechanics of breathing.

References

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