Rev Port Pneumol. 2017;xxx(xx):xxx–xxx

revista portuguesa de
PNEUMOLOGIA
portuguese journal of pulmonology
www.revportpneumol.org

BRIEF COMMUNICATION

The reliability of short-term measurement of heart rate variability during spontaneous breathing in people with chronic obstructive pulmonary disease

C.A. Sima[a], J.A. Inskip[a,b], A.W. Sheel[c], S.F. van Eeden[a,d], W.D. Reid[e], P.G. Camp[a,b,*]

[a] *Centre for Heart Lung Innovation, University of British Columbia, Vancouver, Canada*
[b] *Department of Physical Therapy, University of British Columbia, Vancouver, Canada*
[c] *School of Kinesiology, University of British Columbia, Vancouver, Canada*
[d] *Department of Internal Medicine, University of British Columbia, Vancouver, Canada*
[e] *Department of Physical Therapy, University of Toronto, Toronto, Canada*

Received 8 March 2017; accepted 4 June 2017

KEYWORDS
Autonomic nervous system;
Heart rate variability;
Pulmonary rehabilitation;
Chronic obstructive pulmonary disease

Abstract
Background: Reduced heart rate variability (HRV), a marker of autonomic system dysfunction, has been reported in patients with chronic obstructive pulmonary disease (COPD). Yet, limited data exists on the reliability of HRV measurement in this population. Here we investigated the reliability of short-term HRV measurement performed during spontaneous breathing in patients with COPD.
Methods: Thirteen individuals (8 males) with moderate-to-severe COPD (FEV_1 46 ± 16% predicted; FEV_1/FVC 49 ± 13) underwent standard time and frequency domain HRV measurements derived from 5-minute electrocardiograms collected on two separate days using a SphygmoCor device. Absolute and relative reliability was assessed by a number of coefficients including within-subject random variation, systematic change in the mean, and retest correlations.
Results: Within-subject coefficients of variation (CV) ranged from 4.3% to 193.4%. The intraclass correlation coefficients (ICCs) ranged from 0.72 to 0.93 for parameters related to overall HRV, and from 0.57 to 0.59 for those related to parasympathetic tone in both time and frequency domains. Mean heart rate was the only parameter that showed excellent absolute and relative reliability (CV = 4.3%, ICC = 0.93).
Conclusion: The HRV measurements showed overall moderate-to-substantial reliability during spontaneous breathing in COPD population. Our findings support the use of HRV parameters for diagnosis and cardiac risk assessment, but only mean heart rate can be used reliably for monitoring changes in autonomic status following rehabilitation intervention in this population.

* Corresponding author.
E-mail address: pat.camp@hli.ubc.ca (P.G. Camp).

http://dx.doi.org/10.1016/j.rppnen.2017.06.001

Please cite this article in press as: Sima CA, et al. The reliability of short-term measurement of heart rate variability during spontaneous breathing in people with chronic obstructive pulmonary disease. Rev Port Pneumol. 2017. http://dx.doi.org/10.1016/j.rppnen.2017.06.001

Introduction

Cardiovascular disease is a common comorbidity in patients with chronic obstructive pulmonary disease (COPD).[1] Autonomic system dysfunction, through sympathetic nervous overactivity, may play an important role in the initiation and progression of cardiovascular disease in this population.[2] Reduced heart rate variability (HRV), a marker of autonomic dysregulation and a significant predictor of cardiac events,[3] has been reported in patients with COPD.[4] Therefore, monitoring HRV changes with various interventions in this population may be useful to assess their cardiovascular risk profile.

Aerobic exercise training, such as during pulmonary rehabilitation program, has the potential to influence HRV in COPD patients.[5] However, measuring HRV for cardiac risk stratification or evaluation of rehabilitation program effectiveness in improving cardiac autonomic function has not yet been implemented clinically. Possible explanations for this delay are related to the complexity of HRV analysis and the instability of this measurement under various psychophysiological conditions, which may limit its reliability.[6]

To the best of our knowledge, there is only one study investigating HRV measurement reliability in patients with COPD.[7] Despite reporting good measurement reliability, the study employed a limited number of HRV parameters and statistical analyses to be of use for making clinical decisions. Moreover, the HRV measurement was performed under controlled respiratory rate – a procedure that is not always feasible, or requires prolonged training, in patients with more severe COPD who are those commonly referred for pulmonary rehabilitation. Therefore, we conducted this study to examine the test–retest reliability of HRV measurement from short-term electrocardiogram (ECG) recording performed during spontaneous breathing in individuals with moderate-to-severe COPD.

Methods

Study design and population

This study used a within-subject repeated measure design, and was conducted in an outpatient Pulmonary Rehabilitation Clinic. The study population included seventeen subjects over 50 years of age, with a physician diagnosis of COPD confirmed by clinical and GOLD spirometric criteria, in stable lung and cardiac condition (e.g., without respiratory infection or hospitalization of pulmonary or cardiac causes as well as without changes in their medication during the preceding month entering the study). The exclusion criteria were cardiac dysrhythmia, cardiac pacemaker, valvular disease, and conditions that would preclude lying supine in a relaxed position. The study was approved by the Research Ethics Board at University of British Columbia and all participants provided written informed consent.

Study procedure

Resting HRV data were collected on two visits within one week. Testing sessions were conducted at the same time of day (~9:00 a.m.) with the participants lying supine in a quiet and temperature controlled room, and following a rigorous standardized protocol. All participants were instructed to avoid heavy exertion for a minimum of 24 h, and to refrain from taking any medication, smoking, eating, drinking alcohol and beverages containing caffeine for at least 12 h before testing; conditions that could easily be achieved in clinical practice.

Prior to the initiation of the HRV measurement, patients' characteristics including hemodynamic parameters were collected. Then, the experimental procedure was described and patients were asked to relax, breathe normally, and refrain from moving, talking, or sleeping during the procedure. A 3-lead ECG was attached to the participants' chest in the lead II configuration, and they were left to rest in the supine position for ten more minutes before the ECG recordings were performed.

HRV measurement

Time and frequency domain evaluations of HRV were obtained from short-term five-minute ECG recording performed during spontaneous breathing using a SphygmoCor® CPV device (AtCor Medical, Inc., USA). One recording was obtained at each visit.

Three time domain HRV parameters were analyzed: mean heart rate, standard deviation of normal to normal R–R intervals (SDNN), and square root of the mean squared difference of successive normal to normal R–R intervals (RMSSD). The mean heart rate and SDNN are considered to reflect both sympathetic and parasympathetic activity, while the RMSSD represents primarily the parasympathetic or vagal influences.[3]

Three frequency domain HRV parameters were analyzed: low-frequency (LF, 0.04–0.15 Hz), high frequency (HF, 0.15–0.4 Hz), and total power (TP, 0–0.5 Hz). The LF power is considered to reflect both sympathetic and parasympathetic modulation of the heart, while the HF power reflects primarily vagal control and the mechanical effects of breathing on heart rate throughout the respiratory cycle.[3] The ratio between LF and HF power (LF/HF) is also often used to assess the sympatho-parasympathetic balance. Ultimately, the total power is considered to be a global index of HRV.[3]

Following visual examination of the ECGs, only stable and artifact free recordings with normal sinus rhythm were included in the analysis. The HRV calculation was deemed unacceptable in three patients due to extreme noise or large number of ectopic beats. One participant was excluded as they were unable to complete the two testing sessions. A total of thirteen patients (8 males and 5 females) were included in the final analysis.

Statistical analysis

Continuous variables were described using mean and standard deviation. Since computation of reliability coefficients depends on the assumption of normal distribution, the data was examined for normality using Kolmogorov–Smirnov test and HRV indices with skewed

Please cite this article in press as: Sima CA, et al. The reliability of short-term measurement of heart rate variability during spontaneous breathing in people with chronic obstructive pulmonary disease. Rev Port Pneumol. 2017. http://dx.doi.org/10.1016/j.rppnen.2017.06.001