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Slow breathing influences cardiac autonomic responses to postural maneuver
Slow breathing and HRV

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A B S T R A C T

Chronic slow breathing has been reported to improve Heart Rate Variability (HRV) in patients with cardiovascular disorders. However, it is not clear regarding its acute effects on HRV responses on autonomic analysis. We evaluated the acute effects of slow breathing on cardiac autonomic responses to postural change manoeuvre (PCM). The study was conducted on 21 healthy male students aged between 18 and 35 years old. In the control protocol, the volunteer remained at rest seated for 15 min under spontaneous breathing and quickly stood up within 3 s and remained standing for 15 min. In the slow breathing protocol, the volunteer remained at rest seated for 10 min under spontaneous breath, then performed slow breathing for 5 min and rapidly stood up within 3 s and remained standing for 15 min. Slow breathing intensified cardiac autonomic responses to postural maneuver.

1. Introduction

Slow breathing has gained consideration because the literature reported positive physiological effects, including blood pressure reduction and improvement in chronic heart failure [1–3]. Reduction in the respiratory rate also acutely reduced anxiety and, it was considered sufficient to control physiological arousal during stressful conditions in musicians [4].

The effects of slow breathing include beneficial changes in the Autonomic Nervous System (ANS) [5]. It was demonstrated that slow breathing increases parasympathetic cardiac modulation and reduces sympathetic cardiac control [6]. In this manner, Heart Rate Variability (HRV) [7,8] is a simple and non-invasive method that analyzes cardiac autonomic regulation. It measures the fluctuation of the intervals between consecutive heart beats (RR intervals) [9].

Previous studies have illustrated increases in HRV caused by chronic guided breathing sessions in hypertensive subjects. These studies support slow breathing as a complementary and alternative intervention for cardiovascular disorders [10,11].

Autonomic tests are applied to evaluate the adequate function of the ANS. A standard test applied in the clinical daily routine is the postural change maneuver (PCM). This test is based on the measurement of heart rate reflex changes in response to postural change stimulation [12].

A further study demonstrated that slow breathing training decreased baseline blood pressure and declined the pressor response to handgrip exercise [13]. Nonetheless, the acute effects of slow breathing on HRV responses to different autonomic tests are unclear. Additionally, non-pharmacological intervention is of assistance to add new elements in alternative and complementary therapies. In this situation, we investigated the acute effects of slow breathing on cardiac autonomic responses to PCM.

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2. Methods

2.1. Study population

The subjects participating in the study were 21 healthy male students - all non-smokers, aged between 18 and 35 years old. All volunteers were informed about the procedures and the objectives of the study and gave written informed consent. All study procedures were approved by the Ethics Committee in Research of our Institution (No. 2014-953), and were in accordance with Resolution 196/96 National Health 10/10/1996.

2.2. Non-inclusion criteria

We excluded subjects under the following conditions: Body Mass Index (BMI) > 35 kg/m^2; systolic blood pressure (SBP) > 140 mmHg or diastolic blood pressure (DBP) > 90 mmHg (at rest); cardiovascular, respiratory, endocrine and reported neurological disorders that did not allow the volunteers to perform the procedures. Subjects under medication that influence the ANS were excluded.

2.3. Initial evaluation

Baseline information collected included age, gender, mass, height and Body Mass Index (BMI). Mass was determined using a digital scale (W 200/5, Welmy, Sao Paulo, Brazil) with a precision of 0.1 kg. Height was determined using a stadiometer (ES 2020, Sanny, Sao Paulo, Brazil) with a precision of 0.1 cm and 220 cm of extension. BMI was calculated as weight/height [2], with weight in kilograms and height in meters.

2.4. HRV analysis

HRV was analyzed according to instructions from the Task Force guidelines [7]. Instantaneous RR intervals (RRi) were recorded with a digital telemetry system, consisting of a transmitter placed on the patient's chest and a heart rate monitor (Polar® RS800CX; Polar Electro Oy, Kempele, Finland). This system detects ventricular depolarization, corresponding to the R wave on the electrocardiogram. This was achieved at a sampling rate of 500 Hz. It had been previously validated [14] and further downloaded to the Polar Precision Performance program (v.3.0, Polar Electro, Finland). The software enabled the visualization of heart rate and the extraction of a cardiac period (RR interval) file in "txt" format. Subsequent digital filtering complemented with manual filtering for the elimination of premature ectopic beats and artefacts, 256 RR intervals were applied for the data analysis. Only series with sinus rhythm greater than 95% were included in the study.

2.5. Time and frequency domain indices of HRV

For HRV analysis in the frequency domain we applied the spectral components of low frequency (LF: 0.04–0.15 Hz) and high frequency (HF: 0.15–0.40 Hz) in absolute (ms [2]) and in normalized units. The spectral analysis was calculated with the Fast Fourier Transform (FFT) algorithm [15].

Time domain analysis was accomplished through the SDNN (average standard deviation of normal RR intervals), pNN50 (percentage of adjacent RR intervals lasting more difference than 50 ms), RMSSD (square root of the average square differences between normal adjacent RR intervals) and SDNN/RMSSD ratio [16]. For analysis of linear indices in the frequency and time domain we applied the Kubios HRV® analysis software [17].

2.6. Slow breathing protocol

The slow breathing protocol was based on the literature which emphasized cycles with 10–12 s duration, corresponding to a breathing rate of 5–6 cycles per minute [18]. In this *modus operandi* the volunteers performed about 6 cycles per minute each with 10 s duration (0.1 Hz) for 5 min. The researcher guided the volunteer's breathing with a metronome. The volunteers were instructed to perform deep, but slow inspirations, and similar expirations with lung volumes ranging from the total lung volume to residual volume.

2.7. Experimental protocols

Data collection was undertaken in the same sound-proofed laboratory for all volunteers with the temperature between 20 °C and 26 °C; and relative humidity between 40% and 60%. Volunteers were instructed not to drink alcohol and/or caffeine for 24 h before evaluation and 24 h with no extenuous exercise, with a light meal at least 2 h before conducting tests. Datasets were collected on an individual basis, between 18:00 h and 21:00 h to standardize the circadian cycle. All procedures necessary for the data collection were explained on an individual basis and the subjects were instructed to remain at rest and avoid conversation during the data collection.

In the slow breathing protocol, the subject remained at rest seated for 10 min under spontaneous breathing. After 10 min, the volunteers performed slow breathing for 5 min and promptly stood up from a seated position within 3 s according to verbal command and remained standing for 15 min. In the control protocol, the subject remained at rest seated for 15 min under spontaneous breathing (Table 1). The sequence of the protocols was randomized.

2.8. Statistical analysis

Standard statistical methods were applied for the calculation of means and standard deviations. Normal Gaussian distribution of

Table 1
Experimental protocols.

Control protocol	10 min	10–15 min	15 min	15–20	20–25	25–30
	HRV recording under spontaneous breathing at seated rest.	HRV recording under spontaneous breathing at seated rest.	Change from seated to standing.	HRV recording at standing under spontaneous breathing.	HRV recording at standing under spontaneous breathing.	HRV recording at standing under spontaneous breathing.
Paced breathing protocol	10 min	10–15 min	15 min	15–20	20–25	25–30
	HRV recording under spontaneous breathing at seated rest.	Slow breathing at seated rest.	Change from seated to standing.	HRV recording at standing under spontaneous breathing.	HRV recording at standing under spontaneous breathing.	HRV recording at standing under spontaneous breathing.