

## Effect of combined physical exercise program on improving the functional capacity and the cardiac autonomic modulation of Chagas cardiomyopathy

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**Abstract - Aims:** Patients with Chagas cardiomyopathy (ChC) could have a significant reduction in functional capacity (FC). This study aimed to report the effect of a 24-week combined physical exercise program on the FC of a patient with ChC. **Methods:** A woman, 44 years old, with positive serology for ChC in stage B2 has submitted the following assessments: i) Physical assessment; ii) Cardiopulmonary exercise test; iii) Test of 1-maximum Repetition; iv) Evaluation of cardiac autonomic modulation by heart rate variability (HRV). **Results:** The results obtained revealed a reduction in the anthropometric parameters and the SBP after training. Additionally, we observed an improvement in FC (aerobic and strength condition) and cardiac autonomic modulation after 24 weeks of combined training. **Conclusion:** Our findings show that of a 24-week combined physical exercise program improved either FC or HRV of the patient with ChC.

**Keywords:** Chagas cardiomyopathy, aerobic training, strength training, functional capacity, heart rate variability.

### Introduction

Patients with Chagas cardiomyopathy (ChC) with left ventricular dysfunction (LVD) could have impaired functional capacity. Cardiac remodeling induced by pathogens in ChC can lead to a progressive reduction in cardiac performance with an impact on the functional capacity of individuals. In this context, cardiac damage, abnormalities of the sympathetic-vagal balance, poor diet, chronic and systematic inflammatory process, medications, and physical inactivity could explain intolerance to physical exercise, muscle weakness, and worsening of the quality of life of patients with ChC<sup>1-3</sup>.

Oxygen consumption at peak effort ( $VO_2$  peak), metabolic thresholds, ventilatory efficiency (VE/VCO<sub>2</sub>-slope) with gravity marker, and presence of periodic breathing (PB) have been evaluated in the ChC<sup>1,2,4</sup>. However, few studies have investigated the effects of a combined formal exercise program with aerobic exercise and strength exercise in patients with ChC with LVD. This makes the case report potentially interesting when sharing the experience of our group in non-drug therapy in ChC. In this context, the present case study aimed to report the

effect of a 24-week combined physical exercise program on the clinical profile and FC of a patient with ChC with LVD without symptoms of heart failure.

### Case report

A woman, 44-years-old, housewife, with positive serology for ChC, diagnosed 15 years ago, in stage B2 of the disease (altered electrocardiographic signal and left ventricular ejection fraction of 42% without HF clinic). The patient was using optimized and unchanged medication over the 24 weeks of the study (Carvedilol 6.25mg/day), had normal pulmonary function values with a forced vital capacity (FVC) of 2.11 L, and a forced expiratory volume in the first second (FEV<sub>1</sub>) of 2.09 L. Additionally, the patient had BMI characterizing grade I obesity, was sedentary, free of comorbidities such as hypertension, diabetes, dyslipidemia, or the coexistence of other diseases. Anthropometric, clinical, strength, and hemodynamic characteristics were presented in Table 1. This study was approved by the Ethics Committee of Hospital Universitario Clementino Fraga Filho da Universidade Fed-

**Table 1** - Anthropometric, clinical, strength, and hemodynamic values from a woman with Chagas Cardiopathy measured at baseline (T1), three (T3), and six (T6) months after 24-week combined physical training.

Characteristics	T1	T3	T6
<b>Anthropometric</b>			
Body mass (kg)	85.7	84.4 (-1.51%)	83.4 (-2.68%)
BMI (kg/m <sup>2</sup> )	33.5	33 (-1.49%)	32.6 (-2.68%)
SBP (mmHg)	150	100 (-33%)	120 (-20%)
DBP (mmHg)	90	70 (-22%)	80 (-11%)
MBP (mmHg)	110	80 (-27%)	87 (-21%)
Percentage body fat (%)	37.5	35.7 (-4.8%)	33.1 (-11.7%)
WHR (cm)	0.84	0.80 (-4.7%)	0.79 (-5.9%)
<b>Cardiopulmonary Exercise Test</b>			
<b>At rest</b>			
VO <sub>2</sub> absolute (L/min)	0.04	0.02 (-50%)	0.07 (+75%)
VO <sub>2</sub> relative (ml/kg/min)	0.47	0.24 (-51%)	0.84 (+79%)
<b>VAT</b>			
VO <sub>2</sub> absolute (L/min)	0.63	0.53 (-15.8%)	0.57 (-9.5%)
VO <sub>2</sub> relative (mL/kg/min)	7.41	6.31 (-14.8%)	6.87 (-7.2%)
Time (s)	146	324 (121%)	321 (119%)
Load (watts)	40	65 (62.5%)	65 (62.5%)
<b>Peak</b>			
VO <sub>2</sub> absolute (L/min)	1.2	0.85 (-29%)	0.89 (-26%)
VO <sub>2</sub> relative (mL/kg/min)	13.7	10.12 (-26.2%)	10.72 (-22%)
Time (s)	480	624 (30%)	612 (27.5%)
Load (watts)	95	115 (21%)	115 (21%)
Ventilatory efficiency (VE/VCO <sub>2</sub> Slope.)	26.25	21.99 (-16.2%)	18.27 (-30.4%)
<b>1-MR Test</b>			
Squat (kg)	62	76 (22.5%)	82 (32.2%)
Wide grip Lat pull down (kg)	45	48 (6.6%)	52 (15.5%)

Legend: BMI: body mass index; DBP: diastolic blood pressure; MBP: mean blood pressure; SBP: systolic blood pressure; WHR: waist-to-hip ratio. VO<sub>2</sub>: oxygen consumption; VE/VCO<sub>2</sub> Slope: ventilatory equivalents of carbon dioxide; VAT: ventilatory anaerobic threshold; 1-MR: one maximum repetition. The values in parentheses represent percentage increases or decreases comparing T1 x T3 e T1 x T6.

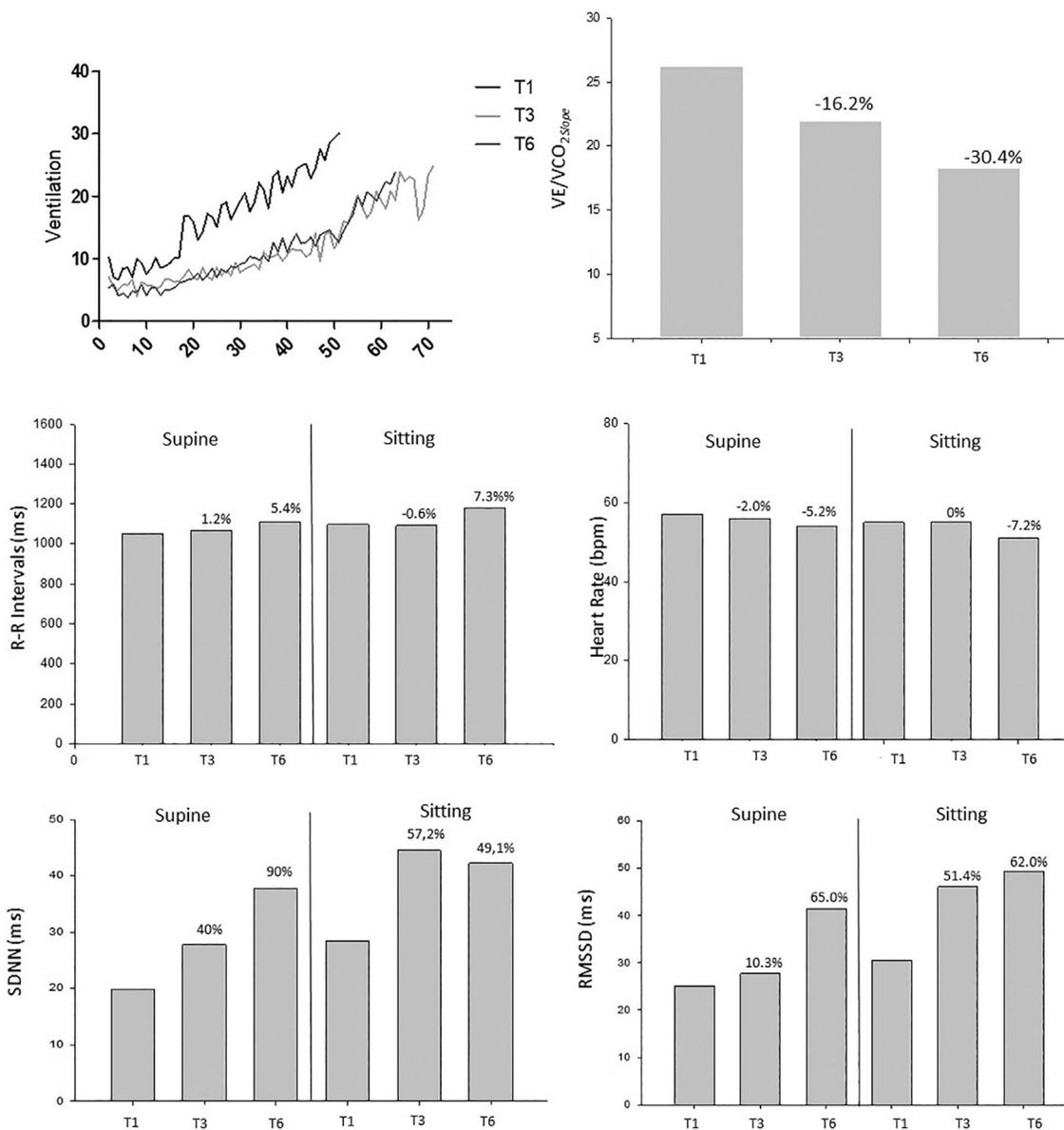
eral do Rio de Janeiro- (CAAE No. 26421619.1.0000.5257).

The following assessments were carried out: i) Anamnesis and anthropometric assessment: measurements of body mass (kg), height (cm), body mass index (BMI), waist circumference (cm), and fat percentage<sup>5</sup>; ii) Cardiopulmonary exercise test (CPET - VO2000 - *Portable Medical Graphics Corporation*<sup>®</sup>): The test was performed on a cycle ergometer using a ramp protocol (incrementation of 10W/min) (Inbramed, Porto Alegre, Brazil). Oxygen consumption and workload at peak of CPET, ventilatory anaerobic threshold (VAT), ventilatory efficiency, and periodic breathing were obtained to assess FC<sup>6,7</sup>; iii) Test of 1-Maximum Repetition (1-MR): the maximum strength of

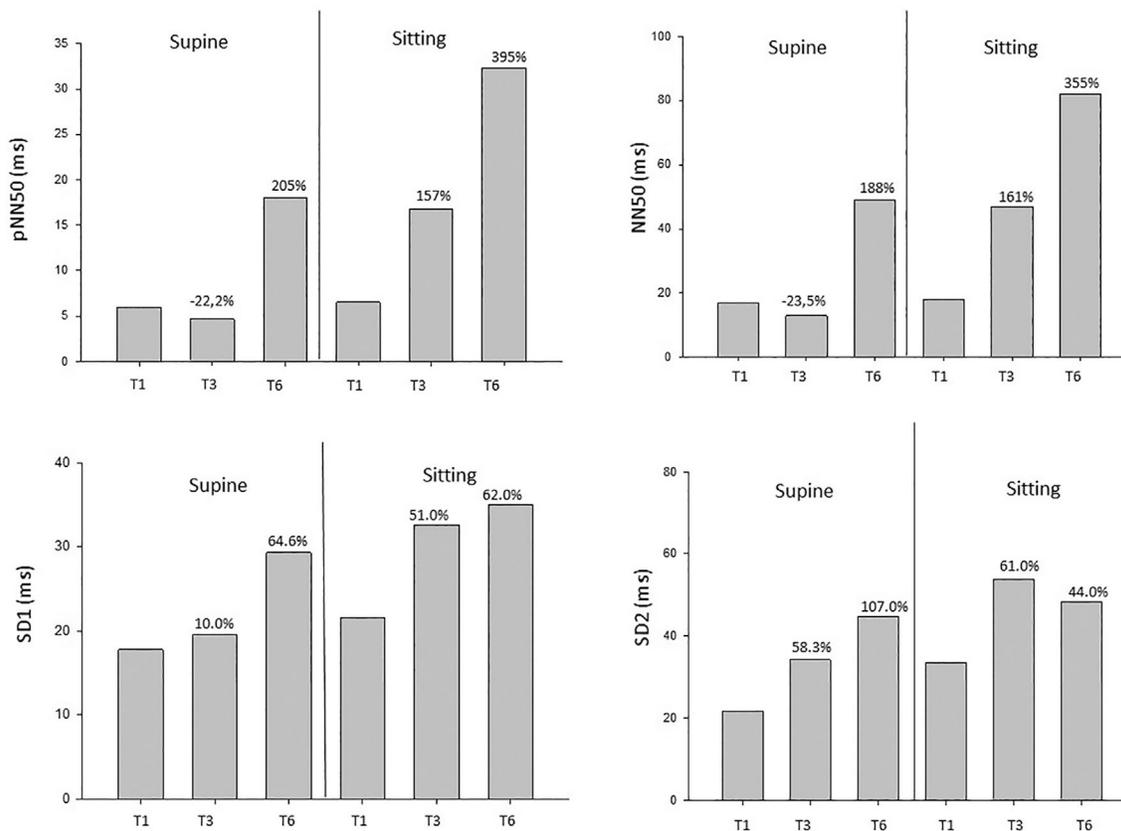
5 consecutive attempts of the squat and lat pulldown exercises was evaluated<sup>8</sup>, and iv) Heart rate variability (HRV) was recorded by ECG system (Wincardio USB, Micro-med, Brasília, Brazil) at rest in the supine and sitting positions. SDNN and SD2 indices (representative of the total HRV) and RMSSD, pNN50, NN50, and SD1 (representative of parasympathetic modulation) were analyzed<sup>9</sup>. In the sequence, the patient participated in a combined physical exercise program for 24 weeks, 3 times/week, and was accompanied by a multi-professional team. The routine was defined as (i) Aerobic training - 35 minutes on a cycle ergometer, with 5 minutes of warm-up at 40% of the VAT, 25 minutes at 100% of the VAT and 5 minutes of cool down; and, ii) Strength training - 5 exercises with 3 sets

with repetitions varying according to periodization (60 - 90% 1-MR) for the main muscle groups - squat, wide-grip pullup, back row, shoulder press, and sit-ups. Finally, the patient was evaluated at baseline (T1), in the third (T3), and sixth months (T6) after training. Table 1 shows the anthropometric and systemic blood pressure (SBP), cardiorespiratory characteristics, and muscle function at three moments. The results obtained revealed a reduction in the anthropometric parameters and the SBP after training. Regarding  $VO_{2peak}$  and VAT, an improvement was

observed in workloads of CPET after six months of intervention. At moments T3 and T6, the VAT and  $VO_2$  peak occurred later than the baseline condition, revealing an improvement in FC. An increase in muscle strength in T3 was found in the squat and the wide-grip pull-up exercises. Figure 1 shows the ventilation in the three moments, where lower periodic breathing in T3 and T6 can be observed concerning the baseline condition, as well as a reduction in the  $VE/VCO_{2slope}$  of T1vs.T3 and T1vs.T6. It is possible to highlight the SDNN and RMSSD parameters



**Figure 1** - Data on ventilation, ventilation efficiency, and heart rate variability from a woman from a woman with Chagas Cardiopathy throughout the intervention process in the lying and sitting position at baseline (T1), three (T3), and six (T6) months after 24-week combined physical training Legend: IRR: RR intervals; SDNN: Standard deviation of all normal RR intervals; RMSSD: Square root of the mean of the square of the differences between the adjacent normal RR intervals; NN50: Represents the adjacent RR intervals with a difference in duration greater than the 50s; pNN50: Percentage of adjacent RR intervals with a difference in duration greater than 50s; SD1: Scattering of points perpendicular to the identity line; SD2: Scattering of points along the identity line.



**Figure 1 (cont.)** - Data on ventilation, ventilation efficiency, and heart rate variability from a woman from a woman with Chagas Cardiopathy throughout the intervention process in the lying and sitting position at baseline (T1), three (T3), and six (T6) months after 24-week combined physical training Legend: IRR: RR intervals; SDNN: Standard deviation of all normal RR intervals; RMSSD: Square root of the mean of the square of the differences between the adjacent normal RR intervals; NN50: Represents the adjacent RR intervals with a difference in duration greater than the 50s; pNN50: Percentage of adjacent RR intervals with a difference in duration greater than 50s; SD1: Scattering of points perpendicular to the identity line; SD2: Scattering of points along the identity line.

in which percentage increases were observed in T3 and T6 and especially in the parameters related to vagal modulation in the sitting position.

## Discussion

In the present case report, the patient showed an improvement in exercise capacity, an increase in peripheral muscle strength, and interestingly, lower periodic breathing with a reduction in  $VE/VCO_{2slope}$  after 3 and 6 months of combined physical training. Besides, it was possible to observe an improvement in anthropometric parameters and better cardiac autonomic modulation with reduced pressure values without changing the medication approach.

Patients with heart failure (HF) of chagasic etiology (the patient has no HF clinic) may have peripheral muscle dysfunction caused by a reduction in the volume of muscle mitochondria, in addition to a worsening in the action of oxidative enzymes, such as, for example, cytochrome C oxidase<sup>10</sup>. This interferes with the use of oxygen, increas-

ing the proportion of fibers with type II characteristics that determine early fatigue and decreased functional capacity and autonomy for activities of daily living<sup>10</sup>. However, the chronic stimulus of aerobic training combined with strength training can induce improvement of the left ventricular preload, with greater cardiac output and, mainly, adaptations of the trained peripheral muscles, potentiating the use of oxygen<sup>2</sup>. In this sense, the improvement in the physical exercise capacity in the T3 and T6 conditions can be attributed to the adaptations induced by the regular stimulus of the combined training in the improvement of the oxidative capacity. This finding should be highlighted, although the relative  $VO_2$  is lower in T6. There is solid evidence that peak  $VO_2$  increases with combined physical training. However, there is also the understanding that it is not an isolated parameter of improvement in patients with chronic cardiorespiratory diseases, mainly because cardiopulmonary testing is voluntary. In this context, a set of parameters (time of exhaustion, load,  $VE/VCO_{2slope}$ ,  $VO_2$ ) must be considered for the most assertive determination of improvement in functional capacity through combined

training<sup>7</sup>. Additionally, despite the ventricular dysfunction presented by the patient, the improvement in PB, VE/VCO<sub>2slope</sub>, and cardiac autonomic modulation may be related to greater cardiac performance<sup>9</sup>.

Finally, this case allows us to conclude that the of a 24-week combined physical exercise program improved the FC, muscle strength, and cardiac autonomic modulation of the patient with ChC. Besides, it modified the response of the PR and VE/VCO<sub>2slope</sub>, suggesting less pulmonary congestion and better cardiac performance.

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