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Original article

Inspiratory muscle training reduces heart anxiety in patients submitted to coronary artery bypass grafting: Controlled randomized clinical trial

Treinamento muscular inspiratório reduz a ansiedade cardíaca em pacientes submetidos à cirurgia de revascularização do miocárdio: ensaio clínico

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ABSTRACT

Introduction: Cardiac anxiety (CA) is a common finding in patients undergoing preoperative and postoperative care for coronary artery bypass grafting (CABG). Inspiratory muscle training (IMT) aimed at increasing muscle strength may reduce CA in the postoperative period. **Objective:** to verify whether IMT reduces cardiac anxiety in patients undergoing myocardial revascularization and whether there is a correlation between inspiratory muscle strength and cardiac anxiety. **Methods:** This is a controlled and randomized clinical trial. In the preoperative phase, all patients completed a cardiac anxiety questionnaire, which included two domains: fear and vigilance and avoidance. Additionally, maximum inspiratory pressure (MIP) was assessed. After the surgical procedure, patients were divided into a control group (CG) that received routine hospital care and a training group (TG) that underwent an IMT protocol until hospital discharge. **Results:** Eighty patients were evaluated. The IMT group showed a 17% decrease in MIP, while the CG experienced a 43% decrease ($p < 0.01$). The fear and vigilance domain showed a reduction of -16±3 in the CG, while the TG had a reduction of -8±3 ($p < 0.01$). Furthermore, a strong correlation was found between MIP in the TG and the domains of fear/vigilance (r -0.77) and avoidance (r -0.72). **Conclusion:** IMT is associated with a reduction in the loss of inspiratory muscle strength, resulting in a lower level of cardiac anxiety in patients undergoing coronary artery bypass grafting.

Keywords: cardiac surgery; exercise; anxiety.

RESUMO

Introdução: A ansiedade cardíaca (AC) é um achado comum em pacientes no pré e pós-operatório de cirurgia de revascularização do miocárdio (CRM). O treinamento muscular inspiratório (TMI) para gerar aumento da força muscular pode causar diminuição da AC no pós-operatório. **Objetivo:** verificar se o TMI diminui a ansiedade cardíaca de pacientes submetidos à revascularização do miocárdio e se existe correlação entre força muscular inspiratória e ansiedade cardíaca. **Métodos:** Trata-se de um ensaio clínico controlado e randomizado. No momento pré-operatório, todos os pacientes responderam a um questionário de ansiedade cardíaca, composto por dois domínios: medo e vigilância e evitação. Além disso, foi avaliada a pressão inspiratória máxima (PImáx). Após o procedimento cirúrgico, os pacientes foram divididos em um grupo controle (GC) que recebeu cuidados hospitalares de rotina e um grupo de treinamento (GT) que foi submetido a um protocolo de TMI até o momento da alta hospitalar. **Resultados:** Foram avaliados 80 pacientes. O grupo TMI apresentou uma diminuição de 17% na PImáx enquanto o GC diminuiu 43% ($p < 0,01$). O domínio medo e vigilância teve uma redução de -16±3 no GC enquanto no GT a redução foi de -8±3 ($p < 0,01$). Para além disso, verificou-se uma forte correlação entre a PImáx do TG com os domínios do medo/vigilância (r -0,77) e evitamento (r -0,72). **Conclusão:** O TMI está associado a uma redução na perda de força muscular inspiratória, resultando em um nível reduzido de ansiedade cardíaca em pacientes submetidos à cirurgia de revascularização do miocárdio.

Palavras-chave: cirurgia cardíaca; exercício; ansiedade.

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Introduction

Coronary artery bypass grafting (CABG) has improved quality of life for patients with coronary heart disease [1], but despite continuous innovations and improvements in the quality of interventions, the surgical procedure is still a difficult time for the patient and also for his family. The high complexity of the procedure can cause stress, anxiety and depression as the main neuropsychological manifestations [2,3].

In addition to being associated with the high rate of recurrences, death and prolonged hospitalization, anxiety and depression can lead to poor prognosis and are associated with psychological stress that affects the health of patients undergoing cardiac surgery [3]. Several studies have highlighted the importance of assessing psycho-emotional stressors in patients before and after myocardial revascularization. As an example, high levels of anxiety are associated with depression, which negatively affects physiological parameters and influences patient recovery in several factors [4].

Cardiac anxiety (CA) is defined as an unpleasant emotional state or condition with experiential, physiological and behavioral components [5]. The clinical manifestation of CA is agitation and disorientation, and these changes can lead to increased heart rate, respiratory rate, and blood pressure [5,6]. CA may remain elevated in the postoperative period due to factors such as poor nursing care during this period and the ventilatory restriction generated by pain and reduced muscle strength caused mainly by median sternotomy and surgical manipulation [6,7]. Inspiratory Muscle Training (IMT) is therefore an alternative to reduce the loss of ventilatory muscle strength and, consequently, eliminate the stressor and limiting factor that is ventilatory muscle weakness [8,9]. In IMT a load is applied against muscle activity. Due to the overload generated in the muscle, there will be an increase in muscle strength [9].

Several studies use IMT as an instrument to optimize outcomes such as functional capacity, length of hospital stay and postoperative pulmonary complications [9], however, there is a knowledge gap about the impact of IMT on cardiac anxiety. Therefore, the aim of this study was to assess the impact of IMT on inspiratory muscle strength and its relationship to cardiac anxiety in patients undergoing myocardial revascularization.

Methods

This randomized controlled clinical trial was carried out at a referral hospital in cardiology in the city of Feira de Santana, Bahia, Brazil from February to November 2018. It was approved by the Research Ethics Committee of Faculdade Nobre de Feira de Santana under the number 2.366,995 and is found in the Brazilian Registry of Clinical Trials (ReBEC) under number RBR-8dqrdq. All participating patients signed a Free and Informed Consent Form.

Patients

The criteria were analyzed in the preoperative period, when patients were admitted to the hospital. Patients of both sexes aged between 30 and 70 years, who underwent myocardial revascularization with extracorporeal circulation and median sternotomy were included. Patients were excluded if they had valvular heart disease, previous lung disease, death, inability to understand how to perform the inspiratory muscle strength assessment, presented hemodynamic instability (mean arterial pressure below 70 mmHg or above 110 mmHg and / or heart rate below 60 or above 120 beats per minute) during assessment or inspiratory muscle training, inability to answer the heart anxiety questionnaire and emergency surgery.

Assessment of cardiac anxiety

In the preoperative period and at hospital discharge, all patients answered a cardiac anxiety questionnaire in a version validated for Portuguese by Sardinha *et al.* [10] applied by a blind examiner regarding the allocation process of the groups. This scale has 18 items, distributed in two domains - fear and hypervigilance and avoidance, with responses ranging from 0 (never) to 4 (always). Patients respond about heart-related fear (8 items, e.g. "I worry that I might have a heart attack" and "If the test comes out normal, I still worry about my heart") and avoidance (5 items, e.g. "I take it easy as much as (5 items, e.g. "I check my pulse"). Higher scores reflect greater cardiac anxiety.

Measurement of ventilatory muscle strength

The ventilatory muscle strength was determined by assessing maximum inspiratory pressure (MIP) using an analog manovacuometer (Indumed®, Brazil) in the preoperative period in both groups. The measurement was performed according to the protocol evaluated by Neder *et al.* [11], which uses a unidirectional valve coupled to the manovacuometer and a nozzle with a 1mm millimeter orifice. The participant was asked to perform a maximum exhalation up to the residual volume and then a maximum and slow inhalation until the total lung capacity. The measurements were repeated three times, with an interval of one minute between them, using the highest value reached, provided that this value was not the last [10]. Evaluation of muscle strength and cardiac anxiety were checked preoperatively and at the time of hospital discharge.

Inspiratory muscle training

After the surgical procedure, the patients were referred to the Intensive Care Unit (ICU) and received care according to the institution's protocol. On the first postoperative day, patients were randomized and performed the procedures according to the allocation groups: Inspiratory Muscle Training Group (TG). Patients underwent inspiratory muscle training with a linear pressure load device (PowerBreathe Knectic Series®, HaB International, UK), with a load equivalent to 40% of the MIP, performing

3 series with 15 repetitions [8]. This training was carried out twice a day, until the day of hospital discharge in association with the usual care of the physiotherapy team.

Control Group (CG) - Patients were managed exclusively according to the usual routine, which consists of applying non-invasive ventilation, breathing exercises, kinesiotherapy, cycle ergometry and stimulating walking.

Statistical analysis

Data analysis was performed using SPSS version 20.0. The Shapiro-Wilk test was used in order to determine the standard of data normality. Quantitative variables were expressed as mean and standard deviation, intra-group comparison of preoperative values with values obtained at hospital discharge were performed using the paired Student t test, and the independent Student t test for inter-group analyzes. Spearman's test was used to correlate the muscle strength variable with the cardiac anxiety outcome. P <0.05 was considered significant.

Results

The flowchart for selecting patients included in the study is shown below (Figure 1). The groups showed homogeneity in the preoperative period, with no statistically significant differences, both for demographic and clinical variables (Table I). During the research period, no patient who underwent inspiratory muscle training experienced adverse events.

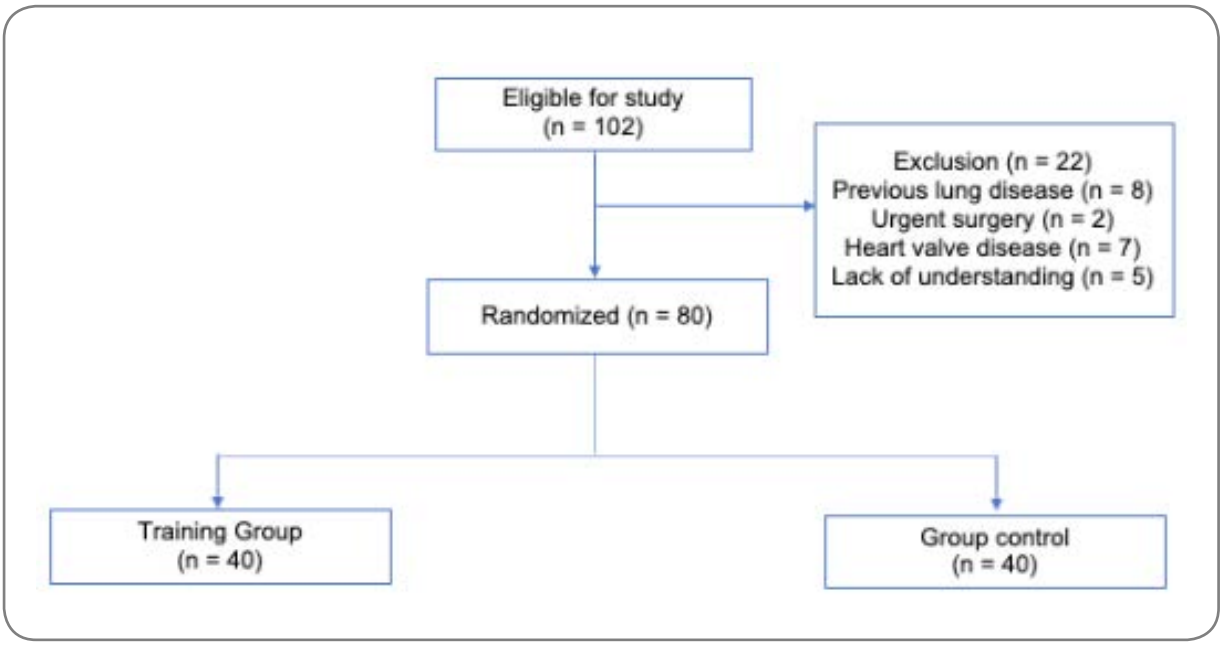

Figure 1 - Flow chart of patients' progression during the study

Table I - Demographic, clinical and surgical characteristics of the patients studied

Variable	TG (n = 40)	CG (n = 40)	p
Sex			0.52[a]
Male	28 (70%)	25 (63%)	
Female	12 (30%)	15 (37%)	
Age (years)	57 ± 7	55 ± 8	0.24[b]
BMC (kg/m²)	26 ± 5	26 ± 8	0.89[b]
Comorbidities			
SAH	27 (68%)	25 (63%)	0.67[a]
DM	18 (45%)	15 (37%)	0.54[a]
DLP	16 (40%)	18 (45%)	0.60[a]
Sedentary lifestyle	22 (55%)	21 (53%)	0.79[a]
CPB time (min)	88 ± 12	92 ± 10	0.53[b]
MV time (hours)	6 ± 3	7 ± 4	0.76[b]
Number of grafts	2 ± 0.4	2 ± 0.5	0.82[b]
Number of drains	2 ± 0.2	2 ± 0.4	0.87[b]
Surgery time (min)	312 ± 30	315 ± 28	0.35[b]

[a] = Chi-square; [b] = Independent Student T test; BMI = Body Mass Index; SAH = Systemic Arterial Hypertension; DM = Diabetes Mellitus; DLP = Dyslipidemia; CPB = Cardiopulmonary bypass; MV = Mechanical Ventilation

The group that performed the inspiratory muscle training showed a 17% drop in inspiratory muscle strength while the control group showed a 43% decrease (p <0.01) (Table II). The TG patients remained hospitalized for 6 ± 2 days against 9 ± 3 days in the CG (p = 0.04), totaling an average of 13 ± 4 sessions of IMT during the hospital stay.

Table II - Behavior of Inspiratory Muscle Strength between the groups studied

Variable	TG (n = 40)	CG (n = 40)	p
MIP (cmH_2O)			
Preoperative	114 ± 10	110 ± 12	0.45
Hospital discharge	98 ± 8	77 ± 11	<0.01
p[b]	0.12	< 0.01	
Δ MIP	16 ± 8	33 ± 12	<0.01

[a] = Independent Student T test; [b] = Paired Student's t-test; MIP - Maximum Inspiratory Pressure; Δ = preoperative value subtracted from hospital discharge value

The variation in cardiac anxiety (Table III) was greater in the training group when compared to the control group, both in the fear and vigilance and avoidance domains (p <0.01).

Table III - Behavior of Cardiac Anxiety among the groups studied

Variable	GT (n = 40)	GC (n = 40)	p[a]
Fear and vigilance			
Preoperative	34 ± 2	33 ± 3	0.77
Hospital discharge	18 ± 3	25 ± 2	0.03
p[b]	< 0.01	0.04	
Δ	-16 ± 3	-8 ± 3	<0.01
Avoidance			
Preoperative	33 ± 3	34 ± 3	0.67
Hospital discharge	16 ± 4	24 ± 4	<0.01
p[b]	<0.01	<0.01	
Δ	-17 ± 4	-10 ± 4	<0.01

[a] = independent Student T test; [b] = Paired Student's t-test; Δ preoperative value subtracted from hospital discharge value

Table IV shows the correlation between the variation in inspiratory muscle strength in absolute value and the two domains of cardiac anxiety. We noted that improved muscle strength was associated with decreased anxiety in the patients studied.

Table IV - Correlation between absolute variation in inspiratory muscle strength and cardiac anxiety domains

Δ MIP				
	TG (n = 40)		CG (n = 40)	
Variable	r*	p	r*	p
Δ Fear and vigilance	- 0.77	<0.01	- 0.22	0.33
Δ Avoidance	- 0.72	<0.01	- 0.31	0.12

*Spearman test; MIP = Maximum Inspiratory Pressure

Discussion

Based on the findings, it can be suggested that the increase in inspiratory muscle strength, through inspiratory muscle training, was associated with decreased levels of cardiac anxiety in patients undergoing myocardial revascularization.

Anxiety and depression are interdependent variables and several studies have already shown a reduction in the intensity of these conditions in patients undergoing cardiac surgery exposed to physical exercise [5,12,13]. However, no studies were found to determine the impact of inspiratory muscle training on cardiac anxiety in this population.

A possible explanation for this result is the increase in levels of the brain-derived neurotrophic factor (FNDC), mainly in the hippocampus region [14], the FNDC is of fundamental importance for the learning and consolidation of memory, which in turn, are responsible for the long-term effects of environmental stimuli as stressful life events [15]. Broman-Fulks and collaborators demonstrated a decrease in the self-reported feeling of fear or anxiety in patients undergoing an aerobic exercise program [16].

Another possibility for reducing anxiety is the increase in cerebral neurogenesis, which can be obtained through physical exercise. To achieve this change in brain structure, some conditions are associated, such as: increased endorphin B, vascular endothelial growth factor, FNDC and serotonin [14].

In addition, Bettencourt *et al.* report that the ability to exercise has a direct influence on anxiety and depression [17]. The greater the capacity to perform activities, the lower the cardiac anxiety. Patients undergoing cardiothoracic surgery tend to have reduced physical capacity in the postoperative period [8,9] and that IMT is a tool to increase functional capacity. Thus, the reduction in anxiety found in our study may have been influenced by the increase in functional capacity secondary to muscle training.

Tamuleviciute-Prasciene *et al.* [18] concluded in their literature review that physical exercise enhances clinical and functional outcomes such as increased strength and muscle mass, mobility, cognition, activities of daily living and reduced anxiety. Most of these studies address aerobic exercises as part of phase I rehabilitation, in our study we increased the protocol with the IMT, achieving encouraging results.

During IMT there is a reduction in the diaphragmatic metaborreflex, generating a greater blood supply to appendicular muscles, thus improving performance in activities [13,19], increasing the self-esteem of these patients, causing a reduction in cardiac anxiety.

A study entitled EUROASPIRE III demonstrated that regular physical exercise is associated with decreased levels of anxiety and depression in patients with coronary artery disease [20]. A similar result was found by Zheng *et al.*, but in patients after acute myocardial infarction [21].

Pain related to the presence of drains and surgical incision leading to the avoidance of certain activities such as coughing, taking deep breaths and physical activity [22], can generate a reduction in ventilatory muscle strength, thus increasing cardiac anxiety.

Another form of anxiety control resides in the pre and postoperative guidelines. It is based on the possibility of informing the patient what will happen during the entire operative period that extends from hospital admission to discharge home. These guidelines, in addition to reducing anxiety, are linked to improved quality of life, self-report, functional capacity and postoperative complications [6,7]. Orienting and making the patient aware of the need and benefits of inspiratory muscle training is of fundamental importance.

According to our knowledge, this is the first study that correlates the direct impact of IMT on cardiac anxiety in patients undergoing CABG, therefore, we cannot consider that training was the main contributor to reducing the outcome variable.

Some limitations can be pointed out: (1) lack of sample calculation; (2) non-stratification for risk factors such as age, surgical risk and comorbidities; (3) not applying a pain scale, although all patients have protocol-guided analgesia.

Conclusion

Inspiratory muscle strength is strongly associated with cardiac anxiety in the postoperative period of myocardial revascularization and inspiratory muscle training is capable of reducing cardiac anxiety in this population.

Conflict of interest
The authors declare that there is no conflict of interest.

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There was no funding.

Authors' contributions
Conception and design of the research: Cordeiro ALB; Data collection: Cordeiro ALB, Almeida F, Araújo E; Data analysis and interpretation: Cordeiro ALB, Barbosa HCM, Jefferson Petto J; Statistical analysis: Cordeiro ALB, Petto J; Manuscript writing: Cordeiro ALB, Barbosa HCM, Soares LO, Almeida F, Araújo E, Petto J; Critical review of the manuscript: Melo TA, Guimarães AR, Petto J

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