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Inspiratory Muscle Training and Functional Independence in Patients Submitted to Myocardial Revascularization: Clinical Trial

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Abstract

Introduction: The deleterious effects caused by Coronary Arterial Bypass Graft Surgery (CABG) to the organism indicate the need to measure the functionality after this procedure.

Objective: To evaluate the influence of Inspiratory Muscle Training (IMT) on the functional independence, inspiratory and peripheral muscle strength in postoperative patients of CABG.

Methodology: Clinical trial. All patients underwent preoperative assessment of Inspiratory Muscle Strength (MIP) and functional independence through the Functional Independence Measurement scale (FIM). An evaluation of the peripheral muscle strength was performed using the Medical Research Council (MRC). At first ward day, subjects were divided into two groups - Control Group (CG) and Training Group (TG). The TG performed IMT until hospital discharge when all patients from both groups were re-evaluated, in order to compare the results.

Results: 38 patients were included (19 patients/group). Analyzing the functionality, the TG was significantly higher at hospital discharge, 120.1 ± 3.8 versus 115.8 ± 3.8 points (CG), p=0.001. The MIP was also higher in the TG at discharge, 85 ± 20 versus 73 ± 14 cm H2O (CG), p=0.04. In addition, there was no difference in the MRC between both groups (p=0.50).

Conclusion: At hospital discharge, those who performed the IMT protocol presented higher inspiratory strength and functional independence when compared with the ones who performed a conventional physical therapy approach.

Keywords: Postoperative Care; Pulmonary Ventilation; Rehabilitation; Thoracic Surgery

Introduction

Cardiac surgery aims to increase life expectancy in patients with cardiovascular diseases, mainly due to coronary obstruction [1]. Major surgeries include myocardial revascularization [1,2]. This procedure is usually associated with median sternotomy and extracorporeal circulation, both of which may lead to a decline in lung function [3,4]. In addition to lung volumes and capacities, ventilatory muscle strength will also be compromised [5]. With this, the cough mechanism is compromised leading to postoperative complications such as pneumonia [3].

This worsening of ventilatory function shows an association

with decreased functional capacity and consequent reduction in quality of life [5,6]. In order to evaluate the functional independence, the Functional Independence Measurement (MIF) can be used, which represents the individual's ability to perform some activities, such as, for example, locomotion and climbing stairs [7].

Aiming to optimize muscular function, a growing alternative is Inspiratory Muscular Training (IMT), which consists in imposing a resistance against the inspiratory phase, promoting muscle overload and consequent cellular adaptation. During the IMT there is activation of the metaborreflex that generates peripheral vasoconstriction and increase of the diaphragmatic blood volume [8].

There is still a gap in the literature about the repercussion of this improved inspiratory muscle strength on functional independence in patients undergoing cardiac surgery. In addition, it is questioned if there is an association between IMT and peripheral muscle strength gain.

Therefore, the present article aims to evaluate the impact of Inspiratory Muscular Training on functional independence, inspiratory, peripheral muscle strength and postoperative pulmonary complications.

Methods

This is a randomized clinical trial that was performed at a referral hospital in cardiology in the city of Feira de Santana - Bahia. The study was carried out from January to October 2015. As inclusion criteria were patients from 35 to 70 years of age, of both genders and underwent myocardial revascularization surgery via median sternotomy and extracorporeal circulation. The study was approved by the Research Ethics Committee of Noble College.

Patients who did not understand the proposed techniques, hemodynamic instability during inspiratory muscle assessment or training, stay in the Intensive Care Unit (ICU) for more than four days, cognitive or communication alteration that made it impossible to answer or evaluate the patient were excluded. Functional independence, invasive mechanical ventilation time greater than 12 hours or intermittent noninvasive mechanical ventilation for more than 24 hours, chronic obstructive pulmonary disease, and patients who did not agree to sign the informed consent form.

All patients underwent preoperative assessment of inspiratory muscle strength (Maximum Inspiratory Pressure) through an Instrumentation Industries analogue manovacuometer of the MV - 120, with a range of 0 to 120 cmH_2O. In addition, patients responded to a functional independence rating scale, Functional Independence Measurement (FIM), which aims to measure what the person actually does regardless of diagnosis, generating valid disability scores, not disability. This scale assesses the patient's ability to develop body care, sphincter control, transference and locomotion, as well as cognitive function such as communication and memory. A score of 1 to 7 was given, where the lowest value corresponded to the totally dependent patient and the maximum value was this patient completely independent from the functional point of view, being able to reach a maximum value of 126 points when all variables were added together [7]. This scale was used because it is the institution standard.

These individuals were evaluated for their peripheral muscle strength through the Medical Research Council (MRC), which evaluates six muscle groups (shoulder abductors, elbow flexors, wrist extensors, hip flexors, knee extensors and ankle dorsiflexors), giving A score of 0 to 5, where zero represents absence of contraction and five muscular forces preserved [9]. It is noteworthy that all these evaluations were performed in the preoperative period by a blind evaluator who did not know the objectives of the research.

After these evaluations, the patients were referred to the surgical center and then to the ICU. In the ICU, patients were connected to the mechanical ventilator in VCV mode (VC 6 ml / kg, respiratory rate to maintain arterial carbon dioxide pressure between 35 and 45 mmHg, PEEP 05 cmH_2O and inspired 60% oxygen fraction. Researcher had influence on the procedures adopted by the team in relation to weaning and mobilization, and the patient was managed based on the protocol of the institution, which consists of sedestation on the first day after surgery, breathing exercises, cycloergometry and ambulation. The time of mechanical ventilation was counted from the ICU and the time in the operating room was not taken into account.

After discharge from the ICU, the patients were randomized by simple randomization and divided into two groups (Control Group (CG) and Training Group (GT)). The control group did not receive any specific intervention, being managed according to the routine of the unit that consisted of bed kinesiotherapy, cycloergometry, ambulation and ventilatory patterns.

On the other hand, the intervention group underwent PiMax evaluation and initiated inspiratory muscle training with a linear pressure loading device (Threshold® IMT Respironics®), with 40% of the PiMáx, with 3 sets of 10 repetitions. This training was performed twice daily until the day of hospital discharge, according to the protocol of the study by Matheus et al. [10].

On the day of hospital discharge, patients from both groups were again evaluated for MIP, MIF and MRC to compare the results. It is noteworthy that all evaluations were performed by a blind examiner at all times. In addition, postoperative complications between the groups such as atelectasis, pleural effusion, pneumonia and pneumothorax were evaluated.

WinPepi software was used to define the necessary sample

size in order to compare the means of functional independence score achieved by MIF between two groups, with a statistical power of 80%, between the study groups and the comparison group. Thus, 38 patients were required, of which 19 were in each group. To evaluate the normality of the sample, the Shapiro-Wilks test. The chi-square test was used to evaluate the existence of association between categorical variables, the Student's t-test for intergroup analysis and the paired Student's t-test for intra group analysis. It was considered significant when a p <0.05.

Results

During the study period, 50 patients were admitted for cardiac surgery, 5 of them were excluded due to cognitive alteration that made it impossible to apply FIM, 4 because they did not understand the technique of evaluation of peripheral muscle strength and 3 did not sign the consent form Free and enlightened. (Figure 1) shows the flow for patient selection.

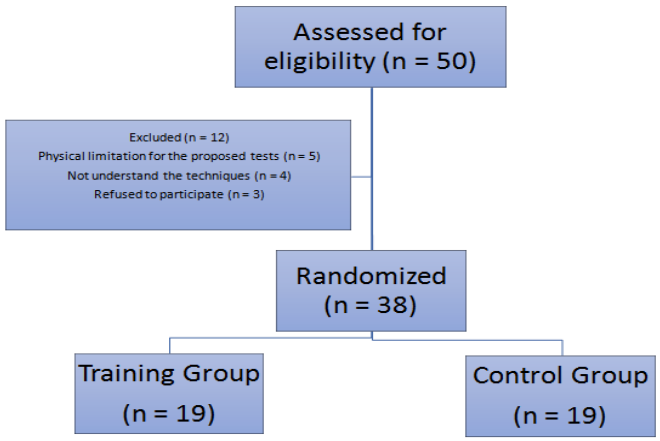

Figure 1: Shows the flow for patient selection.

Therefore, 38 patients were followed up. In the training group 8 males were allocated while 13 in the control group (p = 0.10) and the mean age of the control group was 57 ± 13 years versus 58 ± 13 years of training (p = 0.85). (Table 1) shows the other characteristics of the patients included in the study.

Variables	Group control (n = 19)	Training Group(n = 19)	P
Gender			0,10[a]
Male	13	8	
Female	6	11	
Age (years)	57 ± 13	58 ± 13	0,85[b]
Comorbidities			
Hypertension	10	12	0,51[a]
Dyslipidemia	10	9	0,74[a]
Diabetes	8	7	0,81[a]
Obesity	11	7	0,19[a]
Extracorporeal circulation time (min)	88 ± 21	86 ± 20	0,79[b]
MV time	8 ± 3	8 ± 2	0,67[b]
Drains (n)	2 ± 1	2 ± 1	0,82[b]

[a] test Qui-quadrado; [b] Test T de Student paired. MV - Mechanical Ventilation.

Table 1: Clinical and surgical data of the patients studied.

Other variables analyzed were the behavior of PImax, MIF and MRC between the groups. Regarding muscle strength, both groups suffered a significant decrease, from 101.2 ± 18.3 to 73.4 ± 13.6 (control group) and 94.6 ± 17.2 to 85.4 ± 19.6 (Training group), but the training group had a higher value at hospital discharge compared to the control group in the same period, 73.4 ± 13.6 (CG), versus 85.4 ± 19.6 (GT), with p = 0.04.

Analyzing the functionality, evaluated through MIF, the training group was significantly higher at hospital discharge 120.1 ± 3.8 (GT) versus 115.8 ± 3.8 (GC), p 0.001. In addition, there was no difference in the MRC, the training group obtained a value of 55.8 ± 3.8 (GT) against 54.9 ± 3.7 (GC), p 0.05. These data are expressed in (Table 2).

Variable	Preoperative	Discharge	p[a]
MIP			
Control	101 ± 18	73 ± 14	<0,01
Training	95 ± 17	85 ± 20	0,01
p[b]	0,27	0,04	
FIM			
Control	125,7 ± 0,6	115,8 ± 3,8	<0,01
Training	125,8 ± 0,5	120,1 ± 3,8	<0,01
p[b]	0,77	0,001	
MRC			
Control	59,8 ± 0,5	54,9 ± 3,7	<0,01
Training	59,9 ± 0,2	55,8 ± 3,8	<0,01
p[b]	0,25	0,50	

[a] Test T de Student independent; [b] Test T de Student paired; MIP - Maximal Inspiratory Pressure; FIM – Functional Independence Measured; MRC - Medical Research Council.

Table 2: Intra and intergroup analysis of mean inspiratory pressure, functional independence and peripheral muscle strength of patients undergoing coronary artery bypass grafting.

In addition, the impact of the inspiratory muscle training protocol on the incidence of postoperative pulmonary complications was evaluated. It was observed that IMT had a significant impact on the reduction of the atelectasis rate, 8 (42%) in the control group versus 4 (21%) in the training (p = 0.02). The other complications are shown in (Table 3).

Complications	Group control (n - 19)	Training Group (n - 19)	p[a]
Atelectasis	8 (42%)	4 (21%)	0,02
Pleural effusion	7 (37%)	4 (21%)	0,11
Pneumonia	8 (42%)	5 (26%)	0,15
Pneumothorax	4 (21%)	2 (11%)	0,25

[a] Test T de Student independent.

Table 3: Pulmonary complications between the groups in the postoperative period of myocardial revascularization surgery.

Discussion

Based on the findings, it was verified that the group of patients who performed an inspiratory muscle training protocol presented greater inspiratory muscle strength and functional independence on the day of hospital discharge when compared to the control group. However, there was no impact on the peripheral muscle strength in this population studied.

In terms of functionality, as measured by the MIF scale, both groups showed a marked decrease, corroborating with the results of Borges and colleagues [11], who found a significant difference between the moments studied (pre, 7th postoperative day and hospital discharge). However, again, GT on discharge achieved a significantly better result, re-emphasizing the benefit of IMT for patients undergoing myocardial revascularization surgery.

It is important to highlight that; according to Myles et al. [12] impairment of postoperative cardiac function may be a relevant factor in the prognosis and functional recovery of patients. It should be noted that the maintenance of the functionality was not strictly related to the peripheral muscle strength, as we observed in our study that the MRC parameters were low in both groups, despite the IMT.

This lack of impact on peripheral muscle strength may be associated with meta-reflex. Due to peripheral vasoconstriction during IMT, there is a reduction of blood flow to upper and lower limb muscles, making hypertrophy difficult.

Inspiratory and peripheral muscle strength is routinely described as reduced after cardiac surgery [13-15]. The significant reduction in inspiratory muscle strength found in our study, in both groups, corroborates results already found in the literature. Ferreira et al. [14] found that the measures of PiMáx in the postoperative period were significantly lower, a result ratified by Garcia et al. [13], showing that this variable may fall by up to 64%. Thus, Garcia et al affirm that reductions in respiratory muscle strength justify preventive interventions, such as MRI as soon as possible.

Niemeyer-Guimarães [16] applied the scale in this population seeking to evaluate the functionality until six months after surgery, and verified that the preoperative mean value was 121.30 ± 6.42 versus 112.10 ± 17.10 (within one month) and 117.80 ± 13.50 points (after six months), confirming the decline on functional capacity promoted by the surgery itself and the lack of physical exercise, many times not encouraged by the heart team who assists the patient after this type of procedure.

Considering the measured items, in general, myocardial revascularization surgery decreased the PiMáx, MIF and MRC parameters in both groups, evidencing that, according to the literature, the surgical procedure is related to losses in respiratory and functional parameters, although The decrease in postoperative PiMáx was similar in both groups, the training group obtained better values at the moment of hospital discharge, when compared to the group that only performed the routine physiotherapy procedures, which exalts the importance of IMT in the post - MRI surgery. This type of response to IMT has already been verified by Gardenghi et al. [15] who observed in the IMT group the reestablishment of PiMax, tidal volume and coughing capacity at hospital discharge.

The present study has some bias that should be considered. The researchers did not investigate the pulmonary function through spirometry before inclusion in the protocol, what could create some confusion considering possible diagnoses such as asthma or chronic obstructive pulmonary disease, despite the fact that during the interview any of the subjects mentioned the presence of this kind of diseases. Other point is related with not adopt a model of risk stratification devised to predict mortality and/or complications in cardiac surgery, such as the European System for Risk Assessment in Cardiac Surgery (EuroSCORE), what could also distinguish eventual differences between both studied groups.

Conclusion

Based on the findings, it was found that inspiratory muscle training increased ventilatory muscle strength, functional independence and reduced the incidence of pulmonary complications in patients undergoing coronary artery bypass grafting.

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