REVIEW ARTICLE

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Respiratory physiotherapy in the pre and postoperative myocardial revascularization surgery

Fisioterapia respiratória no pré e pós-operatório de cirurgia de revascularização do miocárdio

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Abstract

The cardiovascular diseases are among the main death causes in the developed world. They have been increasing epidemically in the developing countries. In spite of several alternatives for the treatment of the coronary artery disease; the surgery of the myocardial revascularization is an option with proper indications of medium and long-term with good results. It provides the remission of the angina symptoms contributing to the increase of the expectation and improvement of the life quality. Most of patients undergoing myocardial revascularization surgery develop postoperative lung dysfunction with important reduction of the lung volumes, damages in the respiratory mechanism, decrease in the lung indulgence and increase of the respiratory work. The reduction of volumes and lung capacities can contribute to alterations in the gas exchanges, resulting in hypoxemia and decrease in the diffusion capacity. Taking this into account, the Physiotherapy has been requested more and more to perform in the pre as well as in the postoperative period of this surgery. This study aimed at updating the knowledge regarding the respiratory physiotherapy performance in the pre and postoperative period of the myocardial revascularization surgery enhancing the prevention of lung complications. The Physiotherapy uses several techniques in the preoperative period; such as: the incentive spirometry, exercises of deep breathing, cough, inspiratory muscle training, earlier ambulation and physiotherapeutic orientations. While in the postoperative period, the objective is the treatment after lung complications took place, performed by means of physiotherapeutic maneuvers and noninvasive respiratory devices, aiming at improving the respiratory mechanism, the lung reexpansion and the bronchial hygiene. Respiratory physiotherapy is an integral part in the care management of the patient with cardiopathy, either in the pre or in the postoperative period, since it contributes significantly to a better prognosis of these patients with the use of specific techniques.

Descriptors: **Physical Therapy (Specialty). Myocardial Revascularization. Preoperative Care. Postoperative Care.**

Resumo

As doenças cardiovasculares estão entre as principais causas de morte no mundo desenvolvido, e sua ocorrência tem aumentado de forma epidêmica nos países em desenvolvimento. Apesar das inúmeras alternativas para o tratamento da doença arterial coronariana; a cirurgia de revascularização do miocárdio é uma opção com indicações precisas de médio e longo prazo, com bons resultados. Pode proporcionar a remissão dos sintomas de angina e, também, contribui para o aumento da expectativa e melhora da qualidade de vida. Pacientes submetidos à cirurgia de revascularização do miocárdio desenvolvem, em sua maioria, disfunção pulmonar pós-operatória com redução importante dos volumes pulmonares, prejuízos na mecânica respiratória, diminuição na complacência pulmonar e aumento do trabalho respiratório. A redução dos volumes e capacidades pulmonares contribui para alterações nas trocas gasosas, resultando em hipoxemia e diminuição na capacidade de difusão. Dentro deste contexto, a Fisioterapia tem sido cada vez mais requisitada tanto no pré quanto no pós-operatório deste tipo de cirurgia. Este estudo teve como objetivo atualizar os conhecimentos em relação à atuação da Fisioterapia respiratória no pré e pós-operatório de

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cirurgia de revascularização do miocárdio, com ênfase na prevenção de complicações pulmonares. A Fisioterapia no período pré-operatório atua por meio de inúmeras técnicas, entre as quais, pode-se destacar: a espirometria de incentivo, exercícios de respiração profunda, tosse, treinamento muscular inspiratório, deambulação precoce e orientações fisioterapêuticas. Enquanto que no pós-operatório, tem como objetivo o tratamento das complicações pulmonares instaladas, realizado por meio de manobras fisioterapêuticas e dispositivos respiratórios não invasivos, visando melhorar a mecânica respiratória, a reexpansão pulmonar e a higiene brônquica. A Fisioterapia respiratória é parte integrante na gestão dos cuidados do paciente cardiopata, tanto no pré quanto no pós-operatório, pois contribui significativamente para um melhor prognóstico desses pacientes por meio de técnicas específicas.

Descritores: **Fisioterapia (Especialidade). Revascularização Miocárdica. Cuidados Pré-Operatórios. Cuidados Pós-Operatórios.**

INTRODUCTION

Cardiovascular diseases are among the leading causes of death in developed countries and its incidence has been increasing in epidemic form in developing countries [1]. These diseases, the Brazilian reality, occupy the leading causes of death and hospitalization, accounting for 32.6% of the determined cause of death [1-3].

Despite numerous alternatives for the treatment of coronary artery disease, coronary artery bypass surgery is an option with precise details of the long-term average, with good results, providing the remission of symptoms of angina and contributing to the rising expectations and improving the quality of life of patients with coronary disease [2].

The etiology of pulmonary dysfunction after cardiac surgery (CS) results from open-heart multifactorial association between anesthesia, surgical trauma, cardiopulmonary bypass (CPB), cardiac arrest, time of surgery, duration of mechanical ventilation and pain, causing therefore, decreased functional residual capacity (FRC), increased intrapulmonary shunt and enlargement of alveolar-arterial oxygen (O2) [3-4].

Patients undergoing CS develop, in most cases, postoperative pulmonary dysfunction (PO) with a significant reduction in lung volume [5-7], damage in respiratory function, decreased lung compliance and increased work of breathing. The reduction in lung volumes and capacities contributes to changes in gas exchange, resulting in hypoxemia and decreased diffusion capacity [3].

Atelectasis and hypoxemia are among the main pulmonary complications postoperatively of CS [3-6], but other complications such as dry or productive cough, dyspnea, wheezing, hypercapnia, pleural effusion, pneumonia, pneumothorax, and congestive reintubation ventilation are also observed [7].

In addition, the length of hospital stay for this type of procedure usually causes discomfort, stress, depression, restlessness, boredom, exacerbation of pain and anxiety in both pre-and postoperatively, which may affect the transport of the O2 enabling the development of postoperative complications [8].

Given the context of pulmonary dysfunction associated with CS and its possible repercussions, it is crucial a better understanding and more research about the resources available today to reverse this situation [1,5]. Within this context, the respiratory therapy has been increasingly required [9], because it uses techniques to improve respiratory mechanics, re-expansion pulmonary and bronchial hygiene.

Respiratory therapy is often used in the prevention and treatment of postoperative complications such as retention of secretions, atelectasis and pneumonia. The duration and frequency of respiratory therapy for surgical patients are variable, depending on individual needs, treatment preference and institutional practice [10-11].

This study aimed to update knowledge regarding the role of respiratory therapy in pre-and post-operative coronary artery bypass grafting with emphasis on the prevention of pulmonary complications.

PREOPERATIVE PHYSIOTHERAPY

The preoperative physiotherapy in cardiac surgery includes functional assessment, orientation of the procedures to be performed and their relationship with the respiratory capacity for recovery of the patient, and to identify possible risk of respiratory complications after surgery [1].

A study by Morsch et al. [12] evaluated the ventilatory profile, radiological and clinical data of patients undergoing elective coronary artery bypass graft (CABG) in a cardiology referral hospital in southern Brazil, with a sample of 108 individuals, using spirometry and ventilatory muscle strength (VMS) of manuvacuometry to evaluate lung volumes and capacities, as well as the presence of respiratory disorders.

The assessments were conducted preoperatively and at six days after surgery, where there was significant reduction in end-expiratory volume (EEV1), forced vital capacity (FVC) and VMS expressed in maximal inspiratory pressure and pressure maximal expiratory comparing the preoperative period to the sixth postoperative day. The incidence of pulmonary complications was higher in the sixth postoperative day (78%) when compared to the first postoperative day (40%). Patients undergoing CABG surgery have a significant reduction in lung volumes and capacities, as well as the VMS in the postoperative period. This proof demonstrates the necessity of preoperative physiotherapeutic procedures on patients who require CABG surgery [12].

Leguisamo et al. [13] verified the effectiveness of a physiotherapy program for pre-operative patients undergoing CABG with regard to reducing the length of hospital stay, prevention of pulmonary complications, changes in pulmonary volumes and inspiratory muscle strength. We conducted a randomized clinical trial with 86 patients divided into intervention group (44 patients) and control group (42 patients). The intervention group was assessed and received physiotherapeutic guidance with written 15 days before surgery. The control group received standard care on the day of hospitalization. A significant reduction in hospital stay ($P < 0.05$) in the intervention group. There was no difference in changes in pulmonary volumes, inspiratory muscle strength and incidence of pulmonary complications between the groups. The authors concluded that patients instructed preoperatively will be better prepared to cooperate with postoperative treatment.

Garbossa et al. [1] found the effects of physiotherapy instructions on the level of anxiety of patients undergoing CABG surgery in the pre-and postoperatively in 51 subjects, 27 in the control group and 24 in the intervention group. The evaluation was done using a questionnaire (Beck Scale for Anxiety) to measure the level of anxiety and a scale (analogue pain), to measure the level of localized pains, where only the second group received instructions on the procedures of surgery and breathing exercises . The lower levels of anxiety were observed in patients who received the intervention in the period before surgery (9.6 ± 7.2 versus 13.4 ± 5.9, $P = 0.02$). In the control group, the difference between anxiety levels before and after surgery was statistically significant ($P = 0.003$).

The female subjects showed more anxiety before surgery compared with males ($P = 0.058$). The patients were instructed and educated about physical therapy and respiratory exercise routine of the hospital had reduced their anxiety levels before surgery compared to the control group. However, postoperatively, both groups showed their anxiety levels reduced without significant difference between them [1].

According to Feltrim et al. [7] to pre-operative chest physiotherapy using the technique of inspiratory muscle training in patients at high risk for elective CABG surgery can reduce the risk of pulmonary complications as it improves strength and endurance of respiratory muscles. Thus, the benefit obtained by the reduction of pulmonary complications greater impact supports the indication of inspiratory muscle training in the pre-surgery elective CABG in high risk patients.

Research was conducted at Utrecht University Medical Center, Netherlands, with the aim of evaluating the effectiveness of prophylaxis with preoperative inspiratory muscle training on the incidence of postoperative pulmonary complications (especially pneumonia and length of postoperative hospital stay) in high-risk patients scheduled for elective coronary artery bypass grafting. Subjects were 279 patients who were followed until hospital discharge and divided into inspiratory muscle training group preoperatively ($n = 140$) and usual care group ($n = 139$). It was found that after surgery, the pulmonary complications were present in 25 (18%) patients, inspiratory muscle training group and 48 (35%) of members of the usual-care group. Pneumonia occurred in nine (6.5%) in the inspiratory muscle training group and 22 (16.1%) in the usual care group. The median length of postoperative hospital stay was 7 days (range 5-41 days) for inspiratory muscle training group versus 8 days (range 60-70 days) in the usual-care group. The inspiratory muscle training before surgery reduced the incidence of postoperative pulmonary complications and length of stay in high-risk patients undergoing CABG [14].

Bragé et al. [15] in an observational study involving 263 patients undergoing coronary artery bypass grafting with cardiopulmonary bypass (CPB), wanted to determine whether chest physiotherapy preoperatively reduces the incidence of pulmonary complications after surgery, with 159 of 263 patients received preoperative physiotherapy consisting of a daily session involving incentive spirometry, deep breathing, coughing, and ambulation. The most frequent complications were postoperative hypoventilation (90.7%), pleural effusion (47.5%) and atelectasis (24.7%). The prophylactic therapy was associated with lower incidence of atelectasis (17% vs. 36%). It was concluded that the pre-operative physiotherapy is associated with a lower incidence of atelectasis.

POSTOPERATIVE PHYSIOTHERAPY INTERVENTION

Physical therapy is often used in postoperative cardiac surgery for the treatment of pulmonary complications such as atelectasis, pneumonia and pleural effusion in an attempt to accelerate the recovery of lung function that occurs normally only 15 days after surgery [16].

Some features may be used to perform physical therapy in the postoperative period of cardiac surgery, maneuvers such as physiotherapy, continuous positive airway pressure, positive airway pressure for two levels, expiratory pressure, intermittent positive pressure breathing and incentive spirometry, which are safe, easy to apply and can be used throughout the postoperative period. There are technical differences between these features because each has a specific action for the recovery of pulmonary function and respiratory mechanics [16,17].

Renault et al. [3] in a literature review on the different techniques used in chest physiotherapy after cardiac surgery, selected eleven randomized controlled trials. Among the studies included, incentive spirometry was used in three, deep breathing exercises in six, deep breathing exercises associated with positive expiratory pressure in four and positive expiratory pressure increased inspiratory resistance in two. Three studies used intermittent positive pressure breathing. Continuous positive airway pressure and bi-level positive were used in three and two studies, respectively. The protocols used were varied and the co-interventions were present in most of them. Despite the known importance of postoperative physical therapy, there is, so far, consensus regarding the superiority of one technique over the other.

Current study [18] compared the effects of incentive spirometry and deep breathing exercises in patients undergoing coronary artery bypass grafting on the following variables: forced vital capacity and forced expiratory volume in one second, maximal respiratory pressures and oxygen saturation using a sample of 36 patients who were randomized into two groups as follows: incentive spirometry (n = 18) and deep breathing exercises (n = 18). Spirometric variables were evaluated in the preoperative period and on the seventh postoperative day. The respiratory muscle strength and oxygen saturation were evaluated in the preoperative period, the first, second and seventh postoperative day. The groups were homogeneous in relation to demographic and surgical variables. There was a reduction in the values †of forced vital capacity and forced expiratory volume between the preoperative and postoperative seventh, but no significant differences between groups.

Maximal respiratory pressures fell on the first day, but with gradual and partial recovery by the seventh postoperative day, also without significant differences between groups. Oxygen saturation was the only variable that was fully recovered on the seventh postoperative day, also without significant differences between groups. There were no significant differences in maximal respiratory pressures in spirometric variables and oxygen saturation in patients undergoing deep breathing exercises and incentive spirometry following CABG [18].

Romanini et al. [16] performed a study with 40 patients after coronary artery bypass surgery, divided into two groups: one was submitted to the application of intermittent positive pressure breathing (IPPB) and the other to incentive spirometry (IS). Patients were assessed preoperatively and 24, 48 and 72 hours postoperatively, with resources being applied postoperatively. The following parameters were analyzed: oxygen saturation, respiratory rate, minute volume, tidal volume, maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP). The groups were homogeneous in relation to demographic and clinical variables.

In the group submitted to IPPB, there was an increase in oxygen saturation 48 (P = 0.007) and 72 hours (P = 0.0001) after surgery, when compared to IR. The respiratory rate, minute volume and tidal volume, there was no statistically significant differences between groups. The group submitted to IS showed a significant increase in MEP 24 (P= 0.02) and 48 hours (P = 0.01) after surgery. With the goal of reversing hypoxemia earlier, IPPB was more efficient compared to the IS, however, the incentive spirometry was more effective in improving respiratory muscle strength [16].

In a recently published study, Nery et al. [19] found the presence of changes in functional capacity of patients who undergo coronary artery bypass graft (CABG) by means of the six-minute walk after two years, through prospective cohort study in which 179 patients were followed over two years, classified into active and sedentary, according to physical activity during leisure time and tested the six-minute walk preoperatively and two years later. Of the 179 patients evaluated preoperatively of CABG, 67% were male, mean age was 63 (± 9.75) years. Pre and after two years of CABG, 52 patients remained active and walking distances were 359m (± 164.47) and 439m (± 171.34), respectively, P = 0.016.

The distance walked during the pre-and postoperatively, of 45 patients who remained sedentary, were, respectively, 255m (± 172.15) and 376m (± 210.92) P <0.001. Eighty-two patients were transferred between these two groups, 71 went from sedentary to active and walked 289m (± 157.15) before and 380m (± 125.44) postoperatively, P = 0.001; the 11 patients who were active became sedentary and walked in the pre 221m (± 191.91) and postoperatively, 384m (± 63.73) P = 0.007. The functional capacity of patients undergoing CABG improved significantly in the midterm follow-up [19].

Ferreira et al. [20] evaluated a training program for preoperative inspiratory muscle held at home and to improve respiratory function, reduced the morbidity and / or mortality in adult patients undergoing coronary artery bypass grafting and/or plasty. Thirty volunteers of both sexes and aged at least 50 years, while waiting for coronary artery bypass grafting and / or heart valve surgery were randomly divided into two groups. Fifteen patients were enrolled in a home program of at least two weeks of training preoperative inspiratory muscle, using a device with a load of 40% of maximal inspiratory pressure. The other 15 received general guidance and not trained the inspiratory muscles.

Spirometry before and after the training program, as well as the evolution of arterial blood gases and inspiratory and expiratory pressure maximum before and after the operation were evaluated in both groups. They observed that inspiratory muscle training increased FVC, maximum voluntary ventilation and EEV1no relationship between the first and second days after surgery. The evolution of arterial blood gases and peak inspiratory and expiratory pressures before and after surgery was similar in both groups, with similar results also. The home program of inspiratory muscle training was safe and improved forced vital capacity and maximal voluntary ventilation, although the clinical benefits of the program was not clear in the study [20].

A prospective clinical trial [21], involving 48 individuals doing deep breathing exercises was compared with a control group (n = 42) who did not perform breathing exercises to investigate the effects on lung function, atelectasis, gas levels in the blood and subjective experience of patients in the postoperative period (PO) of CABG. Patients in the group of deep breathing exercises were instructed to perform breathing per hour during the day for the first four postoperative days. The exercises consisted of 30 slow deep breaths performed with a positive expiratory pressure device. Measurements of spirometry, spiral CT (three transverse levels), arterial blood gas analysis and scoring of the subjective experience of breathing exercises were performed at postoperative day 4.

Compared with the control group, patients in the deep breathing had a significantly smaller reduction in forced vital capacity (to 71 ± 12% vs. 64 ± 13% of preoperative values) and forced expiratory volume in one second (for 71 ± 11% vs. 65 ± 13% of preoperative values). In the group of deep breathing, 72% of patients experienced a subjective benefit of the exercises. Patients who performed deep breathing exercises after CABG surgery had significantly less atelectasis areas and better pulmonary function on the fourth postoperative day compared with the control group did not exercise [21].

A recent study [23] used the Pleth Variability Index (PVI), an algorithm that allows continuous control of respiratory variations in the wave pulse oximetry plethysmographic, the hypothesis to predict the hemodynamic effects of 10 cmH2O end positive expiratory pressure (EPEP) in 21 patients on mechanical ventilation (MV) and sedation in the postoperative coronary artery bypass surgery (CABG). Patients were monitored with pulmonary artery catheter, pulse oximeter and a sensor attached to the index finger. The hemodynamic data (cardiac index [CI], PVI, change in pulse pressure, central venous pressure) were recorded in three successive tidal volumes (Vt) (6, 8 and 10 mL / kg body weight) during the zero maneuver in end expiratory pressure (ZEEP), and then, after the addition of 10 cmH2O EPEP for each Vt. Hemodynamically unstable patients were defined as those with a decrease of> 15% in the CI after the addition of EPEP.

EPEP induced changes in CI and Vt for IVP of 8 and 10 mL/kg. Hemodynamic instability was present in five patients with a Vt of 6 ml / kg in six patients with a Vt of 8 ml / kg, and in nine patients with a Vt of 10 mL / kg. The Pleth Variability Index can be useful in the noninvasive detection of hemodynamic effects of EPEP when applied to Vt higher than 8mL/kg in sedated and ventilated patients with acceptable sensitivity and specificity [23].

Botega et al. [24] performed a study that aimed to evaluate the behavior of the cardiovascular variables during a program of cardiac rehabilitation hospital in patients undergoing CABG in a total of 14 patients (mean age: 55.4 ± 6.4 years, 78.6% were male) with previous diagnosis of coronary insufficiency and indication for elective surgery. The protocol consisted of a group of low-impact exercise (2-3 METs) for upper and lower extremity and walking exercises performed during the pre-and postoperatively (3 and 4 days). The following variables were evaluated at rest and after exercise program, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and scale of perceived exertion index (PEI). A significant increase in HR in the individual analysis (P <0.001), as well as the analysis of the evaluation days (P <0.001 for HR), but only reaching maximum values †that were <30% predicted. In addition, there was a negative correlation between the scale PEI with SBP and MAP. The proposed exercises shown to be safe with the change of fundamental physiological variables throughout the experiment below the recommended amount for the hospitalization phase.

Another recent study [25] tested the use of incentive spirometry (IS) associated with positive expiratory pressure in the airway (PEPA) after CABG in improvement of dyspnea, feeling of perceived exertion and quality of life after CABG. Sixteen patients undergoing CABG were randomized to the control group (n = 8) or the IS + PEPA group (n = 8). The protocol IS + PEPA was conducted in the immediate postoperative period and for another 4 weeks at

home and were evaluated respiratory muscle strength, functional capacity, lung function, quality of life and level of physical activity. After the walk test (TC6), the score for dyspnea (1.6 ± 0.6 vs. 0.6 ± 0.3, *P* <0.05) and the sense of effort (13.4 ± 1 2 vs. 9.1 ± 0.7, *P* <0.05) were higher in the control group compared with the IS + PEPA group. In evaluating the quality of life, the rule related to limitations on the physical aspects was better in the IS + PEPA group (93.7 ± 4.1 vs 50 ± 17, *P* <0.02). Patients who underwent IS + PEPA have less dyspnea, less sense of effort after the TC6 and also better quality of life after CABG.

Barros et al. [26] sought to highlight the loss of ventilatory capacity in the postoperative period in patients undergoing CABG and to test the hypothesis that respiratory muscle training (RMT), performed after surgery, can improve the ventilation in this population through randomized study where 38 patients (age: 65 ± 7 years, 29 male) undergoing CABG with cardiopulmonary bypass were divided into two groups: 23 patients in the TMR group and 15 in the control group (CO). The TMR group performed physical therapy + TMR, the CO group performed only conventional physiotherapy. It was assessed at three time points (preoperative, first postoperative day and hospital discharge) variables: maximal inspiratory and expiratory pressures (MIP and MEP), pain, dyspnea (Borg), peak of expiratory flow (PEF), tidal volume (VT) and hospital days. The MIP group TMR was higher at discharge, as well as MEP. PEF group TMR was higher after hospitalization. There were no differences between groups with respect to days of hospitalization, dyspnea or pain. It was concluded that there is a loss of respiratory muscle strength in patients undergoing coronary artery bypass grafting. The TMR, performed in the postoperative period, was effective in restoring the following parameters: MIP, MEP and PEF in this population.

Current study [27] evaluated the hemodynamic changes caused by PEPA in patients after cardiac surgery monitored by Swan-Ganz catheter. Were included in the study, patients in the first or second postoperative cardiac surgery, including 17 CABG, hemodynamically stable. They were evaluated at rest and after the use of 10 cmH2O PEPA randomly. The variables studied were: oxygen saturation, heart and respiratory rate, mean systemic arterial pressure and pulmonary (PAMP and PAM), central venous pressure (CVP) and pulmonary wedge stick (PWP), cardiac output and cardiac index, and vascular resistances systemic and pulmonary. Patients were divided into subgroups (ejection fraction d" 50% or> 50%) and data were compared by t test and ANOVA. Comparing the PEPA versus rest period, the changes observed were statistically significant increases in PAOP, PAMP and MAP. The PEPA was well tolerated by patients and hemodynamic changes found showed an increase in measures of right ventricular filling pressure and left, as well as mean arterial pressure.

FINAL CONSIDERATIONS

Coronary artery bypass grafting has been used with great frequency and attendance among the medical community. Thus, the occurrence of pulmonary complications after surgery is quite common among them include the atelectasis and pneumonia [22].

Respiratory therapy is an integral part in the management of cardiac patient care, both pre-and postoperatively, it contributes significantly to a better prognosis for these patients, performing preoperative techniques aimed at the prevention of pulmonary complications and in postoperative maneuvers hygiene and pulmonary expansion.

It is of fundamental importance the role of respiratory therapy in pre-and postoperative period of CABG surgery, however, there is a need for further studies that address this theme by drawing on several specific methodological techniques used in attempt to standardize procedures.

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