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RESEARCH ARTICLE

Maximum inspiratory pressure of the patients after open-heart surgery following physiotherapy

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ABSTRACT

Background: After open-heart surgery, various complications require specific care, especially in the respiratory system. To reestablish it, several strategies should be used, such as respiratory muscle training, which aims to improve respiratory muscle strength, leading to a reduction in post-operative pulmonary complications in patients undergoing cardiac surgery. **Aims and Objectives:** The objective of the study was to measure and compare maximum inspiratory pressure (MIP) in open-heart surgery patients following conventional physiotherapy group and conventional physiotherapy plus inspiratory muscle training (IMT) group. **Materials and Methods:** The study was an experimental design and it was a prospective randomized control study where participants were taken from cardiac hospital using balance block computer-generated randomization method. Fifty participants were divided into two groups of 25 each. Group A received conventional physiotherapy and Group B received conventional plus inspiratory muscle exercise (B) by pressure threshold IMT instrument. Physiotherapy treatment was delivered by qualified physiotherapy, twice a day preoperatively and after extubation, 4–5 sessions per day were given until they discharged. The pre-operative, at discharge, and at the 1st follow-up, patient MIP was measured. **Results:** There was no statistically significant change in inspiratory muscle strength in patients exposed to an IMT program compared to the control group ($P > 0.05$). **Conclusion:** There was no difference in MIP in conventional physiotherapy and conventional plus inspiratory muscle trainer group in "pre-operative," "discharged," and "1st follow-up" in open-heart surgery patient.

KEY WORDS: Open Heart Surgery; Inspiratory Muscle Training; Physiotherapy; Maximum Inspiratory Pressure

INTRODUCTION

In India, more than 10.5 million deaths occur annually, and it was reported that coronary artery disease led to 20.3% of these deaths in men and 16.9% of all deaths in women.[1] The age-adjusted cardiovascular diseases (CVD) mortality rates are 349/100,000 in men and 265/100,000 in women. These rates are >2–3 times greater than in the United States, where rates are 170/100,000 in men and 108/100,000 in women.[1] Valvular heart disease remains common in industrialized countries because the decrease in the prevalence of rheumatic heart diseases has been accompanied by an increase in that of degenerative valve diseases. The prevalence of valvular heart disease increases sharply with age, due to the predominance of degenerative etiologies.[2] Cardiac surgery is a procedure performed in patients with CVD. Surgical treatment remains the therapeutic option related to better survival of individuals with coronary heart disease, in addition to patients with valvular heart diseases.[3] Patients undergoing heart surgery require effective cardiac rehabilitation which is the enhancement and maintenance

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of cardiovascular health through individualized programs designed to optimize physical, psychological, social, vocational and emotional status.[4]

A decrease in pulmonary function up to 60-70% of the pre operative values is known after open heart surgery. Radiological signs of atelectasis are common and a range of studies have documented reduced lung volumes and oxygenation in the postoperative period. Reasons for the restrictive impairment and atelectasis can be many e.g. residual effect of anesthesia, intra-operative events such as internal mammary artery harvesting, changes caused by mechanical alteration of the thoracic cavity, immobilization and pain. Chest physiotherapy is routinely used in order to prevent or reduce pulmonary complications after cardiac surgery.[5-7] Ragnarsdottir *et al.*, found that median sternotomy had the potential to impair respiratory muscles, decrease pulmonary function, and produce atelectasis for up to at least 8 weeks postoperatively due in part to post-sternotomy alterations in respiratory mechanics.[8] Pre-operative and post-operative physiotherapy after cardiac surgery, physiotherapy consisting of breathing exercises emphasizing inspiration, incentive spirometry, techniques to clear bronchial secretions, and early mobilization is given with the aim of increasing lung ventilation, functional capacity (endurance), preventing chest infections, as well as reducing the length of stay in hospital. [5,6,9,10] inspiratory muscle training (IMT) will be an important strategy to reduce post-operative complication and length of stay after major surgery, especially those involving respiratory muscle and chest wall damage.[11] Maximum inspiratory pressure (MIP) is a simple, quick, and non-invasive clinical procedure for determining inspiratory muscle strength in both healthy and in patients with pulmonary or neuromuscular disease.[12]

After cardiac surgery, among the various complications that would require specific concern are, to restore decreased respiratory muscle strength. It has been shown that the use of respiratory muscle training, builds respiratory muscle strength and reduces risk of pulmonary complications in adult patients undergoing cardiovascular surgery.[1] Therefore, the objective of the study was to measure and compare MIP in open-heart surgery patients following conventional physiotherapy group (control group) conventional physiotherapy plus IMT group (experimental group).

MATERIALS AND METHODS

Study Design

This was an experimental study design.

Type of Study

This was a prospective randomized control study.

Source of Data

Patients were recruited from B and M Patel Cardiac Centre, Karamsad.

Sampling Method

Balance block computer-generated randomization.

Sample Size

The sample size was 50.

Inclusion and Exclusion Criteria

Patients who were hemodynamically stable with 18–70 years of age of both genders, undergoing elective open-heart surgery included in the study while unstable angina or severe chest pain, ejection fraction <30%, left main coronary artery involved, any severe musculoskeletal condition, and any psychiatric problems were excluded from the study.

Methods

The ethical approval was obtained before the commencement of the study from the Institutional Ethics Committee (IEC) of the institute. All the patients who were posted for elective open-heart surgery referred for physiotherapy and were also satisfying the inclusion and exclusion criteria were recruited from Cardiac Centre, Karamsad. Written informed consent of all the patients was obtained after explaining the purpose of study, procedure, and its benefits. All medical records were reviewed and basic investigations were recorded as required. Patients were divided into two Groups A and B by means of balance block computer-generated randomization method. The control Group A was given conventional physiotherapy (education, breathing exercises, incentive spirometry, forced expiratory techniques, high sitting, standing, ambulation, and stair climbing), while the experimental Group B was additionally given IMT with inspiratory threshold loading

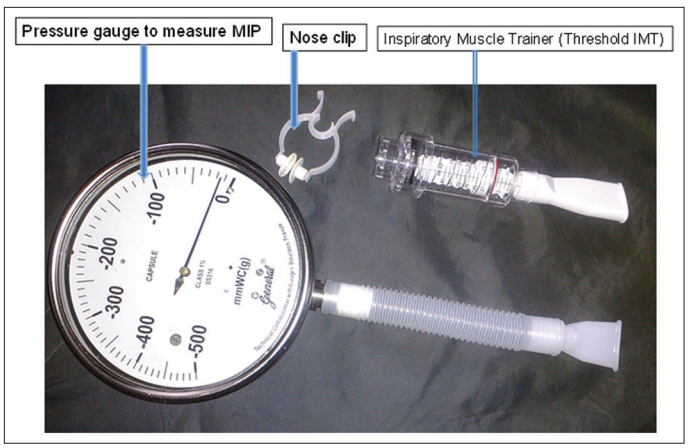

Figure 1: Inspiratory muscle training and pressure gauge

device (Threshold® IMT, Respironics, USA) until they were discharged [Figure 1]. The patients were started to breathe at a resistance equal to 15% of their inspiratory muscle strength postoperatively. Then, the resistance was increased incrementally from 15% to 45% based on the patient's tolerance in the following days.[13]

Physiotherapy sessions were delivered to the patients twice a day by the physiotherapist once the patient got admitted to the hospital. Preoperatively the MIP was measured by using the capsule sensing pressure gauge-V (Gauges Bourdon Pvt. Ltd, India), demographic data, baseline assessment, and parameters were noted. Postoperatively, after extubation physiotherapy sessions were given -four to five times a day in Intensive care unit (ICU), and thereafter three to four times a day in step down ward till they were discharged from hospital. The MIP was measured on the day of discharge and the 1st follow up of patient at Out patient department (OPD). The standard treatment in the form of routine nursing care, pharmacological therapy, inhalation therapy advised by the concerned Intensivist/Cardiac Surgeon/Anesthetist was strictly followed throughout the study.

RESULTS

Statistical analysis has been done using the SPSS. Analysis started with descriptive statistics, independent sample test to compare mean values of variables between two groups. The statistical significance level for each comparison was considered at 5% level ($P < 0.05$). In the present study, a total of 50 patients were included, 25 in each group. Out of this group, 25 were control Group A (conventional physiotherapy) and 25 were experimental Group B (conventional physiotherapy + IMT). The mean age of the control group was 53.64 years and the experimental group was 52.40 years [Table 1]. The mean body mass index of the control group was 23.86 kg/m^2 and the experimental group was 22.22 kg/m^2 [Table 1]. Out of 25 patients in each group, control Group A had 10 male patients whereas in experimental Group B had 18 male patients were included. The patients of coronary artery bypass graft surgery were more than valve replacement surgery in both groups [Table 2]. The difference of MIP at pre-operative, at discharge, and at follow-up between the groups was not statistically significant ($P < 0.05$) [Table 3].

Table 1: Age and BMI of both the groups

Group (n=25)	A	B
Age	53.64 (12.14)	52.40 (15.18)
BMI	23.86 (5.34)	22.22 (4.71)

BMI: Body mass index

Table 2: Common surgeries of both the groups

Group (n=25)	A	B
CABG	15	11
MVR/AVR	9	10
CABG+MVR	0	3
Other	1	1

CABG: Coronary artery bypass graft, MVR: Mitral valve replacement, AVR: Aortic valve replacement

DISCUSSION

In the present study, the MIP "at pre-operative," "at discharge," and "at follow-up," the difference between the control group and experimental group was not statistically significant.

Open-heart surgery with cardiopulmonary bypass involves systemic alteration that reflects as poor outcomes after surgery. Among these systemic alterations, respiratory dysfunctions are predominant. The systemic inflammatory response is illustrated by the change in lung biomechanics ranging from diminished compliance, pulmonary edema, raised shunt fraction, and decreased functional residual capacity. This dysfunction in the respiratory system leads to increased work of breathing, which also is combined with impaired complacency of the thoracic cage which results in a decrease of MIP.[3] According to Cavenaghi *et al*., respiratory or chest physiotherapy is an essential part of managing patients in the post-operative period for rehabilitation, as it contributes considerably to an enhanced prognosis of these patients that can be carried out as pulmonary reexpansion and muscle training.[14] Evidence suggests that IMT is able to reduce post-operative complications such as pleural effusion and pneumonia. In a systematic review, Hulzebos *et al*. noted that besides reducing overall complications, they also led to shorter hospital stay.[15] In a study published in 2009, the authors evaluated the impact of MIP on the hospital stay in the post-operative period for thoracic surgery, they concluded that an MIP below 75% is a predictor of an increased length of hospital stay.[3] It suggests that muscle dysfunction

Table 3: Difference of MIP in pre-operative, discharged, and follow-up between the groups

Difference of MIP	Group	Mean (standard deviation)	Sig. (two tailed)
MIP_Dif_Post_Pre	A	13.60 (14.543)	0.569
	B	10.92 (18.277)	
MIP_Dif_FW_Post	A	2.40 (13.928)	0.535
	B	4.64 (11.287)	

MIP: Maximum inspiratory pressure, P<0.05

occurred in the post-operative period of cardiac and thoracic surgery. Hence, IMT appears as an important strategy in reversing muscle weakness. The surgical procedure involves reduced respiratory muscle strength. The respiratory muscle strengthening promotes better efficacy in airway clearance and inspiratory and expiratory pressure and prevents fatigue of the respiratory muscles.[14]

In the current study, it was found that no considerable enhancement in inspiratory muscle strength was observed in patients undergoing cardiac surgery who were exposed to an IMT program. In future, the large sample size and other variables need to assess for more specific changes.

CONCLUSION

The study concluded that there was no significant difference in MIP in conventional physiotherapy and conventional plus inspiratory muscle trainer group in "pre-operative," "at discharge," and "1st follow-up" in open-heart surgery patients. Furthermore, the study will be continued for more samples to specify data and also see functional capacity changes with an individual of open-heart surgery patients.

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CONFLICTS OF INTEREST

The MIP measuring by the Capsule Sensing Pressure Gauge -V was donated by Gauges Bourdon Pvt. Ltd, India for present research study.

REFERENCES

1. Gupta R, Mohan I, Narula J. Trends in coronary heart disease epidemiology in India. Ann Glob Health 2016;82:307-15.
2. Iung B, Vahanian A. Epidemiology of valvular heart disease in the adult. Nat Rev Cardiol 2011;8:162-72.
3. Cordeiro AL, Melo TA, Neves D, Luna J, Esquivel MS, Borges DL, *et al*. Inspiratory muscle training and functional capacity in patients undergoing cardiac surgery. Braz J Cardiovasc Surg 2016;31:140-4.
4. Rajendran AJ, Manoj S, Karthikeyan D, Davis S. Cardiac rehabilitation for CABG patients in South Indian setup: A prospective study. IJPMR 2004;15:23-33.
5. Westerdahl E, Lindmark B, Almgren SO, Tenling A. Chest physiotherapy after coronary artery bypass graft surgery--a comparison of three different deep breathing techniques. J Rehabil Med 2001;33:79-84.
6. Westerdahl E, Lindmark B, Eriksson T, Friberg O, Hedenstierna G, Tenling A. Deep-breathing exercises reduce atelectasis and improve pulmonary function after coronary artery bypass surgery. Chest 2005;128:3482-8.
7. Yánez-Brage I, Pita-Fernández S, Juffé-Stein A, Martínez-González U, Pértega-Díaz S, Mauleón-García A. Respiratory physiotherapy and incidence of pulmonary complications in off-pump coronary artery bypass graft surgery: An observational follow-up study. BMC Pulm Med 2009;9:36.
8. Ragnarsdóttir M, KristjAnsdóttir A, Ingvarsdóttir I, Hannesson P, Torfason B, Cahalin L. Short-term changes in pulmonary function and respiratory movements after cardiac surgery via median sternotomy. Scand Cardiovasc J 2004;38:46-52.
9. Herdy AH, Marcchi PL, Vila A, Tavares C, Collaço J, Niebauer J, *et al*. Pre-and postoperative cardiopulmonary rehabilitation in hospitalized patients undergoing coronary artery bypass surgery: A randomized controlled trial. Am J Phys Med Rehabil 2008;87:714-9.
10. Snowdon D, Haines TP, Skinner EH. Preoperative intervention reduces postoperative pulmonary complications but not length of stay in cardiac surgical patients: A systematic review. J Physiother 2014;60:66-77.
11. Kendall F, Oliveira J, Peleteiro B, Pinho P, Bastos PT. Inspiratory muscle training is effective to reduce postoperative pulmonary complications and length of hospital stay: A systematic review and meta-analysis. Disabil Rehabil 2018;40:864-82.
12. Mundada N, Retharekar S. Effect of respiratory muscle training as an adjunct to conventional therapy in phase i cardiac rehabilitation for median sternotomy patients. Int J Ther Rehabil Res 2016;5:224-33.
13. Savci S, Degirmenci B, Saglam M, Arikan H, Inal-Ince D, Turan HN, *et al*. Short-term effects of inspiratory muscle training in coronary artery bypass graft surgery: A randomized controlled trial. Scand Cardiovasc J 2011;45:286-93.
14. Cavenaghi S, Ferreira LL, Marino LH, Lamari NM. Respiratory physiotherapy in the pre and postoperative myocardial revascularization surgery. Rev Bras Cir Cardiovasc 2011;26:455-61.
15. Hulzebos EH, Helders PJ, Favié NJ, De Bie RA, Brutel de la Riviere A, Van Meeteren NL. Preoperative intensive inspiratory muscle training to prevent postoperative pulmonary complications in high-risk patients undergoing CABG surgery: A randomized clinical trial. JAMA 2006;296:1851-7.

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