Journal of Diseases Open access

Research Article

Effectiveness of Incentive Spirometry to Reduce Pulmonary Complications and Improve Respiratory Parameter after Coronary Artery Bypass Graft Surgery: A Narrative Review

Abdullah Ibn Abul Fazal[1]*, Kaniz Fatema[2], Md Waliul Islam[1], Suraiya Salek[1] and Md Golam Kibria[1]

[1]*Department of Physiotherapy, Centre for the Rehabilitation of the Paralysed (CRP), Dhaka, Bangladesh*

[2]*Department of Occupational Therapy, Bangladesh Health Professions Institute (BHPI), Dhaka, Bangladesh*

***Correspondence:** *Abdullah Ibn Abul Fazal, Department of Physiotherapy, Centre for the Rehabilitation of the Paralysed (CRP), Dhaka, Bangladesh*

Abstract

Background: Coronary artery bypass graft (CABG) surgery is a surgical procedure to restore normal blood flow to the heart by bypassing obstructed coronary arteries. The goal of coronary artery bypass graft (CABG) surgery is to bypass clogged coronary arteries and return normal blood flow to the heart. Incentive Spirometry is used frequently as a component of postoperative pulmonary management and rehabilitation purpose. This study aimed to explore the effectiveness of Incentive Spirometry by reviewing of the article. Five articles were reviewed in order to fulfil the purpose of this study. With a PEDro score ranging from 5 to 7, randomized controlled trial was used. Studies compared or combined with Incentive spirometry, DBE, ACBT, expiratory positive airway pressure and conventional physiotherapy. From the review it is found out that Incentive spirometry improved arterial oxygenation, functional capacity, oxygen saturation, inspiratory muscle strength and prevention of atelectasis among patients undergone Coronary artery bypass graft (CABG) surgery. Therefore, it is convenient to conclude from the overall review that Incentive Spirometry (IS) is not superior to other conventional physiotherapy techniques, but when used in combination, it can be used as the most effective treatment technique for patients who have undergone coronary artery bypass grafting.

Keywords: Respiratory physiotherapy, Incentive spirometry

Received date: Mar 04, 2025; **Accepted date**: Mar 11, 2025; **Published date**: Mar 21, 2025

Citation: Fazal, Abdullah Ibn Abul, Kaniz Fatema, Md Waliul Islam and Suraiya Salek, et al. Effectiveness of Incentive Spirometry to Reduce Pulmonary Complications and Improve Respiratory Parameter after Coronary Artery Bypass Graft Surgery: A Narrative Review. J Dis 4,2.

INTRODUCTION

Coronary artery bypass graft (CABG) surgery is a surgical procedure to restore normal blood flow to the heart by bypassing obstructed coronary arteries [1]. The goal of coronary artery bypass graft (CABG) surgery is to bypass clogged coronary arteries and return normal blood flow to the heart. The rate of postoperative pulmonary complications (PPCs), such as atelectasis, pleural effusion, pneumonia, and pneumothorax following CABG surgery, has not improved as much and remains a challenge [2,3], despite significant advancements in surgical methods, anesthesia procedures, and postoperative care [3]. In the postoperative phase of CABG, respiratory physiotherapy has been suggested to advance lung functioning and prevent or treat pneumonic problems. As of right now, incentive spirometry (IS) is being used to predict PPC [4]. Prior studies have evaluated the effects of various respiratory physiotherapy interventions on PPC following CABG, including breathing and coughing exercises, incentive spirometry, and expiratory positive airway pressure (EPAP) [5]. The risk of developing pulmonary problems, such as atelectasis, pneumonia, and pleural effusion, is normally high in patients after CABG. When mortality is taken into account, these issues lengthen hospital stays and increase the need for financial resources [6]. Transpiratory factors that influence the development of aspiratory problems include common anesthetic, pulmonary modifications following extracorporeal circulation, use

of the inner mammary route, and postoperative discomfort therefore, over the past ten years, efforts have been undertaken to identify patients who are more likely to have difficulties and to identify ways to foresee these complications [7].

In the first few days following open heart surgery, patients receiving chest physiotherapy treatment in the intensive care unit (ICU) are frequently attached. The goals of physiotherapy are to lessen pain, reduce the accumulation of aspiratory discharges, pneumonia, and atelectasis, maintain aspiratory volume, adjust ventilation and perfusion ratios, reduce aviation route resistance, advance respiratory and peripheral muscle quality, reduce postoperative complications, shorten hospital stay, and reduce quiet horror and mortality [8].

Patients undergoing open heart surgery are frequently advised to undergo various forms of chest physiotherapy and breathing exercises with or without mechanical devices to prepare for or lessen the frequency of impaired lung function. Positioning, incentive spirometry (IS), early mobilization, expiratory positive airway pressure, respiratory muscle training, cough support, deep breathing exercises, and active cycle of breathing methods (ACBT) are a few of them [9].

MATERIALS AND METHODS

This narrative review was done following the methodology described [10].

Search strategy

A comprehensive search was conducted on PEDro, Pubmed and google scholar including Medical Subject Headings (MeSH) terms identified as "Incentive Spirometry", "exercise", "chest physiotherapy", "coronary artery bypass graft", "pulmonary complication", "respiratory exercise". Inclusion criteria were randomized controlled trial with a PEDro score of >4.

RESULTS AND DISCUSSION

The immediate aftermath of coronary artery bypass grafting (CABG), pulmonary problems are a cause of morbidity. According to studies, patients who already have lung disease are more likely to experience difficulties after surgery 13. Chest physical therapy improves respiratory muscle performance and increases inspiratory volume, both of which reduce the risk of pulmonary problems following CABG surgery. Therefore, a study conducted on CABG surgery where they explored the effect of postoperative combined incentive spirometry and DBE *vrs.* DBE alone on inspiratory muscle strength following CABG. Ninety (90) patients were included, with 47 and 43 patients alloted to the study and control groups. The study group received incentive spirometry and DBE, and the control group received DBE only. Maximal inspiratory pressure (MIP) before surgery and at day 4 after surgery was assessed by a respiratory pressure meter. Secondary outcomes, including postoperative pulmonary complication and duration of postoperative hospitalization, were obtained from the medical records. Patients in the study group had significantly better recovery of inspiratory muscle strength on day 4 post- CABG than patients in the control group. There was no significant difference between groups for either postoperative pulmonary complications or length of hospital stay [11] (Table 1).

It is not well established how to employ expiratory positive airway pressure (EPAP) in conjunction with incentive spirometry (IS) to prevent postoperative pulmonary complications (PPC) following coronary artery bypass graft (CABG). There is a study conducted where they determine the paraphernalia of Incentive spirometry with expiratory positive airway pressure (IS + EPAP). In that study Thirty-four patients enduring CABG were randomly assigned to case and control group. Outcome measure are Maximal respiratory pressures, pulmonary function test, 6-minute walk test and chest x-ray. After 1 month in patients undergoing CABG, IS + EPAP results in improved pulmonary function rather than control group [12].

There is controversy whether chest physiotherapy is more superior than IS. There is a study where it was to determine whether the addition of incentive spirometry (IS) to postoperative pulmonary physical therapy is more effective than physical therapy alone in reducing postoperative pulmonary complications in high-risk patients after coronary artery bypass grafting (CABG) Patients with chronic airflow limitation following CABG (N=185) participated. They were randomly assigned to receive either postoperative pulmonary physical therapy (breathing exercises, secretion removal, mobility) or physical therapy combined with IS. Incentive spirometry combined with physical therapy is no more effective than postoperative physical therapy alone in reducing atelectasis for this population [13].

IS and ACBT are commonly used techniques for the prophylaxis and treatment of respiratory complications in post-surgical patients [14]. A patient with various states can simply undergo ACBT. It can be used independently, either with manual approaches included or not. It works well to increase oxygenation, airway clearance, and pulmonary function [15]. Evaluations of the ACBT's efficacy may be found in acute respiratory failure, chronic obstructive lung illness, and stable cystic fibrosis. There is no information about its use in CABG surgery patients, though. A study conducted where they evaluated the efficacy of incentive spirometer (IS) and active cycle of breathing techniques (ACBT) following coronary artery bypass graft (CABG) surgery. This prospective randomized trial comprised 60 male CABG patients, aged 41 to 75.

Thirty patients had ACBT, and another thirty underwent IS plus mobilization. The 6-minute walk test (6MWT), chest radiography, arterial blood gases,

pulmonary function tests, and visual analogue scale for pain assessment were all used to

Assess patients. From the first postoperative day, both therapies increased arterial oxygenation. Functional ability was well preserved with the use of ACBT or IS after a 5-day treatment. On the rate of atelectasis, pulmonary function, and pain perception, both physiotherapy techniques exhibited comparable results [16] (Table 2).

There is a study which aimed to examine the effects of forced vital capacity (FVC), forced expiratory volume in one second (FEV1), maximal respiratory pressures (MRPs), and oxygen saturation in patients who had coronary artery bypass grafting (CABG) with the flow-oriented incentive spirometry (IS). 36 CABG postoperative patients were randomly divided into two groups, DBE (n=18) and IS (n=18), and had non-invasive ventilation for 30 minutes throughout the first 24 hours following extubation. The preoperative period and the seventh postoperative day were used to evaluate the spirometric variables (POD). With regard to the surgical and demographic factors, the groups were thought to be homogeneous. Between the preoperative period and the seventh POD, it has been seen that FVC and FEV1 values have decreased, but there were no appreciable variations between groups. Although there was a progressive and partial recovery up until the seventh POD and no significant differences between groups, the peak respiratory pressures decreased in the table.

CONCLUSION

Patients in combination with IS, DBE, ACBT, breathing exercises, chest expansion exercises, active range of motion exercises and early mobility had shown its effectiveness to minimize pulmonary complication, improve vital capacity, maximal respiratory pressures (MRPs), FVC, after coronary artery bypass graft surgery. It also prevents the length of hospital stay for patients undergone coronary artery bypass graft surgery.

REFERENCES

1) Wynne, Rochelle and Mari Botti. "Postoperative pulmonary dysfunction in adults after cardiac surgery with cardiopulmonary bypass: Clinical significance and implications for practice." *J Crit Care* 13 (2004): 384-393.

2) Westerdahl, Elisabeth, Birgitta Lindmark, Tomas Eriksson and Arne Tenling, et al. "Deep-breathing exercises reduce atelectasis and improve pulmonary function after coronary artery bypass surgery." *Chest* 128 (2005): 3482-3488.

3) Hulzebos, Erik HJ, Paul JM Helders, Nine J. Favié and Rob A. De Bie, et al. "Preoperative intensive inspiratory muscle training to prevent postoperative pulmonary complications in high-risk patients undergoing CABG surgery: A randomized clinical trial." *Jama* 296 (2006): 1851-1857.

4) Toumpoulis, Ioannis K, Constantine E. Anagnostopoulos, Sandhya K. Balaram and Chris K. Rokkas, et al. "Assessment of independent predictors for long-term mortality between women and men after coronary artery bypass grafting: Are women different from men?." *J Thorac Cardiovasc Surg* 131 (2006): 343-351.

5) Stiller, Kathy, Joseph Montarello, Malcolm Wallace and Helen Yates, et al."Efficacy of breathing and coughing exercises in the prevention of pulmonary complications after coronary artery surgery." *Chest* 105 (1994): 741-747.

6) Ferguson, Mark K. "Preoperative assessment of pulmonary risk." *Chest* 115 (1999): 58S-63S.

7) Groeneveld AB, Evert K. Jansen and Joanne Verheij "Mechanisms of pulmonary

8) Sevilay Sakinc, D. İnal İnce and Erkan Kuralay, et al. "Active cycle of breathing techniques and incentive spirometer in coronary artery bypass graft surgery." *Fiz Rehabil* 17 (2006): 61.

9) Gasparyan, Armen Yuri, Lilit Ayvazyan, Heather Blackmore and George D. Kitas. "Writing a narrative biomedical review: Considerations for authors, peer reviewers, and editors." *Rheumatol Int* 31 (2011): 1409-1417.

10) Manapunsopee, Siriluck, Thanitta Thanakiatpinyo, Wanchai Wongkornrat and Wilawan Thirapatarapong. "Effectiveness of incentive spirometry on inspiratory muscle strength after coronary artery bypass graft surgery." *Heart Lung Circ* 29(2020): 1180-1186.

11) Haeffener, Mauren Porto, Gloria Menz Ferreira, Sergio Saldanha Menna Barreto and Pedro Dall'Ago, et al. "Incentive spirometry with expiratory positive airway pressure reduces pulmonary complications, improves pulmonary function and 6-minute walk distance in patients undergoing coronary artery bypass graft surgery." *Am Heart J* 156 (2008): 900-e1.

12) Crowe, Jean M and Christine A. Bradley. "The effectiveness of incentive spirometry with physical therapy for high-risk patients after coronary artery bypass surgery." Phys therap 77 (1997): 260-268.

13) Kunduracılar Z. "Koroner arter cerrahisinde postoperative erken donemde uygulanan gogus fizyoterapisi yontemlerinin

karşılaştırılması. Fizik Tedavi ve Rehabilitasyon Programı Doktora Tezi." *Hacettepe universitesi saglık bilimleri enstitusu. Ankara*; 1998.

14) Inal Ince, Deniz, Sema Savci and Hulya Arikan. "Active cycle of breathing techniques in non-invasive ventilation for acute hypercapnic respiratory failure." *J Physiother* 50 (2004): 67-73.

15) Savci, Sema, Sevilay Sakinc and Erkan Kuralay. "Active cycle of breathing techniques and incentive spirometer in coronary artery bypass graft surgery." *Fiz Rehabil* 17 (2006): 61.

16) Renault, Julia Alencar, Ricardo Costa-Val, Márcia Braz Rosseti and Miguel Houri Netoet. "Comparison between deep breathing exercises and incentive spirometry after CABG surgery." *Braz J Cardiovasc Surg* 24 (2009): 165-172.