ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 2, Issue – 5, September - October - 2019, Page No. : 60 - 64

Role of Incentive Spirometry in Post Cardiac Surgery

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Pulmonary complications are the most frequently occurring complications following cardiac surgeries. Chest physiotherapy along with incentive spirometry after surgery is directed towards maximal inspiration in an attempt to prevent atelectasis. Incentive spirometry is a device with visual feedback designed to achieve and sustained maximal inspiration. Various factors like age, gender, pulmonary complications, clinical diagnosis, type of surgery, type of incision, pain, etc., has an influence on the performance of incentive spirometry.

Aim: The aim of the study to find out the

Conclusion: Pulmonary complications occurred in 30% of the patients receiving IPPB, 15% of those using an incentive spirometer, and 8% of those using blow bottles.

Keywords: Incentive spirometry, Thoracotomy, Pulmonary complications.

Introduction

Coronary artery disease is a leading cause of morbidity and mortality [1]. Coronary artery bypass graft (CABG) surgery is adopted for heart revascularization. During this surgery, the patient is subjected to general anesthesia, the heart is exposed through a median sternotomy, and its metabolism is reduced using a solution called cardioplegia solution. The blood circulating in the body is circulated through a cardiopulmonary bypass machine for the duration of the operation. The saphenous vein, internal mammary artery, or radial artery is harvested and connected to the aorta, and the occluded coronary branches are bypassed [2]. Although CABG surgery provides the heart with new vascularization, it is associated with postoperative pulmonary complications in the form of ventilatory dysfunction and reduced spirometric values [3]. Cardiac rehabilitation is a usual practice after CABG and it is composed of three phases, I, II, and III [11].

Phase-I is the acute phase, which takes place during the 3–5 days immediately after surgery when the patient's condition is stable, as decided by his/her surgeon. The pulmonary complications and reduced spirometric values are managed during cardiac rehabilitation Phase-I [4]. An incentive spirometer (IS) is a simple and inexpensive breathing exercise device that is commonly used as a part of the protocol to correct reduced spirometric values [5]. Using an IS and performing breathing exercise has many benefits, including facilitation of deep and prolonged inspiratory efforts, filling of deflated alveoli, enhancement of pulmonary compliance, fostering the re-expansion of

the lung, and diminishing the regional ventilation–perfusion mismatch [6]. Because the benefits of performing breathing exercises with an IS are highly dependent on the patient's effort and accurate use of the device [7], it is customary to offer cardiac patients a preoperative educational session [8]. During this session the physiotherapist instructs the patient on the benefits of performing breathing exercises using an IS and demonstrates its correct usage.

Postoperative pulmonary complications are reported in the range of 2–39%, and include atelectasis, pneumonia, and respiratory failure. Upper-abdominal surgical procedures are associated with a higher risk of complications, followed by lower-abdominal surgery and thoracic surgery [9]. To prevent or reverse atelectasis and improve airway clearance Preoperative and postoperative respiratory therapy aims. The risk and severity of complications can be reduced by the use of therapeutic maneuvers that increase lung volume. Incentive spirometry has been performing important role of the perioperative respiratory therapy strategies to prevent or treat complications. Incentive spirometry is basically manufactured as a sham intervention which mimics natural sighing or yawning by encouraging the patient to take long, slow, deep breaths. This decreases pleural pressure, promoting increased lung expansion and better gas exchange. When the procedure is repeated on a regular basis, atelectasis may be prevented or reversed[10]. Expiratory maneuvers such as positive expiratory pressure (PEP) and vibratory PEP do not mimic the sigh. Whereas incentive spirometry has broad range spectrum in clinics as a part of routine prophylactic and therapeutic treatment in perioperative respiratory therapy, its clinical efficacy is still under debate. It is also known as sustained maximal inspiration[11]. The patient is asked to hold the spirometer in an upright position, exhale normally, and then place the lips tightly around the mouthpiece. Then there is another step which is a slow inhalation to raise the ball or the piston/plate (volume-oriented) in the chamber to the set target. the mouthpiece is removed when it reaches at maximum inhalation, followed by a breath-hold and normal exhalation. Spirometry is the most selected lung expansion therapy used in all patients undergoing thoracotomy regardless of the cause. It is commonly noticed that the performance of Incentive Spirometry in post thoracotomy and abdominal surgery patients varies depending upon the age, gender, patients with history of smoking, pulmonary problems, post pulmonary complications, pain, clinical diagnosis of the patient, type of surgery and incision made [12]. Four respiratory maneuvers have been used with varying success to treat atelectasis: IPPB, resistance breathing, carbon dioxide rebreathing [l], and, recently, voluntary sustained inspiration. This report compares three of these methods. The aim of the study is to rule out the role of incentive spirometry to prevent atelectasis in post cardiac surgery

Methodology

A consecutive group of 145 patients who underwent cardiac operations were treated postoperatively with IPPB, blow bottles, or an incentive spirometer (Table 1). Subsequently, 58 consecutive patients were treated with an incentive spirometer. Although this process did not fulfill strict criteria of randomization, no patients were excluded, and we think the groups were similar enough preoperatively that a valid statistical statement can be made about the results. No differences existed between the groups with regard to associated illnesses, particularly those involving the cardiovascular and respiratory systems. A change in our operative preservation of the myocardium resulted in significantly longer pump times in the group using the incentive spirometer. This longer pump time may well have increased our pulmonary

complication rate in this group. Patients were instructed preoperatively in the use of their respective mode of therapy and were taught deep breathing and coughing techniques. Chest percussion and periodic nasotracheal suctioning were applied with equal frequency in each group. Patients were maintained on a Bennett MA-1 volume respirator by a nasotracheal tube for 6 to 36 hours postoperatively. Forty percent oxygen and cool mist by mask were used following extubation. One group of patients was treated for 15 minutes every 3 hours with IPPB by using a Bennett PR-2 or Bird Mark 4 pressure respirator. An opening pressure of 15 to 20 cm H20, normal saline in the nebulizer, and a 40% oxygen-air mix were used.

The second group of patients was given blow bottles and supervised as they exchanged the water from three to five times every 3 hours. The third group of patients inhaled through the incentive spirometer to their maximum volume and sustained it as long as possible. This process was repeated from three to five times every 3 hours. The patients were encouraged to obtain their preoperative level of vital capacity. All patients were evaluated postoperatively by roentgenogram, physical examination, and serial arterial blood gases in an attempt to evaluate their respiratory status. Observations were made preoperatively and on the first three postoperative days. These included percussion and auscultation of the lungs, vital signs, chest roentgenogram and PaO_2. The PaO_2 was measured with an FIO_2, of 40% on the first postoperative day and ambient air on the remaining days. Pulmonary complications were tabulated. Atelectasis was considered a significant complication if it prolonged hospitalization, if it necessitated bronchoscopy, or if the cardiologist involved in the patient's postoperative care specifically mentioned it in the discharge summary as being troublesome. Gastrointestinal complaints were noted. In any patient in whom the method of respiratory therapy was changed, the consideration was that the primary method had failed and that the patient had significant atelectasis in spite of treatment. This situation occurred once or twice in each group. Results Respiratory rate, pulse rate, and the incidence of rales and egophony were essentially equal in all three groups. Temperature improved daily in groups using IPPB and blow bottles. Those using the incentive spirometer maintained a higher temperature for a longer period (Table 2). Radiographic changes consistent with atelectasis occurred with increasing frequency in the groups utilizing IPPB and the incentive spirometer. Roentgenographic changes did not significantly increase with time in the group using blow bottles (Table 3). By the second postoperative day, 49% of the patients using blow bottles and 43% of those using the incentive spirometer had a PaO_2, of less than 60 torr, whereas 62% of the patients using IPPB had a PaO_2 of less than 60 torr. On the third postoperative day there was a significant improvement in PaO_2 in the group using blow bottles and a lesser improvement in the groups using IPPB or the incentive spirometer. Gastrointestinal complaints were rare in the groups using blow bottles and the incentive spirometer. Only 2% (1145) of the patients using blow bottles and 2% (1/58) of those using the incentive spirometer developed gastric distention, whereas 9% (4142) of IPPB patients did. In addition, no incentive spirometer patients and only 2% (1145) of those using blow bottles experienced nausea post- operatively, whereas 16% (7142) of the IPPB patients did. Most of these patients complained of their symptoms immediately after treatment with IPPB. The incidence of significant atelectasis was lowest in the group using blow bottles (8%) and highest in the group using IPPB (26%). The incentive spirometer group was intermediate, with an incidence of 15%. In the IPPB group, 1 patient developed

pneumonia from which she eventually died. A second patient suffered an anoxic cardiac arrest attributed to a mucus plug, was resuscitated, and left the hospital without sequelae. The total respiratory complication rate is thus 30% (13/42) in the group using IPPB, double that of those using the incentive spirometer (9/58, or 15%) and nearly four times that of those using blow bottles (4/45, or 8 %) .

Table no 1

Diagnosis of patients undergoing cardiac operations			
Diagnosis	IPPB	BB	IS
Coronary artery disease	17	29	43
Aortic valve disease	15	4	8
Mitral valve disease	8	8	3
Double valve disease	2	0	2
Total	42	45	58

Table no 2

Patients with Temperature Greater Than 37.8"C						
Postoperative Day	IPPB No		BB No %		IS No %	
1	14	33	15	33	18	31
2	19	45	16	36	30	52
3	23	55	18	40	35	60

Table no 3

Patients with Roentgenographic Changes of Atelectasis						
Postoperative Day	IPPB No		BB No %		IS No %	
1	14	33	15	33	18	31
2	19	45	16	36	30	52
3	23	55	18	40	35	60

Discussion

Hypoventilation and splinting either alone or through deactivation of surfactant are the probable causes of atelectasis. Once a critical decrease in the vital capacity occurs, more alveolar units approach their closing volume. In the range below normal functional residual capacity, closure of distal airways and small alveoli causes little functional impairment. As the normal range of tidal volume is encroached upon, progressive hypoxia ensues. Sufficient transpulmonary pressure at the patient's current vital capacity will serve to reopen collapsed alveoli. Positive end-expiratory pressure is the best technique to achieve this. It is usually not feasible two or more days postoperatively in a patient who has been extubated. In theory, the incentive spirometer should be the best technique to achieve the reopening of collapsed alveoli. Although the incentive spirometer produced an improvement over IPPB, it was less effective than blow bottles. Although 15% (9/58) of incentive spirometer patients experienced pulmonary complications compared with 30% (13/42) of IPPB patients who did, only 8% (4/45) of the patients using blow bottles experienced such complications. The chi-square value for these results is 7.57 (p = 0.023). In addition, 20% (8/42) of IPPB patients experienced gastrointestinal complications, whereas only 2% (1145) of blow bottle patients and 2% (1/58) of incentive spirometer patients did. This difference in gastrointestinal complications is also significant at a chi-square value of 13.61 (p = 0.0011). Inspiratory and expiratory maneuvers achieved by the patient are superior to the passive use of IPPB in the treatment and prevention of postoperative atelectasis.

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