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Research Article

The Effect of Incentive Spirometer Verses Conventional Chest Physiotherapy on Pulmonary Complications in Coronary Artery Bypass Grafting Patients.

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Abstract

Background: The purpose of this study was to identify the post pulmonary complication faced by the coronary artery bypass grafting patients. So that the most effective treatment is reviewed and selection of incentive spirometer exercise, conventional chest physiotherapy with early mobilization is chosen as the line of treatment. It may improve health status by improving the functional capacities and there by enhance the aerobic performance of an individual. The value of chest physiotherapy has recently been established and accepted but it is still unclear which treatment techniques are most effective. Early mobilization and breathing exercises are often the first choice of treatment, but evidence as to the optimal intensity, timing and choice of exercises is scarce. There are only limited published literatures on how the cardiac surgery patient should be exercised with incentive spirometer and mobilizes during the first postoperative period in hospital.

Aim and objectives: To find the effectiveness of incentive spirometer and conventional chest physiotherapy on pulmonary complications in coronary artery bypass grafting patients.

Material and Method: Intervention was given preoperatively and post operatively. Then the patient was divided into two groups are Group A Incentive spirometer, Group B Conventional chest physiotherapy. All the participants were receive the selected treatment for 2 session's minimum pre operatively and 6 sessions post operatively. Material used are inch tape and pulmonary function test machine

Result: chest expansion pre and postoperatively shows there is extremely significant difference in group A. chest expansion postoperatively shows there is very significant difference between group A and GroupB.FEV1/FVC there is very significant difference between Group A and Group B.

Conclusion: Based on statistical analysis for results, the present study concluded that, incentive spirometer training was significantly effective compared with conventional chest physiotherapy on pulmonary complications in coronary artery bypass grafting patients.

Keywords: Coronary Artery Bypass Grafting; Incentive Spirometer; Conventional Chest Physiotherapy

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]. The World Health Organization has defined ischemic heart disease (IHD) as myocardial impairment due to imbalance between coronary blood flow and myocardial requirements. The most common cause of ischemic heart disease is atherosclerotic coronary artery disease.[2]The disease is more common among men compared to premenopausal women in a ratio of 25:1. However, in postmenopausal women, there is rapid rise in the incidence of atherosclerosis. Women who have undergone oopherectomy have a higher incidence of atherosclerotic coronary heart disease. Estrogens may thus have a protective effect against atherosclerosis [2].

Anatomy of coronary circulation

The two coronary arteries, left and right, arise from the left and right sinus of valsalva, respectively. The left main coronary artery is responsible for supplying approximately two-thirds of the left ventricular myocardium through its two branches, the left anterior descending and circumflex arteries. The left anterior descending artery courses on the anterior surface of the heart near the interventricular surface and curves around the apex. It supplies the interventricular septum through the septal perforators and the anterior surface of the left ventricular through diagonal branches, and also supplies branches to the left and right bundle branches of the conduction system [2].

The left circumflex artery traverses in the left atrioventricular groove and turns posteriorly, giving off several obtuse marginal branches to the lateral and posterior left ventricular wall. In 10% of individuals the circulation is considered as "left dominant" as the circumflex artery gives off the posterior descending artery. In 90%, the circulation is right dominant as the posterior descending artery is given off from the right coronary artery. However, regardless of whether it is a right or left dominant system, the left coronary artery supplies blood to a major portion of the left ventricle [2].

The right coronary artery courses over the right ventricle and gives off the sinus nodal, right atrial and right ventricular branches and terminates as the posterior descending artery while supplying blood to the posterior part of the interventricular septum and the Atrioventricular node [2].

Physiology of coronary circulation

The heart extracts most of the oxygen from the circulating coronary arterial blood. Any extra demand can be met with only by additional blood supply. Coronary reserve refers to this ability of the coronary circulation to provide additional blood to the myocardium when required. In the resting state, coronary blood flow is adequate until there is 75% narrowing of a major epicardial coronary artery. Shortening of diastole, as in tachycardia, reduces coronary blood flow. A decrease in the aortic diastolic pressure also causes ischemia by reducing coronary profusion. During stress the perfusion pressure does no increase and increased flow is maintained by coronary vasodilatation which is controlled by various metabolites like adenosine, prostaglandins, CO_2 and H^+ concentration. Sympathetic stimulation produces direct vasoconstriction and parasympathetic stimulation causes vasodilatation of the coronary arteries [2].

Pathophysiology of myocardial ischemia

- Myocardial ischemia occurs as a result of imbalance between O_2 supply and demand myocardial O_2 supply is determined by the aortic diastolic pressure, extent of coronary artery obstruction, tone of coronary vessels distal to the obstruction, and adequacy of collateral blood flow [2] Myocardial oxygen supply is reduced in conditions [2] like
- Coronary artery disease due to atherosclerotic lesion obstructing the vessel, plaque, rupture, subintimal haemorrhage, platelet aggregates, thrombosis, and spasm on a preexisting atheromatous lesion.
- Coronary artery embolism.
- Tachycardia, increased aortic diastolic pressure, increased Left ventricular size.
- Anomalous origin of left coronary artery from the pulmonary artery.
- Severe anaemia, carbon monoxide poisoning.
- Narrowing of the coronary ostia, as in syphilitic aortitis.
- Thyroid disorders, Hypertension.
- Hypertrophic cardiomyopathy, aortic stenosis.
- Cocaine drug addiction.

Symptoms of Ischemic heart disease

Fatigue, angina, dyspnea, edema, cough or haemoptysis, palpitations, and syncope, as outlined by Braunwald. The initial goal is to determine whether a symptom is cardiac or non-cardiac in origin, as well as to determine the clinical significance of the complaint. An important feature of cardiac disease is that myocardial function or coronary blood supply that may be adequate at rest may become completely inadequate with exercise or exertion. Thus chest pain or dyspnea that occurs primarily during exertion is frequently cardiac in origin, while symptoms that occur at rest often are not [3].

Clinical manifestations

Myocardial ischemia from coronary artery disease may result in angina pectoris, myocardial infarction, congestive heart failure, or cardiac arrhythmias and sudden death. Angina is the most frequent symptom, but myocardial infarction may appear without prior warning [3].

Risk factor for ischemic heart disease [2]

- Hypercholesterolemia
- Smoking
- Hypertension
- Lack of Physical activity
- Obesity
- Diet
- Family History and family aggregation
- Psychological and behavioural factors
- Stress and occupation
- Sedentary life style
- Glucose intolerance
- Alcohol and gender

Indications for Coronary artery bypass grafting [2]

- Left main stem disease.
- Triple vessel disease.
- Two-vessel disease involving left anterior descending.
- Chronic ischemia left ventricular dysfunction.

Cardiac surgery is one of the most common surgical procedures and accounts for more resources expended in cardiovascular medicine than any other single procedure [4]. Because cardiac surgery involves sternal incision and cardiopulmonary bypass, patients usually have a restricted respiratory function in the postoperative period. Anaesthesia and analgesia affect respiratory function (during and after the surgical intervention) [5-7] causing changes in lung volume, diaphragmatic dysfunction, respiratory muscle strength, pattern of ventilation, gas exchange, and the response to carbon dioxide and oxygen concentrations [8-13].

A postoperative pulmonary complication is defined as any pulmonary abnormality occurring during the postoperative period and resulting in clinically significant disease or dysfunction, adversely affecting the clinical course [14].

The respiratory system is directly influenced by the type of surgery, the organ involved *and* the method used. Postoperative pulmonary complications are a major cause of morbidity, mortality, prolonged hospital stay, and increased cost of care [15].

Role of physiotherapy

Physiotherapy treatment is often prescribed to patients undergoing cardiac surgery, in order to prevent or diminish postoperative complications. The physiotherapy treatment during the hospital stay generally consists of early mobilization, range of motion exercises and breathing exercises.

Goals of physical therapy include the promotion of effective alveolar ventilation and adequate oxygenation, mobilization and removal of secretions (with the help of chest manipulation technique, breathing exercises, huffing or coughing) maintenance of chest wall mobility, enhancement of exercise tolerance and mobility, and reduction of pain.

Breathing exercises compensate for and normalize abnormal breathing patterns and may help to reduce the risk of atelectasis and pneumonia [16-19]. The purpose of positioning and mobilization of the patient following surgery is to optimize the ventilation-perfusion relationship and to maximize oxygen transport [20,21] Chest manipulation may be important for surgical patients who have pre-existing mucus hyper secretion and who may be overwhelmed by additional secretions in the postoperative period or for those who develop pneumonia [22,23]. During cardiac surgery, the respiratory muscles may become damaged, leading to weakness, respiratory muscle dysfunction, and respiratory failure [5,6,24]. Inspiratory muscles, like skeletal muscles, can be trained to increase strength and endurance [25,26] Preoperative improvement in the strength and endurance of the inspiratory muscles may lead to increased resistance to fatigue and improved ventilatory function by decreasing the work of breathing and increasing the respiratory reserve [27,28].

Incentive spirometry

Incentive spirometry is a form of ventilator training that emphasizes sustained maximum inspirations. The patient inhales as deeply as possible through a small, handheld incentive spirometer that provides visual or auditory feedback about whether a target maximum inspiration was reached. The purpose of incentive spirometry is to increase the volume of air inspired. It is used primarily to prevent alveolar collapse and atelectasis in postoperative patient [29].

Procedure

Have the patient assume a comfortable position (Semi-Fowler's position if possible) and inhale and exhale three to four times and then exhale maximally with the fourth breath. Then have the patient place the spirometer in the mouth, inhale maximally through the mouthpiece to a target setting and hold the inspiration for several second.

Conventional chest physiotherapy

Postural drainage

Postural drainage (PD) is a passive technique, in which the patient is placed in positions that allow the bronchopulmonary tree to be drained with the assistance of gravity. Positioning the patient to enable gravity to assist the flow of bronchial secretions from the airways has been a standard treatment for some time in patients with retained secretions (Zadai,1981). Each lobe to be drained must be aligned so that gravity can mobilize the secretions from the periphery to the larger, more central airways [28].

Percussion

Percussion, sometimes referred to as chest clapping, is a traditional approach to secretion mobilization. A rhythmical force is applied with cupped hands to the patient's thorax over the involved lung segments with the aim of dislodging or loosening bronchial secretions. This technique is performed with the patient in postural drainage positions and requires a caretaker to administer. Percussion delivered between 100 and 480 times per minute. The proposed mechanism of action of percussion is the transmission of a wave of energy through the chest wall into the lung. The resulting motion loosens secretions from the bronchial wall and moves them proximally where ciliary motion and cough (or suction) can remove them. The combination of postural drainage and percussion has been shown to be effective in secretion removal [28].

Vibration

Vibration is a sustained co contraction of the upper extremities of a caretaker to produce a vibratory force that is transmitted to the thorax over the involved lung segment. Frequency of manual vibration is between12 to 20 Hz. Vibration is applied throughout exhalation concurrently with mild compression to the chest wall. Vibration is often applied in postural drainage positions following percussion to the area. Vibration is proposed to enhance mucociliary transport from the periphery of the lung fields to the larger airways. Since vibration is used in conjunction with postural drainage and percussion [28].

Shaking

It consists of a bouncing maneuver against the thoracic wall in a rhythmic fashion throughout exhalation. A concurrent pressure is given to the chest wall, compressing the thorax. Shaking is similar in application to vibration, with shaking being on one end of the spectrum in application of force, and vibration being on the opposite end, supplying a gentle amount of pressure. Many variations exist throughout the spectrum between these techniques. Shaking may be used in place of percussion or intermittently with percussion and vibration. Frequency for shaking is 2 Hz. Shaking may be used in postural drainage positions. Shaking is proposed to work in the same manner as vibration, mobilizing secretions to the central, larger airways from the lung periphery [28].

Breathing exercise [29]

- Improve or redistribute ventilation.
- Increase the effectiveness of the cough mechanism and promote airway clearance.
- Prevent postoperative pulmonary complications.
- Improve the strength, endurance, and coordination of the muscles of ventilation.
- Maintain or improve chest and thoracic spine mobility.
- Correct inefficient or abnormal breathing patterns and decrease the work of breathing.
- Promote relaxation and relieve stress.
- Teach the patient how to deal with episodes of dyspnoea.
- Improve a patient's overall functional capacity for daily living, occupational, and recreational activities.
- **Diaphragmatic Breathing:** Prepare the patient in a relaxed and comfortable position in which gravity *assists* the diaphragm, such as a Semi-Fowler's position. If patient initiates the breathing pattern with the accessory muscles of inspiration (shoulder and neck musculature), start instruction by teaching the patient how to relax those muscles (shoulder rolls or shoulder shrugs coupled with relaxation). Place your hand on the rectus abdominal muscle just below the anterior costal margin. Ask the patient to breathe in slowly and

deeply through the nose. Have the patient keep the shoulders relaxed and upper chest quiet, allowing the abdomen to rise slightly. Then tell the patient to relax and exhale slowly through the mouth. Have the patient practice these three or four times and then rest. Do not allow the patient to hyperventilate. The patient's hand should rise slightly during inspiration and fall during expiration.

- **Segmental Breathing:** Lateral costal expansion can be carried out unilaterally or bilaterally. Ask the patient to breathe out and feel the rib cage move downward and inward. As the patient breathes out place pressure into the ribs with the palms of your hands. Just prior to inspiration, apply a quick downward and inward stretch to the chest. This places a quick stretch on the external intercostals to facilitate their contraction. Apply light manual resistance to the lower ribs to increase sensory awareness as the patient breathes in deeply and the chest expands and ribs flare. Then, as the patient breathes out, assist by gently squeezing the rib cage in a downward and inward direction.
- **Posterior Basal Expansion:** Have the patient sit and lean forward on a pillow, slightly bending the hips. Place your hands over the posterior aspect of the lower ribs, and follow the same procedure just described for lateral costal expansion.
- **To Mobilize the upper chest and stretch the pectoralis muscles:** While the patient is sitting in a chair with hands clasped behind the head, have him or her horizontally abduct the arms during a deep inspiration. Then instruct the patient to bring the elbows together and bend forward during expiration.

Outcome measures

Chest expansion

Chest expansion measurement will be taken pre and post operatively by a tape and encircle chest around measurements will be taken at initial and at the end of deep inspiration and expiration.

- **1st Level:** Axillary level
- **2nd Level:** Nipple level
- **3rd Level:** Xiphoid process levels

Pulmonary function tests [2]

Spirometry measures static lung volumes and helps to detect ventilator abnormality in conditions associated with airway obstruction or restriction. In the former there is a decrease in airflow and the latter is associated with a decrease in vital capacity. Spirometry is thus an important screening procedure to detect functional abnormalities.

Indications

- Diagnose and characterize type of dysfunction in disorders of respiratory system.
- Uncover unexplained dysfunction.
- Preoperative evaluation.
- Quantification of respiratory disability.
- Respiratory failure.
- Assessment of disease progression.
- Monitor response to therapy

Uses of pulmonary function tests

Test	Uses
FEV_1, FVC	Assess airways obstruction
FEV_1/FVC%	Assess airways obstruction
Flow-volume loops	Assess airways obstruction
Lung volume	Differentiate obstructive from restrictive
Airway resistance	Assess airways obstruction

Table a

Pulmonary function abnormalities in obstructive and restrictive lung diseases

Function	Obstructive	Restrictive
Forced vital capacity (FVC)	↓	↓
Forced expiratory volume in first second (FEV_1)	↓	N ↓
FEV_1/FVC ratio	↓	N or ↑
Maximum voluntary ventilation (MVV)	↓	↑
Peak expiratory flow rate (PEFR)	↓	N
Residual volume (RV)	↓	N
Diffusion capacity (DLCO)	N or ↓	↓
Raw	↑	N or ↓
Compliance	N or ↑	↓
Total Lung Capacity	↑	↓

Table b

Risks of the procedure

Because pulmonary function testing is a noninvasive procedure, it is safe for most individuals. It is quick and the individual needs to be able to follow clear, simple directions.

Complications of pulmonary function testing may include

- Faintness or light-headedness due to hyperventilation
- Asthmatic episode precipitated by deep inhalation exercises
- Certain factors or conditions may interfere with the accuracy of pulmonary function testing. These factors may include, but are not limited to, the following:
- Medications such as bronchodilators (open the airways) or pain medications (may affect the ability to perform the tests)
- Gastric distention (may affect the ability to take in deep breaths)
- Fatigue or other conditions that affect the ability to perform the tests

Before the procedure

- Doctor will explain the procedure to patient and offer the opportunity to ask any questions that might have about the procedure.
- Generally, no prior preparation, such as fasting, fluid restriction, or sedation is required. However, may be asked to avoid eating a heavy meal before the test.
- Notify doctor of all medications (prescription and over-the-counter) and herbal supplements that are taking.
- If smoker, patient will usually be asked to refrain from smoking for a period of time before the test.
- Height and weight will be recorded so that your results can be accurately calculated.
- Based on medical condition, doctor may request other specific preparation.

During the procedure

Pulmonary function testing may be done on an outpatient basis or as part of your stay in the hospital. Procedures may vary depending on your condition and your doctor's practices.

Generally, Pulmonary function testing follow this process:

- Will be asked to loosen tight clothing, jewelry, or other objects that may interfere with the procedure
- If wear dentures, will be asked to wear them during the procedure.
- Will be asked to empty bladder before the procedure to optimize comfort.
- Will sit in a chair or stand for the procedure.
- Will be given a soft nose clip to wear during the procedure so that all of breaths will go through mouth, rather than your nose.
- Will be given a sterile mouthpiece that will be attached to the spirometer.
- With mouth forming a tight seal around the mouthpiece, will be instructed to perform various breathing maneuvers. The maneuvers will be done by inhaling and exhaling. Depending on what measurements are ordered, may be asked to repeat the maneuvers several times before the test is completed.
- Will be monitored carefully during the procedure for faintness, dizziness, difficulty breathing, or any other problems.

After the procedure

Generally, there is no special type of care following pulmonary function testing. Resume usual diet, medications, and activities unless doctor advises. If have a history of respiratory problems or tired after the procedure. Will be given the opportunity to rest afterwards. Doctor may give additional or alternate instructions after the procedure depending upon particular situation.

Material and Methodology

- Study type: Experimental study
- Study design: Randomized controlled trial
- Study Duration: one year
- Sample size: 30 patients
- Sampling method: Convenience sampling
- Place of study: KIMS, Deemed University, Karad.

Inclusion criteria

- Pre operative and post operative coronary artery bypass grafting patients
- Subjects who were willing to participate in the study will be taken
- Both off pump and on pump surgery patients

Exclusion Criteria

- Unstable angina
- Uncontrolled arrhythmia
- Addictive person
- Thromboembolism
- Severe endocarditic
- Psychological disorder
- H/o Cerebrovascular accident
- H/o Pulmonary surgery
- Pneumothorax

Materials

Figure 1: Measuring tape.

Figure 2: Weighing machine.

Figure 3: Incentive spirometer.

Figure 4: Pulmonary function testing machine.

Procedure for study

Intervention was given preoperatively and post operatively. Subject fulfilling the inclusion criteria were given consent form before intervention and explained regarding the study. Then the patient was divided into two groups are Group A and Group B.

- **Group A**: Incentive spirometer.
- **Group B**: Conventional chest physiotherapy.

On the first day of their treatment data collection sheet was filled up and taken from the patient. All the participants were receive the selected treatment for 2 session's minimum pre operatively and 6 sessions post operatively

Group A

Preoperative treatment

On the day of admission to hospital, assessment was taken as well as explains an incentive spirometry, explaining its use and insisting on the importance of using it every hour patient will be awake. The flow-based incentive spirometry is a device based on a feedback principle. Patients can observe their movements during inspiration and/or expiration, which encourage them to keep up their efforts and to carry out sustained maximal inspiration.

Figure 5: Performing incentive spirometer.

Postoperative treatment

- **On day one:** Ask the patient to perform incentive spirometry.

Figure 6: Performing incentive spirometer.

- **On day two:** Patients was mobilized from bed to chair with the help of physiotherapist (provided that they show hemodynamic stability) for 15-30 minutes and was told to continue exercises taught in day one.
- **On day three:** Patient was asked to do the exercises taught in day one and walk (15-30 meter) as tolerated by patient with assistance.
- **On day four:** Patient was ask to do exercise taught in day one with walk in hall (50-70 meter) with minimal assistance and one flight of steps climbing stair.
- **On day five:** Do exercises taught in day one with walk in hall independently (80-150 meter) and one flight of step climbing on stair.
- **On day six:** Do exercises taught in day one with walking independently (100-150 meter) and two flights of steps climbing on stair.

Group B

Preoperative treatment

On day 1 and 2, breathing exercises (BE) was taught and ask to do

- 10 times Diaphragmatic breathing exercise
- 10 times Mobilize upper chest stretch pectorals muscles
- 30 times Segmental expansion exercise (lower, mid and upper)
- Chest manipulation technique (Percussion vibration, shaking), Coughing huffing technique, Supported coughing. They will be also shown how to turn over in bed and how to sit up.

Postoperative treatment

- **On day one:** During the postoperative phase, the exercises began in morning. The patients was in long sitting, high sitting with assistance and encouraged to carry out breathing exercises (BE) like
  - 10 Diaphragmatic breathing exercise
  - 30 segmental expansion exercise (lower, mid and upper)
  - 10 mobilize upper chest and stretch pectoralis muscles
- Chest manipulation technique (Percussion vibration, shaking), coughing huffing technique, supported coughing, Active range of motion exercise for bilateral upper and lower limbs,

- **On day two:** Patient was asked to do exercise taught in day one and patients will be mobilised from bed to chair with the help of physiotherapist (provided that they show hemodynamic stability) for 15-30 minutes.
- **On day three:** Patient was asked to do the exercises taught in day one and walk (15-30 meter) as tolerated by patient with assistance.
- **On day four:** Patient was asked to do exercise taught in day one with walk in hall (50-70 meter) with minimal assistance and one flight of step climbing on stair.
- On day five: Do exercises taught in day one with walk in hall independently (80-150 meter) and one flight of step climbing on stair.
- **On day six:** Do exercises taught in day one with walking independently (100-150 meter) and two flights of steps climbing on stair.

Outcome Measures: Pulmonary function testing and chest measurements.

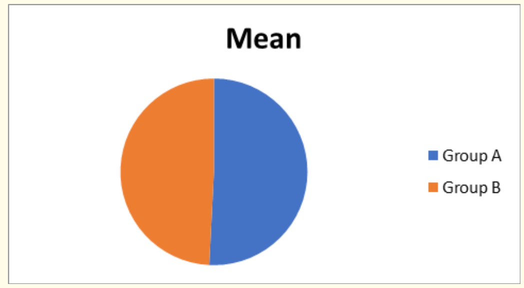
Data presentation and analysis

Results

Table 3 showed mean and SD of chest expansion pre operatively and postoperatively of group A and B. The values were compared by applying Paired t test. It shows that there is extremely significant difference in group A and significant difference in group B.

Age group	Mean	SD	P value	T value
Group A	58.8	8.487	0.5918	0.5425
Group B	60.466	8.340		

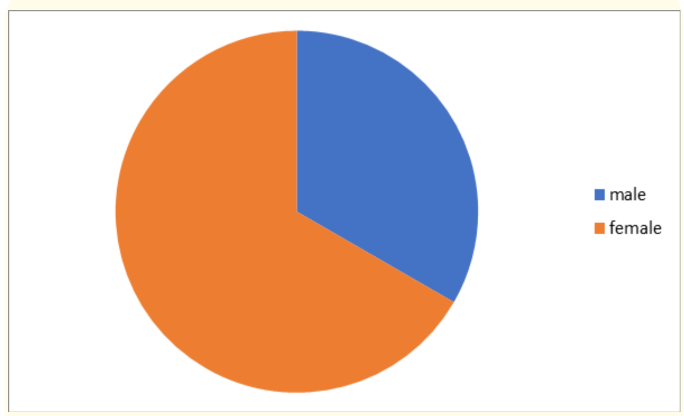
Table 1: Shows age group comparison of mean in group A and B.



Graph 1: Shows age group comparison in group A and B.

Male	Female	Total
20	10	30

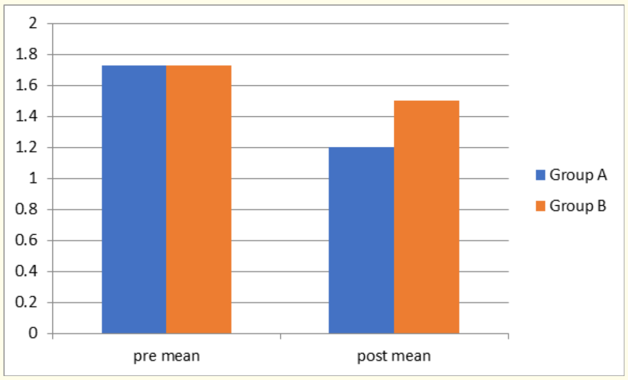
Table 2: Shows comparison of male and female in group A and B.



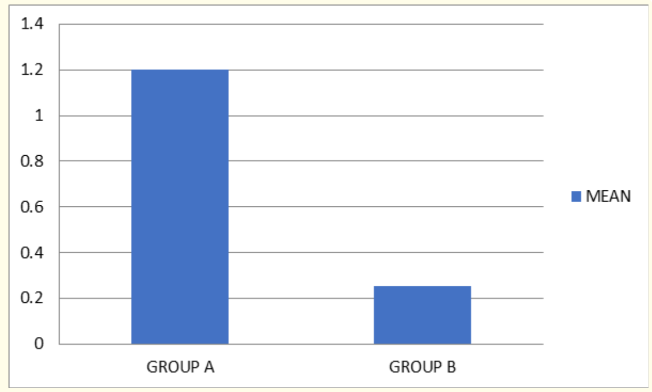
Graph 2: Shows comparison of male and female in group A and B.

Chest expansion	Pre mean	Pre SD	Post mean	Post SD	P value	T value	Improvement
Group A	1.733	0.2582	1.2	0.2535	< 0.0001	16.00	Extremely significant
Group B	1.733	0.2582	1.5	0.2673	0.0135	2.834	Significant

Table 3: Comparison of chest expansion preoperatively and post operatively in group A and B



Graph 3: Shows comparison of chest expansion mean pre and post operatively in group A and B.



Graph 4: Shows comparison of chest expansion mean in group A and B postoperatively.

Chest expansion	Group A	Group B	P value	T Value	Improvement
Group A	1.2	1.5	0.0038	3.154	Very significant
Group B	0.2535	0.2673			

Table 4: Comparison of chest expansion post-operative between group A and B.

Table 4 shows that mean and SD of post operatively in group A and B. The values were compared with unpaired t test. It shows that there is very significant difference between group A and B.

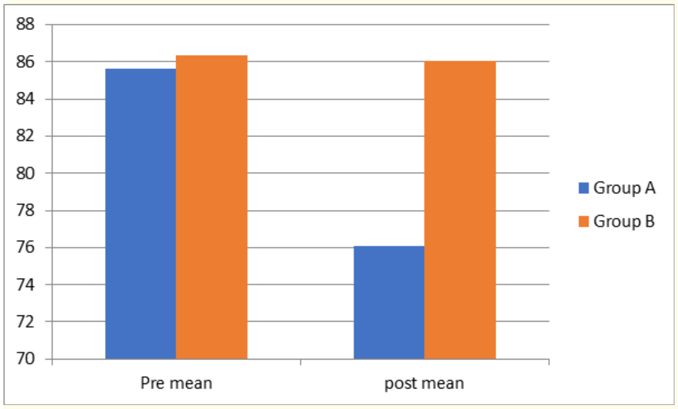
Table 5 Shows that mean and SD of pre and post operatively FEV_1 in group A and B. The values were compared with Paired t test. It shows that there is extremely significant difference in group A and not significant difference in group B.

FEV_1	Pre mean	Pre SD	Post mean	Post SD	P value	T value	Improvement
Group A	85.65	2.431	76.06	3.596	< 0.0001	7.924	Extremely Significant
Group B	86.34	1.742	86.066	1.901	0.6525	0.4601	Not Significant

Table 5: Comparison of preoperatively and post operatively FEV_1 in group A and B.

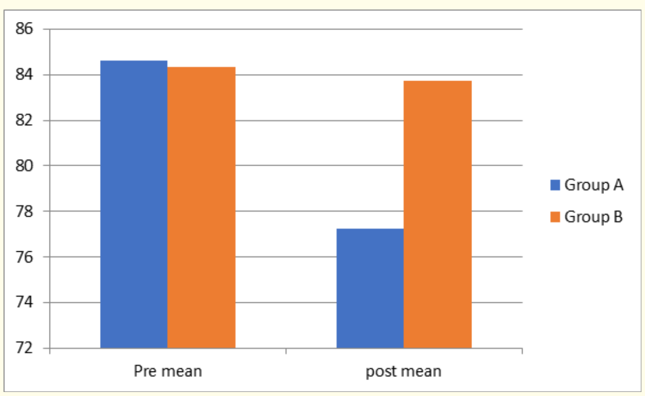
FVC	Pre mean	Pre SD	Post mean	Post SD	P value	T value	Improvement
Group A	84.64	2.557	77.26	5.234	< 0.0001	5.710	Extremely significant
Group B	84.326	2.515	83.733	2.547	0.4019	0.8645	Not significant

Table 6: Comparison of preoperatively and post operatively FVC in group A and B.



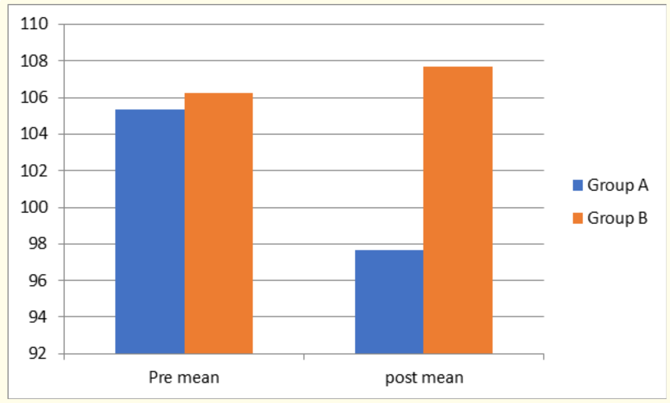
Graph 5: Shows comparison of FEV1 mean pre and post operatively in group A and B.

Table 6 shows mean and SD of pre and post operatively FVC in group A and B. The values were compared with Paired t test. It shows that there is extremely significant difference in group A and not significant difference in group B.



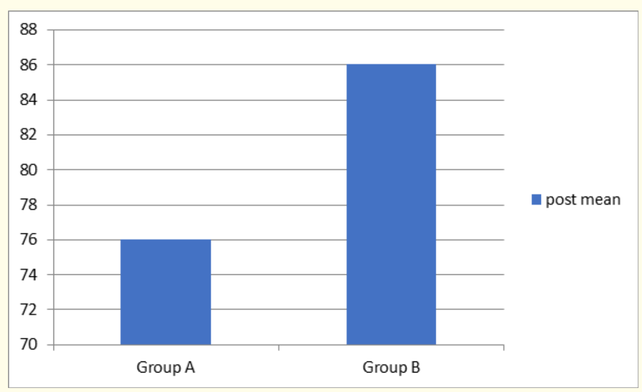
Graph 6: Shows mean of FVC in group A and B pre and post operatively.

Table 7 shows mean and SD pre and post operatively of FEV1/FVC in group A and B. The values were compared with Paired t test. It shows that there is significant difference in group A and not significant difference in group B.



Graph 7: Shows comparison of FEV1 mean pre and post operatively in group A and B.

Table 8 shows comparison of postoperatively FEV1 mean and SD between group A and B. The values were compared with unpaired t test. It shows that there is extremely significant difference.



Graph 8: Shows comparison of FEV1 mean post operatively in group A and B.

FEV1/FVC	Pre mean	Pre SD	Post mean	Post SD	P value	T value	Improvement
Group A	105.34	2.075	97.66	10.487	0.0130	2.845	Significant
Group B	106.27	2.742	107.68	2.839	0.1966	2.839	Not significant

Table 7: Comparison of pre-operative and post-operative FEV1/FVC in group A and B.

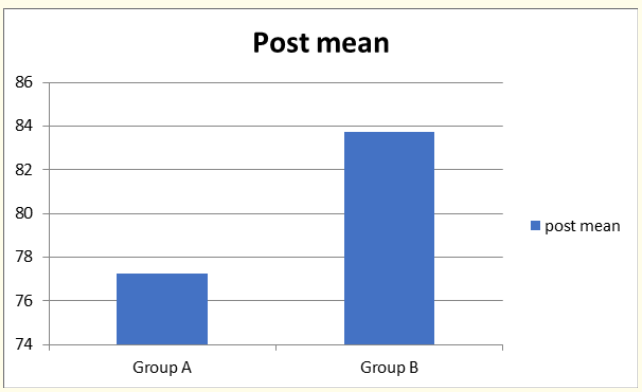
FEV1	Post mean	Post SD	P value	T Value	Improvement
Group A	76	3.596	<0.0001	9.528	Extremely significant
Group B	86.066	1.901			

Table 8: Comparison of post operatively FEV1 between group A and B.

FVC	Post mean	Post SD	P value	T value	Improvement
Group A	77.26	5.234	0.0002	4.307	Extremely significant
Group B	83.733	2.547			

Table 9: Comparison of postoperatively FVC between group A and B.

Table 9 shows that mean and SD of post operatively FVC in group A and B. The values were compared with unpaired t test. It shows that there is extremely significant difference.

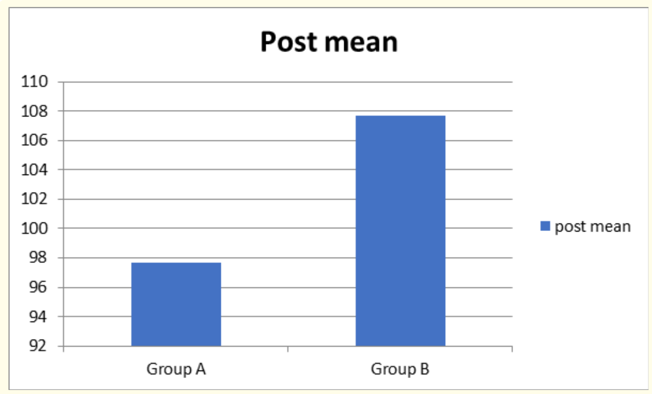


Graph 9: Shows mean of FVC post operatively in group A and B.

FEV_1/FVC	Post mean	Post SD	P value	T value	Improvement
Group A	97.66	10.487	0.0013	3.572	Very significant
Group B	107.68	2.839			

Table 10: Comparison of post operatively FEV_1/FVC in group A and B.

Table 10 shows mean and SD of post operatively FEV1/FVC between group A and B. The values were compared with unpaired t test. It shows that there is very significant difference.



Graph 10: Shows comparison of FEV1/ FVC mean post operatively in group A and B.

Discussion

This study shows that patient treated with incentive spirometer preoperatively and postoperatively is related to a lower incidence of pulmonary complication in coronary artery bypass grafting surgery patients. In our study the incidence of pulmonary complication for group A is 6.67% and for group B is 13.3% was similar to that detected by Johnson., *et al,* who reported an incidence rate of 20%.

Study showed that incentive spirometer combined with early mobilization had effects on lung function, rate of atelectasis, pain perception, and functional capacity after coronary artery bypass surgery. Although lung function decreased, functional capacity was well preserved after 6-days post operatively treatment program consisting of Incentive spirometry combined with mobilization.

The pulmonary functions after coronary artery bypass grafting severely reduced in both treatment groups on the seventh post-operative day, with pre-operative values. The reduction is similar to what have been shown in several previous studies on the fourth post-operative day after open heart surgery. The reasons for the restrictive impairment and atelectasis are multiple and include, besides the effects of anaesthesia, changes caused by mechanical alteration of the thoracic cavity, immobilization and pain. The reduction in lung volumes and expiratory flow rates impairs cough and clearance of secretions, and pain may reduce the ability to cough even more.

Most lung functions are interpreted by comparing the results with predicted or normal values. More complicated tests should be reported by the lung function laboratories, along with the values predicted. A number of different prediction equations are available but, although there is a broad agreement between these equations, they are not identical. Most are based on surveys of European and American populations conducted several years ago using equipment no longer used today. Lung function varies with age, sex and height and these are taken into account, but also it differs to some extent with race/ethnicity and weight which are often not accounted for. The predicted values may not accurately represent your local population, and certainly will be inaccurate for certain individuals in any population. There is also poor standardization of the 'normal' range given on reports. Sometimes only predicted value is given. In short, cautious have to be taken when interpreting the test solely in relation to the predicted values, if the test does not fall into a disease pattern.

Crowe and Bradley investigated effects of physiotherapy (mobilization, sustained maximal inspiratory manoeuvres, secretion removal manoeuvres, and supported coughing) combined with incentive spirometer which showed that FEV_1 and FVC decreased 50% of the pre-operative values on the second and third post-operative days of CABG surgery. Westerdahl., *et al.* found that pulmonary function reduced on the fourth post-operative day of CABG with 60- 75% of the pre-operative values.

In a recent systematic review, Pasquina., *et al*. reported that Vital capacity was 37-72% of pre-operative values in 11 trials and FEV_1 were 34-72% in eight trials of preoperative values for cardiac surgery. The reduction in pulmonary function in our study is similar to what have been shown in previous studies investigating the effects of physiotherapy treatment programs on the fifth post-operative day after open-heart surgery.

The best technique for lung expansion is claimed to be a maximal inspiration. A study by Rothen., *et al*. showed that during general anaesthesia an inflation to vital capacity was needed to reexpand virtually all atelectatic lung tissue. Unfortunately, after surgery, many patients are unable or unwilling to breathe deeply. There is some evidence that regular chest physiotherapy significantly decreases the incidence of pulmonary complications after thoracic surgery.

Some studies have shown that the addition of breathing exercise or incentive spirometry to early mobilization program has no extra benefit following uncomplicated coronary artery bypass surgery.

In a Westerdahl., *et al.* have found that performance of 30 deep breaths performed as deep breathing exercises, inspiratory resistance-positive expiratory pressure or blow bottle, decreased atelectatic area and increased aerated lung area in computerized tomography after cardiac surgery in 61 patients. They also showed a small increase in PaO_2 after deep breathing exercises.

In our study, we found that arterial oxygenation increased and $PaCO_2$ decreased significantly after a single incentive spirometry, and SaO_2 increased significantly after a single incentive spirometer session on the first post-operative day of coronary artery bypass grafting surgery. This finding revealed that incentive spirometer had a favourable effect on alveolar ventilation.

Numerous studies have been conducted to ascertain the pre operative risk profile of Coronary artery bypass grafting patients (Koch., *et al*. Aldea., *et al*. Higgins, Estafanous., *et al*.) to see the pre operative risk.

In the present study out of 30 patients 66.66% (20) male subjects and 33.33% (10) female subjects were taken. Ratio of male is higher due to females are less likely to go for angiography. This finding is similar to several international studies which showed a predominantly male population undergoing coronary artery bypass grafting patients. (Aldea., *et al.* Abramov, Zitser-Gurevich., *et al*.).

In our Study mean of age for group B who receive conventional chest physiotherapy treatment is 60.73 and for group A who receive incentive spirometer treatment is 58.8 with SD for group who receive conventional chest physiotherapy treatment is 8.36 and for group who receive incentive spirometer treatment is 8.19.Old age peoples are more prone for pulmonary complication because there is decrease vital capacity, airway sensitivity and clearance, decrease partial pressure of oxygen.

According to this study we had all stable angina patients are 100% (21) from which 3 patients had post operative pulmonary complication. Ischemia causes the muscle to release acidic substances, such as lactic acid, or other pain-promoting products, such as histamine, kinins, or cellular proteolytic enzymes, that are not removed rapidly enough by the slowly moving coronary blood flow. The high concentrations of these abnormal products then stimulate pain nerve endings in the cardiac muscle, sending pain impulses through sensory afferent nerve fibers into the central nervous system.

According to this study we have 26.67% (8) Myocardial infarction patients from which no one had post operative pulmonary complication. Cardiac muscle weakness caused by the myocardial infarction often causes the ventricle to dilate excessively. This increases the pathway length for impulse conduction in the heart and frequently causes abnormal conduction pathways all the way around the infracted area of the cardiac muscle (Guyton). The pumping ability of the heart is immediately depressed. As a result, two main effects occur :(1) reduced cardiac output and (2) damming of blood in the veins, resulting in increased venous pressure.

Study shows according to the BMI taken 56.66% (17) of coronary artery bypass grafting population is overweight from which 5.88% (1) patient had post operative pulmonary complication.10% (3) are obese from which 66.6% (2) patients had post operative pulmonary complication because patients had risk factor for complication, and 33.33% (10) patients had normal BMI. The body weight was measured without shoes using a weighing machine. Height was measured without shoes to the nearest 0.1 cm using inch tape. Measurements were used to compute the Body Mass Index (BMI) of patients by dividing the weight (Kilograms) by the square of the height (meters)/Weight in Kg

BMI = Height in m^2/Weight in Kg

As per WHO classification (for adult) BMI >25 is overweight and BMI >30 is obesity.

Anaesthetic management of the obese patient is problematic, and tasks such as establishing intravenous access, applying monitoring equipment, managing the airway, and transporting the patient are more difficult. Ventilation may be a particular problem because of obstructive sleep apnoea or because obesity itself imposes a restrictive ventilatory state with decreased expiratory reserve and vital capacity. Induction of anaesthesia is particularly challenging in the obese patient, as there is increased risk of pulmonary aspiration.

According to this study 36.66% (11) patients had history of Diabetic, 76.66% (23) patients had history of IHD, and 53.33% (16) patients had history of hypertension. Our study is similar to American study by Ferguson 32.7% had history of DM. Hypertension common in elderly pts, due to reduced vascular compliance. IHD caused by interruption of the blood supply to the myocardium, usually due to atherosclerosis of the coronary arteries (surgery at a glance). Patients with Diabetic are at an increased risk for perioperative myocardial ischemia, stroke, renal dysfunction or failure, and increased mortality and Increased wound infections and impairment of wound healing.

In this study there is no any patients were having personal history of smoking, Alcohol, Tobacco chewing. Studies conducted internationally have reported that smoking history is known risk for development of post operative pulmonary complication and increase mortality for the patients with coronary artery disease (Hulzebos., *et al.* Critchley and Capewell, Nakagawa., *et al*.) External factors like alcohol consumption increases myocardial consumption.

According to this study indication for Coronary artery bypass grafting surgery 36.67% (11) patients had Double vessel disease from which 9.09% (1) patient had post operative pulmonary complication and 63.33% (19) patients had Triple vessel disease from which 10.52% (2) patients had post operative pulmonary complication.

According to the scar length taken 50% of Coronary artery bypass grafting patients have scar length of 12 to 14 inches, 13.33% of Coronary artery bypass grafting patients have scar length of 14.1 to 16 and 18.1 to 20 inches each and 23.33% of Coronary artery bypass grafting patients have scar length of 16.1 to 18 inches.

According to Visual Analogue Scale mean for group A is 7.466 and group B is 7.333 with SD for group A is 1.20 and for group B is

0.67. Incision pain was measured by Visual Analogue Scale, (0-10, 0 indicates no pain, 10 indicates maximum pain). All participants completed the pain scale by indicating average pain level on post operative day 1.

When a patient undergoes surgery, tissues and nerve endings are traumatized, resulting in incision pain. This trauma overloads the pain receptors that send messages to the spinal cord, which becomes over stimulated. The resultant central sensitization is a type of post traumatic stress to the spinal cord, which interprets any stimulation painful or otherwise-as unpleasant. That is why a patient may feel pain in movement or physical touch in locations far from the surgical site. When pain is controlled or removed, a patient is better able to participate in activities such as walking or eating, which will encourage his or her recovery. Patients will also sleep better, which aids the healing process. Due to pain there is reducing chest expansion and reduce vital capacity.

Dyspnoea scale: Taken according to NYHA scale (New York Heart Association) scale before and after surgery.

- Grade 1: No symptoms with ordinary physical activity.
- Grade 2: Symptoms with ordinary activity, slight limitation of physical activity.
- Grade 3: Symptoms with less than ordinary activity. Marked limitation of activity.
- Grade 4: Symptoms with any physical activity or even rest.

The comparison of means and standard deviation was carried out using Student t-test paired and unpaired t test.

The patients who were treated with incentive spirometry showed extremely significant improvement and with conventional chest physiotherapy showed significant improvement in chest expansion.

The patients who were treated with incentive spirometer showed extremely significant difference in FEV_1 and FVC and significant difference in FEV_1/FVC in pulmonary function testing.

The comparison between both groups A and B post operatively showed extremely significant improvement in FEV_1 and FVC and very significant improvement in FEV_1/FVC.

The comparison between both groups A and B of chest expansion post operatively showed very significant improvement.

Summary

Randomized control trial study was conducted to study the effect of incentive spirometer verses conventional chest physiotherapy on pulmonary complications in coronary artery bypass grafting surgery patients. The study was conducted on 30 subjects. Subjects with on pump and off pump coronary artery bypass grafting surgery patients and both the sexes were included. The subjects were splitted into two groups with convenience sampling. A thorough examination was done. Pretest measurements of outcome variables were done which include chest expansion and pulmonary function testing on day 1 pre operatively and on day 7 post operative. Interventions were carried out 2 days pre operatively and 6 days post operatively. The results were derived by using statistical methods. Comparison between pre and expansion chest expansion pulmonary function testing has been done for group A and B using Paired test. Comparison of post operative chest expansion and pulmonary function testing has been done in group A and B using unpaired t test. The result shows that there is extremely significant difference in pulmonary function testing when incentive spirometer compared to conventional chest physiotherapy post operatively and very significant difference in chest expansion. The patients who were treated with incentive spirometry showed extremely significant improvement and with conventional chest physiotherapy showed significant improvement in chest expansion.

The patients who were treated with incentive spirometer showed extremely significant difference in FEV_1 and FVC and significant difference in FEV_1/FVC in pulmonary function testing.

The comparison between both groups A and B post operatively showed extremely significant improvement in FEV_1 and FVC and very significant improvement in FEV_1/FVC.

The comparison between both groups A and B of chest expansion post operatively showed very significant improvement. Study shows incentive spirometer training was significantly effective compared with conventional chest physiotherapy on pulmonary complications in coronary artery bypass grafting patients. Thus, the alternate hypothesis is accepted.

Conclusion

Based on statistical analysis for results and other evidences for research, the present study concluded that, incentive spirometer training was significantly effective compared with conventional chest physiotherapy on pulmonary complications in coronary artery bypass grafting patients.

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