

Effect of Positive Expiratory Pressure (PEP) Vs Routine Physiotherapy in preventing pulmonary complications following CABG - Results of a pilot study

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Abstract

Background: Chest physiotherapy is an established and routinely used therapy to prevent and treat post operative pulmonary complications after cardiac surgery. Positive expiratory pressure (PEP) is an expiratory resistance breathing exercise which has been incorporated into the routine post-operative regime after open heart surgery. The present study was aimed to evaluate and compare the efficacy of routine physiotherapy and PEP in preventing post-operative pulmonary dysfunction in patients undergoing CABG.

Methods: Subjects (n=18) who underwent elective coronary artery bypass grafting were included in the study. They were randomly assigned into 2 groups. Group 1 was given PEP therapy and Group 2 were administered routine chest physiotherapy. Arterial Blood Gas, PFT (FEV₁, FVC, PEFr,) SPO₂ and 2 min walk distance were measured pre and post cardiac surgery.

Data analysis and Results: 16 subjects completed the study. Fishers exact t test, Mann Whitney 'U' test and Wilcoxon Signed Ranks test were used compare the parameters between and with the groups. There was no significant difference in any of the outcomes between the groups.

Conclusion: Positive Expiratory Pressure clinically as well as statistically has equal effects in preventing postoperative pulmonary complications when compared with conventional physiotherapy.

Keywords: physiotherapy; Thoracic surgery; Coronary artery bypass graft; Post-operative pulmonary complications; Positive expiratory pressure; Breathing exercises; Incentive spirometry.

Introduction

Cardiovascular disease is the cause of steadily rising death rate in developed and developing countries. Cardiac surgery is widely used to treat patients with heart problems despite the numerous alternatives for the treatment of coronary artery disease, it has shown good mid and long term results, providing the remission from angina symptoms increasing the life expectancy and improving their quality of life.^{1, 2} Post cardiac surgery pulmonary dysfunction is one of the most important causes of morbidity and mortality

^{3, 4} Resulting in decrease in FRC leading to impaired gas exchange, arterial hypoxemia and increase in intrapulmonary shunt due to atelectasis related to the use of cardiopulmonary bypass.⁶

Chest physiotherapy is an established and routinely used therapy to prevent and treat post operative pulmonary complications after cardiac surgery. ^{2, 4} It includes airway clearance techniques, positioning, breathing exercises, incentive spirometry, early mobilization ^{5, 8} and several newer techniques like active cycle of breathing (ACBT), inspiratory muscle training (IMT), autogenic drainage (AD), positive expiratory pressure (PEP), flutter etc. ⁹ Postural drainage with percussion was the gold standard of chest physiotherapy for many years and was proved to be superior to breathing exercises in the 1950's. Recently PEP has been used in

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postoperative patients to enhance the function of the diaphragm and improve oxygenation.

Positive expiratory pressure (PEP) is an expiratory resistance breathing exercise which has been incorporated into the routine post-operative regime after open heart surgery in many Western Countries. It prevents or reduces alveolar collapse, mobilizes secretions, favors expectoration, improves inhalational muscle strength. ^{8, 10, 11, 12}

Strong scientific evidence is lacking as to the most effective chest physiotherapy technique for airway clearance post cardiac surgery. ^{5, 7, 8} some studies suggest that positive expiratory pressure (PEP) is more effective than conventional chest physiotherapy in post thoracic surgical patients. ^{10, 11}

The purpose of this study was to evaluate and compare the efficacy of routine physiotherapy and PEP in preventing post-operative pulmonary dysfunction in patients underwent CABG.

Methodology

Subjects posted for elective coronary artery bypass graft aged 50-70 years of males and females with More than 2 vessel diseases were recruited from Father Muller Medical College Hospital from February to September 2010. Subjects who had undergone Emergency Coronary Artery Bypass Graft surgery patients, Intraoperative or post operative Cerebral Vascular Accident, Hemodynamic instability and more than 24 hours of assisted ventilation post operatively were excluded from the study

Procedure

Informed consent was obtained from each patient, and the study was approved by the institutional ethical committee. Subjects were randomly assigned into 2 groups by using simple randomization procedure. In Group 1 subjects received positive expiratory pressure (Threshold PEP) and Group 2 subjects received conventional physiotherapy.

Routine protocol was used pre operatively which consisted of; patient education, general chest assessment and examination, pulmonary function test, preoperative physiotherapy and 2 min walk distance. Oxygen saturation was measured using a pulse oximeter in both groups.

Chest expansion was measured at the level of 2nd, 4th and 6th intercostal space using a tape measure. A minimum of 3 readings were taken and the best reading was recorded. The vitals of the subject at rest namely temperature, heart rate; respiratory rate and blood pressure were also noted.

Pulmonary function testing was performed pre and post operatively in upright sitting position. The instructions given to the subjects to perform pulmonary function testing were to place the mouth piece in the mouth and to form a tight seal with their lips without using their teeth to hold the mouth piece in place. All instructions were given by the same researcher throughout the procedure in the subject's language. Once the subject was familiar with the maneuver, the readings were recorded. They were made to perform three trials with adequate rest. The trials were repeated if the variation was more than 10%.

The 2 minute walk test was performed in an indoor premeasured of 30 metres. Subjects were asked to walk as far as they can in 2 minutes, back and forth along the corridor. No encouragement was given and no talking was allowed during the test. Immediately before and after the walk test, arterial oxygen saturation (SPO₂), heart rate (HR) and respiratory rate (RR) was measured. The distance walked (in meters) was recorded. ¹⁵

All the subjects were given adequate instructions about the surgical procedure they were to undergo.

Subjects of Group 1 were taught PEP. In this subject was made to sit comfortably and upright while holding the mouthpiece tightly between the lips. Expiratory resistor dial was adjusted according to patient's comfort. It was kept between 5-20 cm H₂O.

- The subject was asked to breathe from the diaphragm, taking in a larger than normal tidal breath, but not to total lung capacity.
- The subject was asked to gently exhale approximately 3 times longer than inhalation, maintaining a prescribed pressure of 0-20 cm H₂O as per patient's comfort.
- Subject performed 15 PEP breaths, followed by 2-3 splinted forced exhalation manoeuvres or huff. The procedure was repeated until secretions were cleared.

The subjects of Group 2 were taught SMI, deep breathing exercise with splinted huffing/coughing. They were made to perform the maneuver until they were familiar with it.

Postoperative physiotherapy

Postoperatively, Group 1 subjects received only Threshold PEP from 1st post operative day, 3 times a day and mobilization from 2nd post operative day.

Group 2 subjects received conventional physiotherapy; SMI, breathing exercises, splinted huffing /coughing and mobilization from 2nd post operative day.

Arterial blood gas, SpO₂, temperature, respiratory rate, auscultation changes and chest radiography were analyzed to document the occurrence of postoperative pulmonary complications.

Measurements

On the sixth postoperative day, oxygen saturation (SpO₂), respiratory rate, pulse rate, blood pressure and temperature, pulmonary function tests and 2 minute walk test were repeated in both the groups. This was compared with the baseline readings (preoperative readings) to document the occurrence of PPCs. Data was entered in the data collection form.

Data analysis

The software programme used for data analysis was SPSS 13. Demographic data of

Fig 1. Subject performing post op PEP



Fig 2. Ambulating on POD2

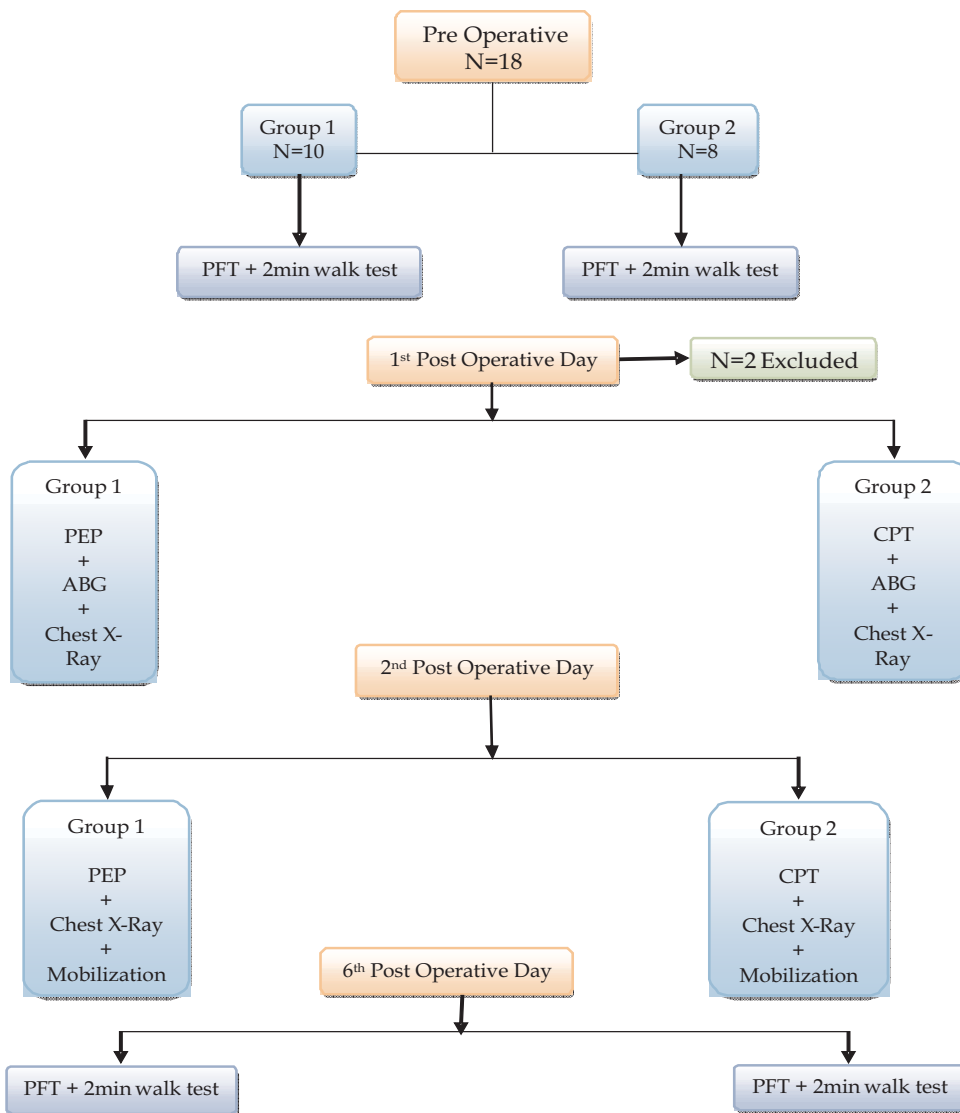


both the groups were analyzed by using Fishers Exact Test. Pulmonary function test parameters, SpO₂ and chest expansion measurements within the group were analyzed by using Wilcoxon Signed Ranks test. Analysis of pulmonary function tests between the groups was done by using Mann Whitney 'U' test. Probability values of less than 0. 05 were considered significant.

Fig 3. Perfoming SMI



Fig 4. Flow chart of methodology



Results

Sixteen subjects completed the study with 1 female and 15 male. There were 10 in PEP group and 6 in Conventional PT group. The mean age in PEP group was 54.70 ± 5.6 SD and 64.6 ± 10 SD in Conventional Physiotherapy group. The average BMI of the subjects was 23.1 ± 2.0 SD in PEP group and 22.1 ± 2.8 SD in Conventional PT group.

For male and female in both the groups the Fishers exact test showed $p=0.625$ and for the grafts used in both the groups Fishers exact test showed $p=0.837$, which showed no significant difference between the groups in the demographic data.

Chest Xray and Oxygen saturation

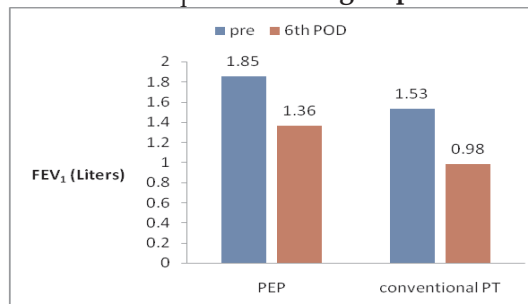
No significant difference was seen in pre and post operative Chest X-rays and Oxygen saturation when compared between the groups.

Pulmonary Function Test

Wilcoxon Signed rank test was used to analyze the significance of reduction in pulmonary function test values from pre operative to 6th post operative day. For FEV1 the Wilcoxon Signed rank test showed a value of 1.48 ($p=1.39$) in PEP group and 2.0 ($p=0.46$) in Conventional PT group, For FVC the test showed a value of 0.46 ($p=0.64$) in PEP group and 1.21 ($p=0.22$) in Conventional PT group and For PEFR the test showed a value of 1.27 ($p=0.20$) in PEP group and 1.63 ($p=0.10$) in Conventional PT group which was not significant.

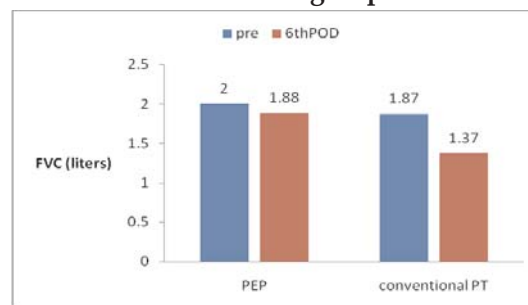
There was no significant change in pulmonary function when compared between the groups postoperatively.

Fig 5. Comparison of pre and post operative FEV₁ between the groups



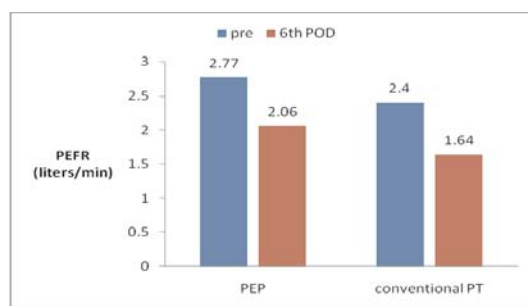
There was no significant reduction in FEV₁ when compared between the groups.

Fig 6. Comparison of pre and post operative FVC between the groups



There was no significant reduction in FVC when compared between the groups.

Fig 7. Comparison of pre and post operative PEFR between the groups



The demographic data are shown

	Conventional group				PEP group			
	Number	Minimum	Maximum	Mean	Number	Minimum	Maximum	Mean
	6				10			
AGE		50	74	64.6		46	62	54.70
Sex	0 Female	0	0	-	1 Female	1	1	-
	6 Male	6	6	-	9 Male	9	9	-
BMI	-	18.0	29.0	22.16	-	19.7	26.2	23.11

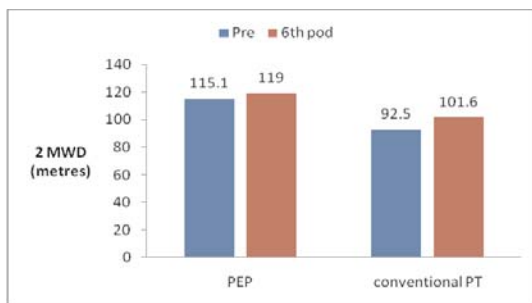
No significant reduction in PEFr was seen when compared between the groups.

There was no significant change in pulmonary function test values between the groups when compared postoperatively.

Two Minute Walk Test

There was no significant change in 2 minute walk distance between the groups when compared postoperatively.

Fig 8. Comparison of 2 Minute Walk Distance between the groups



Discussion

Postoperative physiotherapy is known to improve respiratory mechanics, decreases the incidence of PPCs and shortens length of hospital stay^{2, 5}. But strong scientific evidence is lacking as to the most effective chest physiotherapy technique for airway clearance post cardiac surgery^{7, 9, 11}.

Therefore, this study aimed to compare the effect of positive expiratory pressure as compared to conventional physiotherapy on post operative pulmonary function in CABG. PEP was used in this study as it has been proven that, it helps to slow the emptying of lungs and increases lung volume, prevents or reduces alveolar collapse, mobilizes secretions and favors expectoration^{8,10,13}. It also helps in improving inhalational muscle strength. Both the groups were also mobilized early (on 2nd POD).

This study was completed within 8 months, therefore the sample size was too small and two subjects from group were lost because of untoward events. Therefore this study

strongly prove or disprove the hypothesis that was put forth.

Ninety percent of the subjects in PEP group were male as opposed to the Conventional group where 100% were male. The mean age in PEP group was 54.7 ± 5.6 SD and BMI was 23.1 ± 2.0 SD while in Conventional group it was 64.6 ± 10 SD and BMI was 22.1 ± 3.8 .

Comparing both groups 87.5% presented with normal chest x- rays pre operatively, 100% showed abnormal chest x - ray on 1st POD as opposed to 93.8% normal chest x-rays on 6th post operative day. This could be attributed to the positive effects of PEP which prevents or reduces alveolar collapse, mobilizes secretions and favors expectoration¹¹ conventional physiotherapy also had a similar effect.⁸

All the subjects presented with abnormal values of FEV1, FVC and PEFr pre operatively which had increased to near pre operative levels on the 6th POD. PEFr values were highest in the PEP group on the 6th POD as compared to the conventional group. This could be because PEP exerts a positive pressure during expiration slows the emptying of lungs and therefore increases lung volume.^{11, 12} On the other hand the SMI that was administered to the conventional physiotherapy group aids in lung expansion while DBE reduce atelectasis.^{13, 16} This could be the reason the PFT values also increased in this group.

Sixty percent of the subjects in PEP group and 83.3% subjects in Conventional group had more than four grafts. While only 20% patients in PEP group had three grafts. IMA graft was used in 100% of the subjects. The numbers of grafts used do not predict post operative outcomes.¹ No significant graft related post operative pulmonary complications were seen in any subject from either group.

Hypoxemia post surgically is well documented.⁴ Both the groups had hypoxemia but it was not statistically significant. 60% of the subjects were administered with Oxygen through face mask till the 2nd POD. Post operative physiotherapy recruits lung tissue and this tissue is converted to from a shunt

region to a zone with low ventilation in relation to perfusion, thus increasing the oxygenation of blood.¹⁴

Altered respiratory mechanics, pain and weak cough reflex normally cause a decrease in thoracic expansion post CABG.^{2,3} Respiratory physiotherapy uses techniques capable of improving respiratory mechanics, pulmonary re - expansion and bronchial hygiene.¹⁰ This could possibly explain why the chest expansion values in this study did not decrease despite surgical trauma.

The 2MWD is a measure used to assess functional capacity or ADLs after cardiac surgery. Test values are sensitive to change after cardiac surgery.¹⁵ In this study the distances walked after surgery was improved in both the groups. This is not in accordance with the literature but could be due to chest physiotherapy and early mobilisation which has been proven to have a positive effect in improving functional capacity.¹²

This study was mainly done to demonstrate the efficacy of PEP and conventional physiotherapy and to compare the two techniques in the management of patients who have undergone CABG.

Though there was no statistically significant difference in all the parameters used in this study, the PEP group improved clinically when compared to the conventional physiotherapy group. This shows that PEP has a positive effect in preventing PPCs.

Limitations of the study

Postoperative pain was not quantified by means of any subjective pain scale. Since this study shows that PEP is as effective as Conventional Physiotherapy, a similar kind of study with a larger sample size should be undertaken to find out the real efficacy of PEP. Blinding the therapist who administers the techniques and measures the outcomes would also improve the quality of the study.

Clinical Implications

PEP may be an effective technique in preventing PPC in patients with preoperative risk factors or who develop complications after cardiac surgeries, provided they are trained with the technique preoperatively.

Conclusion

PEP clinically as well as statistically has equal effects in preventing postoperative pulmonary complications when compared with conventional physiotherapy. More studies in patients with preoperative risk factors should be undertaken to find out the efficacy of PEP in preventing postoperative pulmonary complications.

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Conflict of Interest: None

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