

Comparative Study on Effects of Active Cycle of Breathing Technique and Manual Chest Physical Therapy after Uncomplicated Coronary Artery Bypass Grafting Surgery

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ABSTRACT

Purpose: Pulmonary functions tend to alter after surgeries related to cardiovascular system. This study is designed to compare the effects of Active Cycle of Breathing Technique (ACBT) and Manual Chest Physical Therapy (MCPT) along with incentive spirometry (IS) on pulmonary function after normal Coronary Artery Bypass Grafting (CABG) surgery.

Materials and methods: Thirty subjects for elective CABG with the age group of 30 to 65 years were randomly assigned to two groups. Group I received treatment of ACBT along with IS and group II received treatment of MCPT along with IS. Arterial oxygen saturation (SpO₂), respiratory rate (RR), breath-holding time (BHT), partial pressure of oxygen (PaO₂), and partial pressure of carbon dioxide (PaCO₂) were recorded on first postoperative day before treatment and fourth postoperative day after treatment with physiotherapy maneuvers.

Results: To compare between the groups, independent paired t-test was performed, while paired t-test was performed to compare all the variables within each group. Significant difference was found in SpO₂ ($p = 0.003$, $p < 0.05$) and PaO₂ ($p = 0.011$, $p < 0.05$) with MCPT+IS, and significant difference was found in BHT ($p = 0.000$, $p < 0.05$), RR ($p = 0.001$, $p < 0.05$), and PaCO₂ ($p = 0.007$, $p < 0.05$) with ACBT+IS.

Conclusion: Results of this study suggest that both ACBT and MCPT techniques are effective along with IS in postoperative pulmonary functions. Specifically, MCPT is more effective for SpO₂ and PaO₂, while ACBT is more effective with BHT, RR, and PaCO₂.

Keywords: Active cycle of breathing technique, Breath-holding time, Incentive spirometry, Manual chest physical therapy, Respiratory rate.

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INTRODUCTION

Coronary Artery Bypass Grafting

Coronary artery bypass grafting is a surgery used to treat blocked and narrowed arteries that supply blood to the heart. This is accomplished by bypassing the blocked artery from a healthy vessel called "graft" which is harvested from the leg, arm, or chest. A CABG can be either emergent or elective. Emergent CABG surgery is done in acute heart attack, while elective surgery is done when conservative treatment measures have failed to relieve symptoms like chest pain and dyspnea following coronary artery disease.^{1,12}

POSTOPERATIVE COMPLICATIONS

Bleeding

Significant bleeding is reported in approximately 2 to 3% of patients, which may lead to profound hypotension or acute cardiac tamponade.¹²

Arrhythmias

Sinus tachycardia is the most common arrhythmia closely followed by atrial fibrillation. It may occur approximately in 30% of patients after CABG and often reverts to sinus rhythm spontaneously.¹²

Low Cardiac Output State

Low cardiac output state generally occurs in the first few hours after cardiac surgery, probably due to reperfusion/ischemia injury, often requiring inotropic agents to support the heart and its circulation. The clinical manifestation of these situations includes poor peripheral

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perfusion with poor urine output, low blood pressure, and a developing metabolic acidosis.¹²

Atelectasis

This is also known as the collapse of the complete lung or part of a lung, when there is loss of ventilation and decreased lung expansion.² Inhaled foreign body, a mucus plug, or an endobronchial tumor are most frequent risk factors for the atelactatic lung.²

Consolidation

In this condition, air in the alveolies is replaced by the products of the disease, such as water, pus, or blood.³ Localized areas of consolidation occur usually due to infection. Cardiogenic pulmonary edema can also be the reason for the consolidation.^{4,12}

Pleural Effusion

Approximately 10% of the patients who undergo CABG surgery generally develop a small, left-sided pleural effusion in the first few days postoperatively.⁵

METHODS AND MEASUREMENTS

A convenient sample of 30 subjects with the age range of 30 to 65 years scheduled to undergo CABG surgery were included in the study and personal consent was obtained from every individual subject. A sample of 30 patients was collected from the CTVS department of Mahatma Gandhi hospital, Jaipur, who have undergone CABG surgery, after obtaining informed consent.

Sampling Method: Random Sampling

Thirty subjects will be divided into two groups (15 each).

Group I: experimental group and group II: control group.

Group I received ACBT and IS.

Group II received MCPT and IS.

Research Design: Comparative Study Procedure

All subjects were randomly assigned to two groups who met with the inclusion criteria. Fifteen subjects (13 male + 02 female) were included in group I and they received treatment of ACBT along with IS, and 15 subjects (12 male + 03 female) in group II received treatment of MCPT along with IS. All subjects were explained physiotherapeutic maneuvers and interventions before surgery.

Subjects in group I were comfortably positioned in a long sitting position with back completely straight with the help of back support and made to do IS on their own and perform ACBT in supervision of a physiotherapist who

kept instructing the maneuver step by step. Instructions were given to patients to hold the spirometer in front of the face uprightly and asked to inhale slowly and to raise the balls in chambers and maintain them for 2 to 3 seconds. To perform ACBT, patients were asked to do prolonged expiration slowly, but not forcefully, 5 to 7 times to get breathing control; after that, they were asked to inhale deeply with mouth closed carefully so that we can emphasize nasal breathing, simultaneously avoiding the accessory muscle work.^{6,7} Patients were asked to hold breath initially for 3 to 4 seconds and till the third postoperative day, the BHT was gradually increased to the maximum, yet comfortable for the patient. After that, patients were asked to huff 2 to 3 times and then asked to cough 2 to 3 times. Coughing should be supported by keeping the hands over the incision site or by the use of a chest binder. This cycle was repeated minimum two times and maximum three times in one therapeutic session. Two sessions of the treatment were performed on first, second, and third postoperative days. It means that patients were going for six sessions of treatment individually during the study. Data were collected on the first postoperative day before starting the treatment and on the fourth postoperative day, which determines the effect of treatment on the third postoperative day.

Subjects in group II were positioned in supine with head raised to 30 degrees. Firstly, patients were checked for the incision site, the site for the chest tubes to avoid pressure over that area. The physiotherapist applies manual chest vibration all over the lung fields over the chest bilaterally and manual chest shaking with a moderate force with the patient in supine position.⁸ Chest percussions were applied over posterior chest in long sitting position with slightly forward bending of the back.^{9,11} The instruction for the IS was the same as in group I and data collection was also followed in the same way as in group I subjects.

DATA ACQUISITION AND MEASUREMENT

Subjects included in the study were measured for SpO₂ with the measurement of FiO₂, RR in 1 minute, and maximum BHT in seconds. Measurements of PaO₂ and PaCO₂ were done using the arterial blood gas (ABG) analysis report according to the preoperative and postoperative days. All the treatment sessions were performed under supervision and at the same time of the day. All the usual medications were administered during the course of the study.

Following dependent variables were collected before treatment and after treatment on the fourth postoperative day.

SpO₂: The content of oxygen, combined with hemoglobin in the arterial blood, was measured with a standard pulse oxymeter.

F_iO_2 : Measured from medical oxygen flow (air pressure) meter regulator.

Respiratory rate: Recorded as an observation of number of thoracic excursions for 1 minute.

PaO_2 : Partial pressure of oxygen in arterial blood measured from the ABG analysis report.

$PaCO_2$: Partial pressure of carbon dioxide in arterial blood measured from the ABG analysis report.

Breath-holding time: Patients' capacity for holding the breath for a maximum time was measured in seconds with the help of a stopwatch.

DATA ANALYSIS

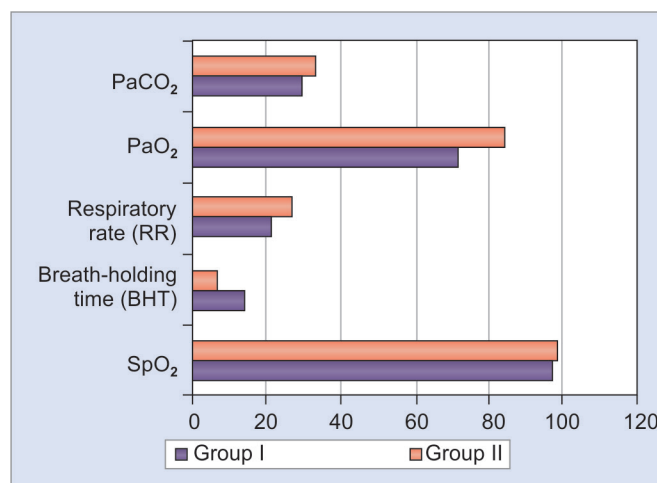
Paired t-test was used to compare the effectiveness of treatment in O_2 saturation, RR, BHT, PaO_2 , and $PaCO_2$ in each group before and after treatment.

Unpaired t-test was used to compare the effectiveness of the two different chest physiotherapy techniques; for group I, there is ACBT+IS and for group II, there is MCPT+IS.

DISCUSSION

Our study was designed to compare the combination of ACBT+IS and MCPT+IS for their effects on the variables like SpO_2 , RR, BHT, PaO_2 , and $PaCO_2$. The present data suggest that there is a significant difference in SpO_2 and PaO_2 with the treatment of MCPT+IS (group II) and there is a significant difference in RR, BHT, and $PaCO_2$ with the treatment of ACBT+IS (group I) (Table 1 and Graph 1). The ACBT and MCPT are both combined with the IS, and hence, we can say that in our study, decrease in SpO_2 is avoided with the IS and additionally MCPT +IS has given much significant result compared with ACBT+IS for the SpO_2 and PaO_2 .

ACBT has found a significant difference in RR, BHT, and $PaCO_2$; the reason behind this can be the thoracic expansion exercises while holding of breath, which resulted in increased airflow to the obstructed areas of the lung and helped better secretion removal. The forced expiratory technique or huffing aims to bring the secretions upward and activate the cough reflex. As ACBT is combined with IS, there are also the beneficial effects of IS for the significant results. The removal of secretions



Graph 1: Comparison of SpO_2 , RR, BHT, PaO_2 , and $PaCO_2$ between groups I and II

is always associated with improvement in the arterial oxygen saturation and this improvement results in improvement in PaO_2 .

A marked improvement in SpO_2 is noted with both treatment maneuvers, but the maneuver of MCPT+IS has shown much significant results compared with the maneuver of ACBT+IS. However, both values are within the normal limits (normal value, 90–100%).

There were significant improvements in the BHT of individual subjects with both maneuvers, but ACBT+IS has shown much improved results compared with the maneuver of MCPT+IS.

A marked improvement in PaO_2 was noted with both the maneuvers of MCPT+IS compared with the maneuver of ACBT+IS (normal value, 80–100 mm Hg).

A marked improvement in $PaCO_2$ was noted with both the maneuvers, ACBT+IS compared with the maneuver of MCPT+IS. There was a significant reduction in $PaCO_2$ in both groups. A marginal significant change was found in the mean difference postoperatively in group I when compared with group II. The measurement of $PaCO_2$ helps to maintain the homogeneity in the subjects (normal value, 30–35 mm Hg).¹⁰

We found that PaO_2 increased and $PaCO_2$ decreased significantly after the ACBT maneuver, and SpO_2 increased significantly after an IS intervention on the first postoperative day of CABG. These findings concluded that both ACBT and IS had much similar and favorable

Table 1: Comparison of mean and standard deviation values for outcome measures between group I (n = 15) and group II (n = 15) after treatment

Outcome measures	Mean ± SD for group I (n = 15)	Mean ± SD for group II (n = 15)	p-value unpaired t-test
SpO_2	97.1333 ± 0.915475	98.86667 ± 1.884776	0.003
BHT	14.09533 ± 1.688798	6.442667 ± 1.331613	0.000
RR	21.53333 ± 2.020263589	27.06667 ± 5.560918	0.001
PaO_2	71.73333 ± 14.22004	84.40133 ± 10.98643	0.011
$PaCO_2$	29.56 ± 3.500979	33.34 ± 3.57	0.01

effect on increasing alveolar ventilation. Improvements in PaO₂ and PaCO₂ are the markers of the improved ventilation, and improvement in RR and BHT can be related to diaphragmatic efficiency, and SpO₂ shows improvement in oxygenation.¹⁰

CONCLUSION

The results suggest that the combination of ACBT+IS is more effective in improvement of BHT, RR, and PaCO₂. The combination of MCPT+IS is more effective in the improvement of SpO₂ and PaO₂ provided that the patient does not have any complication after the CABG surgery. In any case, if patients develop chest infection or other complications, then some additional interventions will be administered. The implications of our findings are that a physiotherapist helps and encourages patients for any of the chest physiotherapy protocol in normal patients after surgery and it can be used without any preference to the type of subjects.

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