ORIGINAL ARTICLE

ACTIVE CYCLE OF BREATHING TECHNIQUES IMPROVES POST-OPERATIVE PULMONARY COMPLICATIONS IN CORONARY ARTERY BYPASS GRAFT SURGERY PATIENTS

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Objectives: To determine effects of active cycle breathing technique (ACBT) on pulmonary function of post coronary artery bypass Graft surgery (CABG) patients.
Methodology: A randomized control trial was conducted with a sample size of 40 post CABG patients from September 2018 to January 2020. Vitally stable both male and female post CABG Consecutive patients of age bracket 30-65 years were included in study. Two groups were made by randomization through sealed envelope method. Patients in ACBT group (n=20) did ACBT whereas control group (n=20) performed deep breathing exercises along with conventional treatment. Lung volumes & capacities, vitals (heart rate, respiratory rate, oxygen saturation and blood pressure) and chest expansion were assessed at baseline and on fifth post-operative day. Data was analyzed using SPSS version 21.
Results: Out of all the 40 patients 26 (65%) were males and 14 (35%) were females with the mean age of 53±7.9 years in conventional and 56±5.9 years in group performing ACBTs. There was significant improvement in Forced Expiratory Volume (FEV1) and chest expansion ($p \leq 0.05$) of ACBT group. However, within group analysis revealed significant improvement in all parameters of both groups ($p<0.01$).
Conclusion: Active cycle breathing technique has beneficial effects in improving FEV1 and chest expansion as compared to traditional physical therapy in post CABG patients during phase I of cardiac rehabilitation.
Keywords: active cycle of breathing technique, chest expansion, coronary artery bypass graft, forced expiratory volume in 1sec, forced vital capacity, peak expiratory flow rate

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INTRODUCTION

Coronary artery bypass graft (CABG) is a well-known procedure for revascularization of coronary arteries in patients with multi vessel coronary disease.[1] CABG is a surgical procedure in which obstructed coronary arteries which are fully or moderately congested by atherosclerotic plaque are replaced with autologous arteries and veins used as implant.[2] Worldwide 100 million CABG procedures are performed annually. This is similar to the increasing trend in Pakistan with the number of surgeries reaching up to 20,000 surgeries in 2016.[3]

Post CABG mortality has been reduced due to surgical advancement and also significant improvement in outcome during and post hospital discharge period.[4]

Post-operative complications reduce the process of progressive recovery which eventually leads to increased hospital stay in CABG patients. The impact of general anesthesia as well as surgical trauma leads to multiple post-operative complications including cardiac, neurological, pulmonary, musculoskeletal, renal, and wound. Pulmonary complications include reduced chest expansion, decreased lung volumes and capacities, atelectasis, and respiratory muscle dysfunction leading towards pleural effusion, pneumonia, pulmonary embolism, acute respiratory distress syndrome, phrenic nerve injury, thoracic incision infection and mediastinitis.[5,6] Pulmonary complications can increase the risk of morbidity and mortality after CABG surgery. There are multiple pre-operative, peri-operative and post-operative factors that play a significant role in the development of these complications. Atelectasis is the most common reason to develop dyspnea, followed by pleural effusion and pneumonia. Literature suggests that patients who develop respiratory complications have prolonged stay in the intensive care unit (ICU). [7]

Literature reports, chest physiotherapy has the potential to reduce severity of post-operative pulmonary complications. Chest physiotherapy techniques like clearance of chest secretions and increasing chest expansion in the ICU can evade respiratory complications like pneumothorax, atelectasis, and pulmonary secretions retention in CABG surgery patients.[8] The traditional chest

physiotherapy treatment includes chest percussions, tissue blowing exercises, deep breathing, spirometer exercises and huffing and coughing techniques to remove the secretions from the lungs.[8] The goal of physiotherapy in CABG patient is to increase lung volume, enhance ventilation–perfusion matching, accelerate the sputum clearance, and decrease pain.

Active Cycle Breathing Technique (ACBT) is a chest clearing technique to remove secretions from the chest to reduce the occurrence of chest infection, thus controlling the additional airway impairment and worsening of lung functions and reducing overall respiratory complications.[9] In ACBT, a cycle of breathing control and deep breathing exercises along with huffing and coughing is followed to remove the secretions from the lungs. Patient can follow this cycle effortlessly as compared to traditional physiotherapy which have no specific pattern of exercises. [10]

ACBT treatment has been proven to be effective for chest clearance in stable cystic fibrosis, Chronic obstructive pulmonary disease, and other respiratory diseases for sputum clearance.[11] For the prevention of post-operative pulmonary complications after open heart surgeries, various interventions are being used. There is limited evidence on effect of ACBT on pulmonary function and complications in Post CABG patients. The current study aims to gather scientific evidence on the effects of ACBTs in preventing chest complications and improving lung function in post-operative CABG patients.

METHODOLOGY

This single blinded randomized control trial was conducted on 40 post CABG patients at Faisalabad Institute of Cardiology from September 2018 to January 2020. The trial is registered with ClinicalTrials.gov Protocol Registration and Results System number NCT04307316. Ethical approval was taken from the Research Ethics Committee of Riphah International University, Islamabad in accordance with the principles of Declaration of Helsinki. The sample size (n=40) was calculated through Open-epi calculator with 95% confidence interval (CI; 2 sided), power 80% and 1:1 ratio of the inter-group using the variable of forced vital capacity. Hemodynamically stable post CABG consecutive patients with vitals falling in normal ranges, both genders of age bracket 30-65 years were included in the study. Out of the 54 approached subjects, 43 were eligible for the study. Hemodynamically unstable patients, patient with re-opening of sternum and infected patients were excluded. Sealed envelope method was used to allocate the participants into two groups. Patients in the experimental group performed ACBTs along with the conventional treatment protocol and patients in control group were given the conventional physical therapy treatment plus deep breathing exercises in replacement of ACBTs. Out of 43, 40 patients completed the protocol with the drop out of 3 patients because of loss to follow up owing to development of complications. The exercise program was carried out for 5 days with 2 exercise sessions done on daily basis. Assessment of lung volumes and capacities including Forced Vital Capacity (FVC), Force Expiratory Volume in 1 second (FEV1) and Peak Expiratory Flow Rate (PEFR) was made through digital Spirometer (SP10). Rate of perceived exertion was assessed through Borg scale of dyspnea and measuring tape was used for assessment of chest expansion at baseline as well as 5th post-operative day. Vitals were also monitored continuously before and after every session of phase I cardiac rehabilitation. Data was analyzed on SPSS version 21. Normality of the data was checked using Shapiro Wilk test which showed that FEV1 and FVC were normally distributed, therefore Independent T test was applied for between group comparison and paired sample T test for within group differences. There was non-normal distribution of PEFR, RPE and chest expansion, therefore Mann Whitney U test was applied for between group and Wilcoxon signed rank test for within group changes.

Table 1: Shows the details of intervention in active cycle breathing technique (ACBT) and control group

ACBT group	Control group
Standardized protocol including: • Chest percussions, • Tissue blowing exercises, • Incentive spirometer • Cough techniques **ACBT** including Breathing control, Deep breathing and Huff and Cough techniques.	**Standardized protocol** including: • Chest percussions, • Tissue blowing exercises, • Incentive spirometer • Cough techniques Deep breathing exercises
Time: 20mins	Time: 20mins
Frequency: twice a day	Frequency: twice a day
Duration: 5 days	Duration: 5 days

RESULTS

Out of all the 40 patients 26 were males and 14 were females. Mean age of participants in conventional treatment group was 53±7.9 years and that in group performing ACBTs was 56±5.9 years. Inferential statistics concluded that although there was significant improvement ($p<0.001$) in lung volumes and capacities and vitals along with decrease in rate of perceived exertion in both groups. However, between group analysis revealed greater improvement ($p<0.05$) in FEV1 and chest expansion of participants performing ACBTs as compared to the participants undergoing conventional physical therapy treatment. (Table 2, 3) Vitals of the patients in both groups also improved significantly with the intervention. (Figure 1).

Table 2: Showing descriptive statistics for demographic variables in Control and ACBT group

	Control	ACBT
Age (Years)	53 ± 7.9	56 ± 5.9
Height (cm)	167.3 ± 10.8	165.5 ± 8.7
Weight (kg)	76 ± 8.7	75 ± 5.8
Gender		
Females	6 (30%)	8 (40%)
Males	14 (70%)	12 (60%)
Smoking		
Yes	9 (43%)	8 (60%)
No	11 (55%)	12 (40%)
Diabetes		
Yes	12 (60%)	11 (55%)
No	8 (40%)	9 (45%)

Table 3: Shows the pre (baseline) and post (endline) values for comparison within control and ACBT group and End line comparison between control and ACBT group

	Control group			Treatment group			End line comparison		
	Baseline	Post-treatment	P-value	Baseline	Post-treatment	P – value	Control	ACBT	P value
Forced vital capacity (liters)	1.19 ± 0.23	2.63 ± 0.23	<0.001	1.21 ± 0.17	2.69 ± 0.16	<0.001	2.63 ± 0.23	2.69 ± 0.16	0.34
Forced expiratory volume in 1st second (liters)	1.19 ± 0.23	2.57 ± 0.21	<0.001	1.20 ± 0.16	2.69 ± 0.17	<0.001	2.57 ± 0.21	2.69 ± 0.17	0.05
Chest expansion (cm)	103 ±7	107 ± 5.75	<0.001	98 ± 2	104 ± 3.15	<0.001	104 ± 5.75	107 ± 3.15	0.047
Rate of perceived exertion	3.00 ± 2	8.00 ± 0.00	<0.001	3.00 ± 1.75	8.00 ± 1.75	<0.001	8.00 ± 0.00	8.00 ± 1.75	0.09
Peak expiratory flow rate (L/min)	5.46 ± 1.25	5.49 ± 1.63	<0.001	8.40 ± 1.11	8.50 ± 1.11	<0.001	5.49 ± 1.63	8.50 ± 1.11	0.15

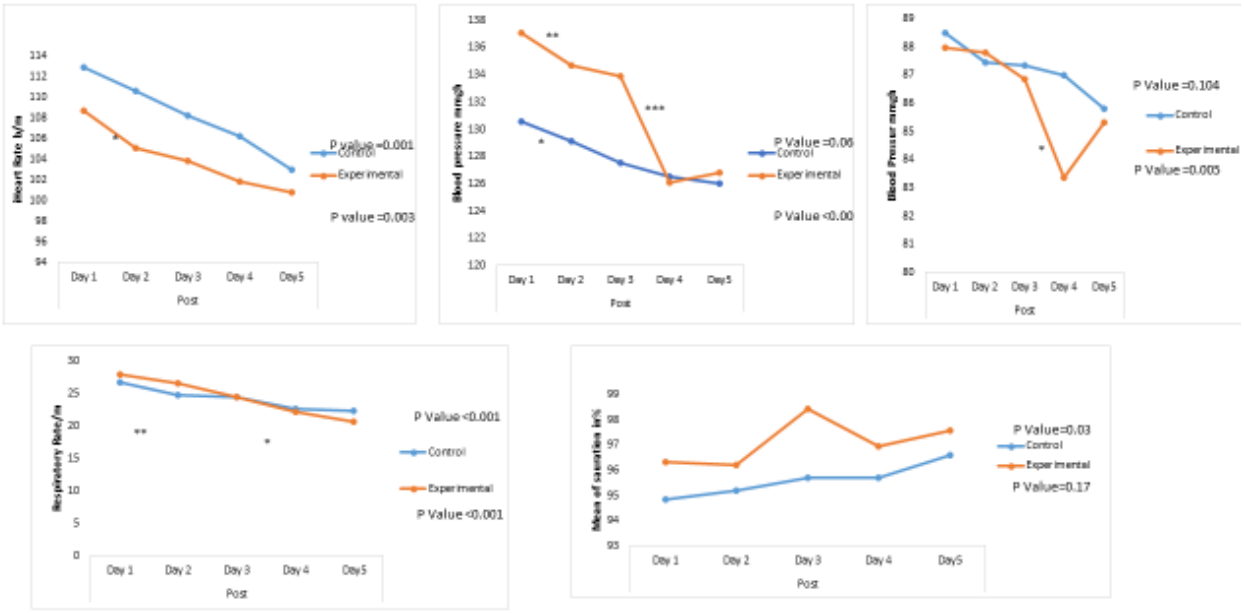

Figure 1: Line chart showing heart rate, systolic and diastolic blood pressure, respiratory rate and oxygen saturation of control and experimental groups

DISCUSSION

This study demonstrates that active cycle breathing technique along with conventional chest physical therapy protocol has positive effects on pulmonary functions of patients after CABG surgery. The improvement in pulmonary function is demonstrated by the increase in FEV1 and chest expansion in ACBT group after five days of treatment in phase I cardiac rehabilitation. All the other study variables were improved significantly in both the groups.

In the current study, ACBT along with conventional treatment improved FEV1 in post CABG patients. There was a significant improvement of FEV1 from baseline to 5th day after treatment. In 2016, Pallavi Wange et all studied the effects of ACBTs and spirometer on flow rate and chest expansion in abdominal surgery patients and found that ACBT improved the FEV1 in abdominal surgery patients as well ($p < 0.001$). [12]

There was a significant statistical and clinical improvement in chest expansion of both the groups signifying that the deep breathing in ACBT might be effective for improving the chest expansion of patients in experimental group. Similar results were found when ACBT was compared to incentive spirometry in post CABG patients and because both interventions promote deep breathing, this might be the reason for better improvement of chest expansion in ACBT as compared to control group.

The findings of this study indicate that the level of dyspnea tend to decrease ($p < 0.05$) with ACBT as well as conventional treatment. Same results are observed in a randomized control trial conducted by Yasemin Çırak, to assess the effects of chest physiotherapy techniques on post CABG surgery complications. Three different exercise protocols were used in that study and overall level of dyspnea was decreased in all groups but there was no difference in the rate of perceived exertion of the three groups.[14] In current study, there was decrease in level of dyspnea in both the groups.

Similar to the results of current study, Salehi Derakhtanjani, Ahmad et al. in 2019 proved that ACBT and routine chest therapy had similar effects on patients. However, there was an abnormal increase in respiratory rate on 2nd post-operative day which was in contrast with our results where the respiratory rate decreased in post-operative days. [15]

Overall, the ACBT along with conventional physiotherapy treatment has been proven to be effective for improving FEV1 and chest expansion in phase 1 rehabilitation of post CABG patients. However, there are some limitations of this study. The chest expansion was measured only at xiphoid level after treatment not on 3 levels (axillary, xiphoid and umbilical). Secondly, patients were given supplementary oxygen post operatively and the amount of oxygen given, and its weaning pattern was not recorded which may lead to variability in results. Also, participants were observed for the effects of treatment for 5 days only. Future studies may be conducted considering the given limitations and conducting the trial for a longer duration of time to study long term effects of the same interventions during phase II and III of cardiac rehabilitation.

CONCLUSION

This study concluded that ACBT is better in effects as compared to conventional protocol for improving FEV1 and chest expansion of the post-operative CABG patients. However, both ACBT and conventional physical therapy are effective for improving overall pulmonary function and vitals of post CABG patients during phase 1 cardiac rehabilitation.

AUTHORS' CONTRIBUTION

MNH: concept and design, data collection, write up, agreement to be accountable. SS: concept and drafting the work, critical revision, data analysis and interpretation, agreement to be accountable. AR: data interpretation, critical review, agreement to be accountable. ANM: critical review, final approval, and agree to be accountable for all aspects of the work.

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