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RESEARCH ARTICLE

BUTEYKO BREATHING TECHNIQUE VERSUS INCENTIVE SPIROMETER ON BREATH HOLDING TIME AFTER CORONARY ARTERY BYPASS GRAFT

[1]Dr. Elsayed Hassan Abdelsalam Mohamed, [2]Dr. BasantHamdy El-Refay and [*,3]Dr. Zahra Mohamed Hassan Serry and [4]Dr. LOFTY M ESSA

[1]Department of Physical Therapy Buraydah Private Colleges, Saudi Arabia
[2,3]Department of Physical Therapy for Cardiovascular/Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University
[4]National Heart Institute

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ABSTRACT

Background: Coronary artery bypass graft (CABG**)** is still associated with frequent development of postoperative pulmonary complications, which are particularly concerning given its link to increased patient morbidity and mortality and resource utilization.
Aim of the work: The aim of this study was to compare between the effects of two inpatient respiratory retraining techniques post coronary artery bypass graft.
Subjects and Methodology: Forty-five patients of both sexes (22 women and 23 men) who underwent coronary artery bypass graft were enrolled in that study for five days while in inpatient period. Their age ranged from 45-55 years. They were assigned into three groups with equal numbers (control group, Buteyko breathing technique group and incentive spirometer group). Breath holding time (control pause) was measured for the three groups at the beginning of the study (1st day postoperative) and after the end of training (5th day postoperative).
Results: There was significant improvement in Breath holding time (control pause). ($P<0.05$) for three groups. Significant difference was noted between three groups postoperatively, in favor of incentive spirometer group.
Conclusion: Both Buteyko breathing technique and incentive spirometer induce significant improvement in Breath holding time (control pause)after Coronary Artery Bypass Graft surgery, in favor of incentive spirometer.

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INTRODUCTION

Pulmonary and associated complications are the major cause of morbidity and mortality in the period following coronary artery bypass graft (CABG) surgery (Wynne and Botti, 2004). Chest physiotherapy is widely used in postoperative care to prevent pulmonary complications such as decreased lung volumes, atelectasis, decreased oxygenation and pneumonia (Herdy *et al*., 2008). Arterial blood gases analysis is a test to evaluate the acid/base balance, partial pressure of oxygen and Co_2 in arterial blood (Pinheiro *et al*., 2011). The Buteyko Method is one of many health-promoting breathing techniques to originate from Russia, made its way to Australia, Europe, and the United States in the 1990s. The attention given by the media to stories of apparent cures of seriously ill individuals popularized this treatment for asthma and eventually a range of other conditions from anxiety to sleep apnea (Stark and Stark, 2002). A number of clinical trials indicate that it is a successful treatment for asthma; however, there is little support for the CO_2 theory that underpins the Buteyko Method. There are, however, many other possible reasons that the breathing techniques used by the Buteyko Method work. These reasons include change in symptom perception and improved sense of control, improved biomechanics of breathing, beneficial effects of low-volume breathing, altered nitric oxide (NO) levels, and resetting of respiratory rhythm generation by breath-holding techniques (Courtney and Cohen, 2008). Previous studies have shown the effect of IS on postoperative pulmonary complications (PPCs) of CABG. It is a well-recognized phenomenon that people practicing the Buteyko method develop an increased ability to comfortably hold their breath, a

Corresponding author: Dr. Zahra Mohamed Hassan Serry,
Department of Physical Therapy for Cardiovascular/Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University

measure known as the control pause (CP). Buteyko practitioners consistently report that a longer CP is associated with decreased symptoms (Artour, 2010). The control pause correlates well with severity of the disease for asthma and heart patients. For example, functional heart disease corresponds to about 5 seconds (sec.) of oxygen in the body, moderate heart disease to about 10 sec. CP, and light forms of heart disease to about 15 sec. Similarly, asthmatics that experience symptoms have about 10 sec. of oxygen. In between attacks (or in stable conditions), asthmatics usually have about a 15 sec. CP. If they get up to a 20 sec. CP, they do not experience chest tightness, wheezing, blocked nose and other pathological effects (Rosalba Courtney, 2008). Up to our knowledge there are no previous studies to show the effect of BBT on reducing PPCs in patients with CABG. Therefore this study attempted to evaluate the effect of BBT on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of CABG

MATERIALS AND METHODS

Participants

Forty-five patients of both sexes (22 women and 23 men), their ages ranged from 45-55 years (yrs) who underwent CABG and were selected randomly from National Heart Institute where the study was conducted. Patient's demographic data, clinical characteristic and all medical history was collected from the admission sheets to ensure that all patients were clinically and medically stable. Their Body mass index (25: 29.9 kg/m^2). Post operative pain was controlled medically. They were assigned into three groups with equal numbers: control group, Buteyko Breathing Technique (BBT) group and incentive spirometer (IS) group.

Exclusion criteria

Patients who had met one of the following criteria were excluded from the study: Obese patients (BMI $\geq$ 30 Kg/m^2), patients who had developed hemodynamic complications (e.g. preoperative myocardial infarction, lung congestion or patients on Intra-aortic balloon), Post-operative renal failure or arrhythmia needed for a pacemaker, Post-operative mechanical ventilation (more than 24 hours) and smoker.

Instrumentation

1) For assessment

***Stop watch*:** It was used to measure the CP for each patient.

2) For treatment

Flow-oriented Incentive Spirometer: Triflow II type. It is one of flow-centered incentive spirometer type.

Intervention program

Pre operative procedures

All patients who were involved in this study had been attended the preoperative meeting and they signed a consent form. All patients had been instructed and taught about the traditional chest physical therapy modalities including (deep breathing exercises, teach the patient right way of cough mechanism, bed mobility and ambulation exercises). The patients in the BBT group were taught about the post operative training program (Buteyko breathing technique) and the patients in IS group had received instructions for proper use of IS.

Post operative procedures

Postoperative physical therapy program started when the patient was extubated from mechanical ventilation and hemodynamically stable in the first day postoperatively and continued after discharge from the ICU for five days postoperative. The patient's incisional pain had been controlled medically by analgesics if it was intolerable before the assessment. The breath holding test was evaluated before the training program.

Breath holding (control pause) test

By using a stop watch to measure CP as following:

a. The patient was sitting upright and adapts a good posture with relaxed shoulders and rested lower back.
b. She/he didn't change breathing before taking CP. Patient was asked to take a small breath in (inspire two sec.) and a small breath out (expire three sec.) hold nose on the 'out' breath, with empty lungs but not too empty. Holding nose is necessary to prevent air entering into the airways.
c. Count how many seconds can comfortably last before the patient needs to breathe in again. Hold breath until feeling the first need to breathe in. Release nose and breathe in through it.

First intake of breath after CP should be no greater than breath prior to taking measurements; should not hold breath for too long as this may cause to take a big breath after measuring the CP **(**Mckeown, 2008**).** It was done 3 times **(**Artour, 2010**)** and taking the mean of three trials.

Treatment programs

The patient had been asked to remember the instructions that had been informed during the pre operative meeting.

- Three groups trained on traditional chest physical therapy modalities including (deep breathing exercises, teach the patient right way of cough mechanism, bed mobility and ambulation exercise training).
- Control group received the traditional chest physical therapy modalities only.
- BBT group: In addition to the traditional chest physiotherapy, the patients received the designed BBT for 15 minutes (min.), two times per day (Cooper *et al*., 2003).
- IS group: In addition to the traditional chest physiotherapy, the patient received IStraining for 15 min., two times per day (Christine *et al*., 2005).

Buteyko Breathing Technique

a. The patient was sitting upright and adapts a good posture with relaxed shoulders and rested lower back.

b. She/he didn't change breathing before taking CP. Patient was asked to take a small breath in (inspire two sec.) and a small breath out (expire three sec.) hold nose on the 'out' breath, with empty lungs but not too empty until feeling the first need to breathe in. Release nose and breathe in through it (Mckeown, 2008).

Step 2: Shallow Breathing

- To monitor the amount of air flowing through his/her nostrils by placing his/her finger under the nose in a horizontal position.
- Then, to breathe air slightly into the tip of his/her nostrils. For example, just take enough air to fill the nostrils and no more. Breathe in a flicker of air with each breath.
- The patient was asked to exhale that to pretend that his/her finger is a feather, and to breathe out gently onto his/her finger so that the feather does not move.
- Breathe out and to concentrate on calming his/her breath to reduce the amount of warm air he/she feel on the finger.
- As the patient reduces the amount of warm air onto his/her finger, the patient will begin to feel a need or want for air. **(**Mckeown, 2008**)**

- Take CP.
- Reduced breathing for 3 min.
- Take CP
- Reduced breathing for 3 min.
- Take CP
- Reduced breathing for 3min.
- Take CP
- Reduced breathing for 3 min.
- Take CP
- Reduced breathing for 3 min. (Mckeown, 2008)

Incentive spirometer training

- Patient was asked to sit and relax quietly for a few min. and pay attention to their present breathing. Then he/she hold the spirometer by one hand and the tube, mouthpiece by the other hand.
- Take three to four slow, easy breaths and maximally exhale with the fourth breath.
- Then, he/she was asked to place the IS in his/her mouth and maximally inhale through the spirometer to try to raise the white ball in the chamber as high as he can, then hold the inspiration for 2-3 sec. before exhaling normally. These steps were repeated for a total of four to five times, and then he /she was instructed to stop and rest for 60 sec. This sequence was repeated for 15 min. (Christine *et al*., 2005)

Statistical Analysis

Descriptive statistics was done in the form of mean and standard deviation. Inferential statistics assessed Changes in CP including: Paired t-test was used for this variable to compare between the pre and post treatment results for each group, analysis of variance (ANOVA) was used to compare between the pre and post treatment results for the three groups together, Least significance difference (LSD) to show the statistical difference between the three groups post treatment. Statistical significance was established at the convention < 0.05 level. Analysis was done using SPSS version 18 and percentage of change was calculated according to:

Step 3: Putting it together

$$\text{Relatives changes percentage} = \frac{\text{post}-\text{pre}}{\text{pre}} \times 100$$

RESULTS

No significant differences were recorded in all anthropometric measurements and clinical data including; age, weight, height and body mass index at the beginning of the study (P > 0.05), as Table (1).

The pretreatment results of this study showed that there were no significant differences in CP measurement among three groups of patients (P > 0.05) before treatment suggesting proper sample subdivision, as Table (2).

There were significant differences in CP for the three groups in comparison of the pre and post treatment mean values (P < 0.05). The percentages of improvement were 4.84%, 38% and 51.72% increasing in CP for control group, BBT group and IS group respectively, as Table (3).

Table 1. Descriptive data of the three groups

Item	Control group mean± SD	BBT group mean± SD	IS group mean± SD	*F level*	*p*-value
Age (yrs)	49.73±3.81	47.60± 2.72	48.33± 3.42	1.57	>0.05
Height(cm)	170.67±3.02	169.13±2.59	168.93±2.66	1.79	>0.05
Weight (kg)	83.00 ± 4.34	81.67± 4.25	80.47± 4.72	1.22	>.0.05
BMI ($Kg/m^{2)}$	28.07± 0.70	27.67± 0.90	27.40± 0.83	2.57	>0.05

SD=Standard deviation P. value= level of significance

Table 2. ANOVA test of control pause, pre treatment, among the three groups

Item	Control group mean± SD	BBT group mean± SD	IS group mean± SD	*F level*	*p*-value
CP	7.37±0.60	7.29±0.60	7.25± 0.50	0.18	>0.05

SD=Standard deviation P. value= level of significance

Table 3. Statistical analysis of control pause, pre and post treatment, for three groups

Item	Pre mean± SD	Post mean± SD	*MD*	*% of improvement*	*t*-value	*p*-value
Control group	7.37±0.60	7.70±0.64	0.33	4.84%↑	-5.54	<0.05*
BBT group	7.29±0.60	10.06±0.57	2.77	38%↑	-35.10	<0.05*
IS group	7.25±0.50	11.00±0.54	3.75	51.72%↑	-45.93	<0.05*

SD=Standard deviation P. value= level of significance
*significant at p-value < 0.05MD= Mean difference
%=Percentage ↑=Increase ↓=Decrease

Table 4. ANOVA test of control pause, post treatment, among the three groups

Item	Control group mean± SD	BBT group mean± SD	IS group mean± SD	F ratio	*p*-value
CP	7.70±0.64	10.06±0.57	11.00±0.54	125.92	<0.05*

SD=Standard deviation P. value= level of significance
*significant at p-value < 0.05

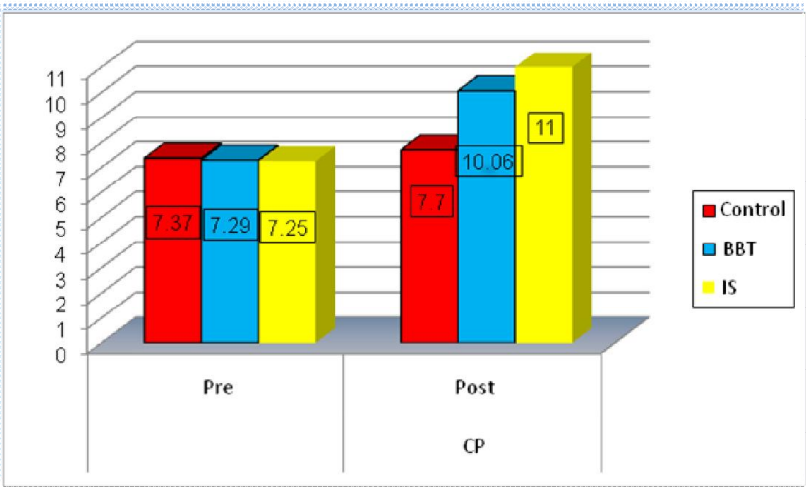

Fig. 1. Mean values of CP, post treatment, among the three groups

There were significant differences in post treatment mean values of CP between three groups in favor of IS group, as Table (4) and Figure (1).

DISCUSSION

In the literature a wide variety of treatments have been suggested. Many strategies and diverse therapies are applied postoperatively and these differ within and between countries (Cooper *et al*., 2003). The CP test not only defines oxygenation of the human body, it also tells us about your minute ventilation (or how much you breathe). If you have normal breathing, your CP should be about 40 seconds. If your CP is about 20 sec., you breathe for 2 times more than the normal. If your CP is 10 sec., you breathe 4 times more than the normal (Nannini *et al*., 2007). The deviation of the pre-treatment results from the normal values could be explained by (Mckeown, 2008) who stated that, many factors have been suggested to be responsible for the decrease in pulmonary function and muscular strength after CABG. Some suggested factors include anesthesia, analgesics, surgical stress, pain, reduced ventricular function, phrenic nerve injury, cardiovascular drugs, and the position of the drains. (Westerdahl and Möller, 2010) Added that the peak of postoperative diaphragm dysfunction, with a decrease in its strength, occurs between 2 and 8 hours postoperatively.

The changing in all the measurable variables in post-treatment results in the control group comes in agreement with (Artur *et al*., 2008) who concluded that, a randomized clinical trial demonstrates that in patients who wait for CABG, a pre- and postoperative program of cardiopulmonary rehabilitation leads to a reduced rate of postoperative complications and a shorter hospital stay. (Westerdahl and Möller, 2010) Added that, the physiotherapy treatment during the hospital stay generally consists of early mobilization, range of motion exercises and breathing exercises. The improvement in the measuring variables recorded in the post treatment results of BBT is supported (Courtney and Cohen, 2008) who reported that, it is a well-recognized phenomenon that people practicing the Buteyko Method develop an increased ability to comfortably hold their breath, a measure known as the CP. Buteyko practitioners consistently report that a longer CP is associated with decreased symptoms. Buteyko claimed that the control pause correlated with alveolar CO_2, and people learning the Buteyko Method are taught that longer control pauses reflect increased CO_2 levels. In a recent study, who investigated the correlation between alveolar CO_2 and the CP, and they found that there was a very slight negative correlation between the CP and end tidal CO_2, directly opposite to Buteyko's claims. They also found that the shorter CP found in asthmatics had a significant correlation with a thoracic-dominant breathing pattern.

The current study reflected that improvement of CP in BBT group which was better than conventional chest physiotherapy intervention only could be explained by (Courtney and Cohen, 2008) who reported that, however, there are several possible neurological, biochemicals, and biomechanical pathways that may also explain the Buteyko effect. One possible biochemical mechanism of Buteyko may be through its influence on NO. Nitric oxide is involved in a large number of physiological responses including bronchodilation, vasodilatation, tissue permeability, immune response, oxygen transport, neurotransmission, insulin response, memory, mood, and learning. Buteyko practitioners' insistence on nasal breathing at all times is likely to affect NO levels, as a large percentage of the body's NO levels are made in the paranasal sinuses. (O'donnell *et al*., 2006) Mentioned that, the work of breathing is most efficient when coordinated contribution from the diaphragm, abdominal muscles, and rib cage muscles results in balanced motion between the upper rib cage and the lower rib cage and abdomen. Unevenness of motion of the chest wall where the upper rib cage movement dominates and lower rib cage expansion is impaired can indicate biomechanically induced dysfunctional breathingthat result in hyperinflation and contributes to breathing symptoms such as Dyspnea. People practicing the Buteyko Method are taught to reduce their volume of breathing by using a combination of increased abdominal muscle tone and relaxation of all the other muscles of breathing, particularly the shoulders and chest. (Courtney and Cohen, 2008) concluded from their study that, it is proposed that altered breathing pattern could contribute to breathing symptoms such as dyspnea and that breathing therapies such as BBT might influence symptoms by improving the efficiency of the biomechanics of breathing.

Improvement observed in the post-treatment results of the IS group comes in agreement with (Joshi and Mathur, 2002) who found that, IS can be used as a preventive measure to reduce pulmonary complications most of which are due to decreased inspiratory capacity and chronic retention of secretions due to decreased expiratory pressure and flow as well as it improves neuromuscular coordination. This is also confirmed by (Restrepo *et al*., 2011) who mentioned that, respiratory therapy that includes daily sessions of IS plus deep breathing exercises, directed coughing, early ambulation, and optimal analgesia may lower the incidence of PPCs. There was significant difference between the effect of IS and BBT, in favor of IS. Incentive spirometer provides deep breathing exercises. (Westerdahl *et al*., 2003) mentioned that a mechanical device could help patients to remember to carry out the respiratory exercises, and that patients find these devices both useful and motivating. As previously mentioned, in our case the patients used a flow-based IS and carried out 30 slow maximal inspiratory maneuvers, as well as daily deep breathing exercises. They found immediate effects of deep breathing performed on the second post-operative day after cardiac surgery and concluded that there was a significant decrease of the atelectic area, increase in aerated lung area and a small increase in PO2 after performance of 30 deep breathing. The results are supported by (Roy, 2013) who conducted a study to compare between the effect of deep breathing technique (DBT) and BBT in patients with upper abdominal surgeries. She observed that the patients in DBT group showed more improvement after a single session of treatment. The chances of PPCs were reduced. As a result, the patient who underwent the intervention involving DBT demonstrates a better result than the group of patients who received BBT.

Summary

This work was designed to compare between the effect of Buteyko Breathing technique (BBT) and incentive spirometer (IS) onbreath holding time (control pause) after CABG. This study was conducted on 45 patients in the form of (22women and 23 men) after CABG. The patients were randomly selected from National Heart Institute to participate in this study. Their ages ranged between 45 to 55 years old. They randomly assigned into three groups of equal numbers: control group, Buteyko breathing technique (BBT) group and incentive spirometer (IS) group. Pre and post program assessment of CP results were done for each patient. The results of the present study revealed no significant differences in control pause between the three groups before treatment. While, there was a significant improvement in the three groups after treatment. There was significant difference between the control and BBT groups, in favor of BBT; between BBT and IS, in favor of IS and between control and IS in favor of IS group.

Conclusion and Recommendation

The results obtained in the present study revealed that, BBT and IS in addition to routine chest physiotherapy program in the form of deep breathing, bed mobility, coughing and early ambulation induce significant improvement in breath holding time after CABG. Also, there was super effect of IS in comparison with the effect of BBT. A limitation of the present study was short duration which showed incomplete effect of the intervention. It is recommended to add a Buteyko breathing technique to the rehabilitation program for patients underwent CABG surgery. More researches are needed to study the effect of BBT on CABG at home and to show its effect on other heart surgeries. Further studies are needed to compare between the effect of BBT and PEEP device after CABG surgery In future, a large study with a follow-up should be conducted to determine the long term effect of the treatment.

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