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The evaluate the effect of buteyko breathing technique (BBT) and incentive spirometer (IS) on reducing post pulmonary complications (PPCS) after coronary artery bypass graft over the age of 60 years

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Abstract
Aim: To find the effectiveness of BBT versus Incentive Spirometry on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of CABG
Methodology: A Quasi Experimental study design consisting of reviews of charts of CABG patients over the age of 60 years. All the patients are presented with post-operative Coronary Artery bypass Graft. Pre- and Post-Treatment scores of Breath hold are assessed to know their breathing capacity by Control Pause Test (CP).
Results: The pre and posttest values were assessed by breath holding in Group A and Group B. The mean difference value, standard deviation, paired 't' test and unpaired 't' test were calculated and compared with table value.
Conclusion: The paired 't' test values have shown that BBT and IS technique has a better effect than the IS and thereby on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of CABG.

Keywords: buteyko breathing technique, incentive spirometer, post pulmonary complications, coronary artery bypass graft, control pause test

Introduction

Pulmonary and associated complications are the major cause of morbidity and mortality in the period following coronary artery bypass graft (CABG) surgery. Chest Physiotherapy is widely used in postoperative care to prevent pulmonary complications such as decreased lung volumes, atelectasis, decreased oxygenation and pneumonia. Arterial blood gases analysis is a test to evaluate the acid/base balance, partial pressure of oxygen and Co_2 in arterial blood. [(1)] 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. 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 [2, 3]. 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. Previous studies have shown the effect of IS on postoperative pulmonary complications (PPCs) of CABG [4]. 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 control pause (CP). Buteyko practitioners consistently report that a longer CP is associated with decreased symptoms. 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. Up to our knowledge there are no previous studies to show the effect of BBT on reducing PPC 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 [5].

CABG

Coronary artery bypass surgery, also known as coronary artery bypass graft (CABG, pronounced "cabbage") surgery, and colloquially heart bypass or bypass surgery, is a surgical procedure consisting of either diverting the left internal thoracic artery (left internal mammary artery or "LIMA") to the left anterior descending (LAD) branch of the left main coronary artery; or a harvested great saphenous vein of the leg, attaching the proximal end to the aorta or one of its major branches, and the distal end to immediately beyond a partially obstructed

coronary artery (the "target vessel") - usually a 50% to 99% obstruction. The purpose is to restore normal blood flow to that partially obstructed coronary artery. It is performed to relieve angina unsatisfactorily controlled by maximum tolerated anti-ischemic medication, prevent or relieve left ventricular dysfunction, and/or reduce the risk of death. It does not prevent heart attacks. This surgery is usually performed with the heart stopped, necessitating the usage of cardiopulmonary bypass; however, two alternative techniques are also available allowing CABG to be performed on a beating heart either without using the cardiopulmonary bypass deemed as "off-pump" surgery or performing beating surgery using partial assistance of the cardiopulmonary bypass called as "on-pump beating" surgery. The latter gathers the advantages of the on-pump stopped and off-pump while minimizing their respective side-effects [6, 7].

The obstruction being bypassed is due to arteriosclerosis, atherosclerosis, or both. Arteriosclerosis is characterized by thickening, loss of elasticity, and calcification of the arterial wall, most often resulting in a generalized narrowing in the affected coronary artery. Atherosclerosis is characterized by yellowish plaques of cholesterol, lipids, and cellular debris deposited into the inner layer of the wall of a large or medium-sized coronary artery, most often resulting in a focal partial obstruction in the affected artery, each can limit blood flow if it causes a cross-sectional narrowing of at least 50%.

Pathology

Coronary Artery Disease (CAD) occurs when atherosclerotic plaque (hardening of the arteries) builds up in the wall of the arteries that supply the heart. This plaque is primarily made of cholesterol. Plaque accumulation can be accelerated by smoking, high blood pressure, elevated cholesterol, and diabetes. Patients are also at higher risk for plaque development if they are older (greater than 45 years for men and 55 years for women), or if they have a positive family history for early heart artery disease [8].

The atherosclerotic process causes significant narrowing in one or more coronary arteries. When coronary arteries narrow more than 50 to 70%, the blood supply beyond the plaque becomes inadequate to meet the increased oxygen demand during exercise. The heart muscle in the territory of these arteries becomes starved of oxygen (ischemic). Patients often experience chest pain (angina) when the blood oxygen supply cannot keep up with demand. Up to 25% of patients experience no chest pain at all despite documented lack of adequate blood and oxygen supply. These patients have "silent" angina, and have the same risk of heart attack as those with angina. When a blood clot (thrombus) forms on top of this plaque, the artery becomes completely blocked causing a heart attack [9].

Epidemiology

Studies of Indian immigrants and cross sectional studies in India, have demonstrated that coronary artery disease (CAD) is rampant in Indians and that its prevalence is several folds higher than in industrialized nations. The Global Burden of Diseases (GBD) study reported the estimated mortality from CAD in India at 1.6 million in the year 2000. Extrapolation of this estimate shows the current burden of CAD in India to be more than 32 million patients. Epidemiological studies show a sizeable burden of CAD in rural (3-5%) and urban (7-10%) populations. A conservative estimate indicates that there could be 30 million CAD patients in India of which 14 million are in urban and 16 million in rural areas. If the current trend continues by the year 2020, the burden of atherothrombotic CVD in India will surpass other regions of the world [10].

Methodology

Thirty patients of both sexes their ages above from 60 years who underwent CABG and were selected randomly 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. The study was conducted at Government Head Quarters Hospital, Erode. The duration of the study was about a period of 12 months. They were assigned into two groups with equal numbers: Group A – (Buteyko Breathing Technique (BBT) and Incentive Spirometer (IS)) Group –B (Incentive Spirometer).

Patients who had met one of the following criteria were excluded from the study: Obese patients (BMI ^30Kg/m2), 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.

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 group A were taught about the post operative training program (Buteyko breathing technique) and Incentive Spirometry *(*IS) and patients from group B 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.

Parameter
Breath Holding (Control Pause) test
Using a stop watch to measure CP as follows
The patient was sitting upright and adapts a good posture with relaxed shoulders and rested lower back. 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. 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. It was done 3 times and taking the mean of three trials.

Procedure
Buteyko Breathing Technique (BBT): The Buteyko breathing technique is another breathing retraining technique; however it is specific to reducing hyperinflation. It was developed based on the theory that bronchospasm is caused by hyperventilation, leading to a low $PaCO_2$. The narrowed airways induce an "air hunger" causing a switch to mouth-breathing and an increased respiratory rate leading to hyperinflation. Buteyko believes that this hyperinflation then also contributes to bronchoconstriction [11]. The Buteyko technique aims to reduce ventilation and subsequently lung volume as a treatment for cardio respiratory diseases.

The Buteyko Breathing Technique is done as follows
- Breathe normally through the nose for 2-3 mins
- Breathe out normally, close nose with fingers, and hold
- Record number of seconds
- On first need to breathe, release nose and return to nasal breathing (Control Pause)
- Wait 3 minutes
- Repeat and hold breath for as long as possible (Maximum Pause)

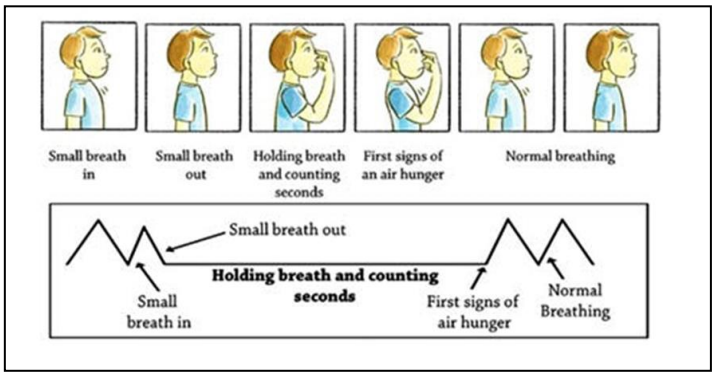


Fig 1: Buteyko breathing technique

Breathing pattern retraining and relaxed breathing techniques are two approaches to improve ventilation of the lungs. The aim of breathing pattern retraining is to develop a more efficient pattern of respiration, thereby reducing breathlessness. This is usually accomplished by slowing the breathing rate, and encouraging relaxed, 'abdominal' breathing. Another potential mechanism for breathing pattern retraining is that by encouraging a longer expiratory time, the effects of any static/ dynamic hyperinflation may be reduced. The aim of this method is to increase the control pause to 60 seconds and the maximum pause to 2 minutes. It is practiced twice a day, with the practitioner there to help with breath holding and ensure safety. Its aim is to reduce minute volume through reduction of respiratory rate, and increasing carbon dioxide levels through breath holding and also reducing bronchospasm in CABG patients [12, 13, 14].

Incentive Spirometer Training (IS)
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 15min [15].

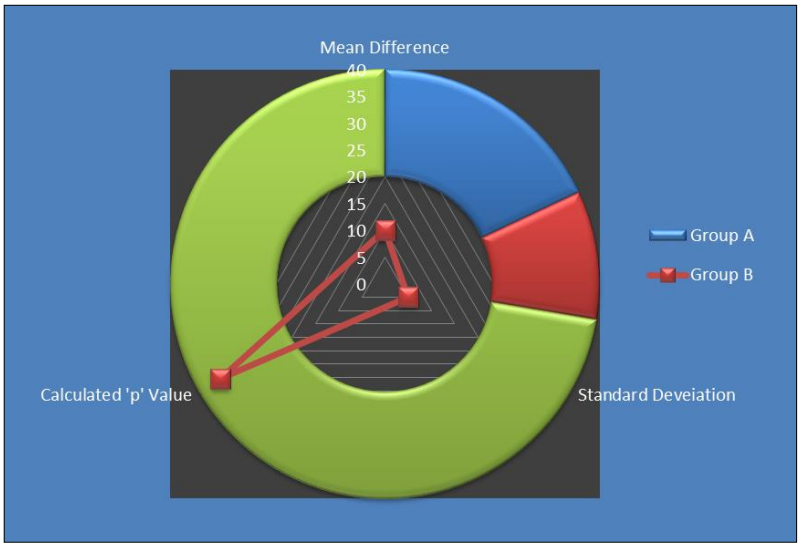
Results

Data Presentation and Stastistical Analysis

Continuous and dichotomous demographic variables (Age and gender respectively) of two groups (Control and Experimental) were compared by independent t test. The change score between the pre and post treatment balance outcome measures of two groups were compared by independent 't 'test. The pre post difference within the group was analyzed using paired t test. A two-tailed (α= 2) probability (p) value p<0.05 or 2.15 was considered to be statistically significant.

Table 1: Comparison of the Mean Difference, Standard Deviation, Calculated 'p' value and Table Value between Group A and Group B

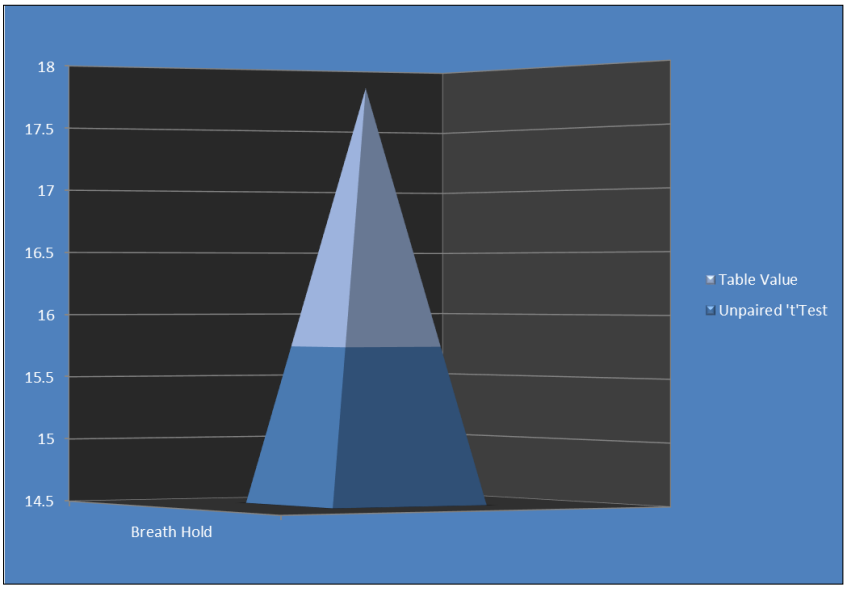
GROUPS	Mean Difference	Standard Deviation	Calculated 'p' value	Table value	Significance
Group A	15	8.09	60.41	2.15	Significant
Group B	10	4.96	35.37	2.15	Significant



Graph 1: Comparison of the Mean Difference, Standard Deviation, Calculated 'p' value and Table Value between Group A and Group B

Table 2: Comparison of unpaired 't' Test and Table Value between Group A and Group B

Parameter	Unpaired 't' Test	Table Value	Significance
Breath Hold	15.75	2.05	Significant



Graph 2: Comparison of unpaired 't' Test and Table Value between Group A and Group B

Results and Discussion

Results

The study sample comprised 30 patients, of which 20 were male and 10 were female. The mean average age of patients was 68 years. The pre and posttest values were assessed by breathe holding in Group A and Group B. The mean difference value is 15 and 10 respectively. The standard deviation value is 8.09 and 4.96 respectively. The paired 't' test value for breathe holding is 60.41 and 35.37.The paired t test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom.

The calculated 't' values by unpaired 't' test were 15.75. The calculated 't' values were more than the table value 2.05 for 5% level of significance at 28 degrees of freedom.

The paired 't' test values have shows that BBT and IS was more effective than IS for patients with coronary artery bypass graft. The unpaired 't' test values have shown that there was significant difference between two groups in showing on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of CABG

Discussion

There are variety of treatment were suggested for CABG, but many strategies and diverse therapies are applied postoperatively and these differ within and between countries. 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.

The deviation of the pre-treatment results from the normal values could be explained by 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. Added that the peak of post operative diaphragm dysfunction, with a decrease in its strength, occurs between 2 and 8 hours postoperatively [16].

The changing in all the measurable variables in post-treatment results in the Group A comes in agreement with 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, in addition to 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 and IS is supported by Courtney & Cohen 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 CO2, and people learning the Buteyko Method are taught that longer control pauses reflect increased CO2 levels. In a recent study, who investigated the correlation between alveolar CO2 and the CP, and they found that there was a very slight negative correlation between the CP and end tidal CO2, 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 and IS group which was better than conventional chest physiotherapy intervention only could be explained by 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 [16, 17].

ODonnell 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 breathing that 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. 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 [18, 19].

Improvement observed in the post-treatment results of the IS group comes in agreement with others 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*., 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 favour of IS. Incentive spirometer provides deep breathing exercises 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 per-formed 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 [20, 21].

Our results are supported by Roy who conducted a study to compare between the effect of deep BBT and IS in patients with upper abdominal surgeries. She observed that the patients in BBT 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 BBT demonstrates a better result than the group of patients who received IS [22, 23].

Summary and Conclusion

Even though both BBT and IS and IS techniques are found to have significant effect in reducing PPCs after CABG, BBT and IS technique has a better effect than the IS and thereby on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of CABG.

Through the results, alternate hypothesis is accepted and also the study could be concluded that there is a significant difference between BBT and IS and IS on reducing PPCs after CABG which will cause reduction in hospital stay and overall cost of
CABG.

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