Comparative study of Anulom Vilom Pranayam (AVP) and Positive Expiratory Pressure (PEP) techniques after uncomplicated Coronary Artery Bypass Grafting

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Abstract— *Coronary artery disease has evolved to be the leading cause of death and morbidity in this era of urbanization and industrialization. Coronary Artery Bypass Grafting (CABG) is the definitive treatment of choice in Coronary artery diseases. Routine Chest Physiotherapy techniques employ various breathing exercises alongwith coughing techniques. Recent advancements in Cardiopulmonary Physiotherapy, clubbed with alternative breathing strategies, combinely prove to be effective in improving oxygenation and augmenting the mucociliary and cough clearance mechanism of the lungs thereby preventing post-operative respiratory complications. The aim of present study was to compare the effect of Anulom Vilom Pranayam (AVP) with Positive Expiratory Pressure (PEP) Device, in respiratory outcomes, following uncomplicated CABG. Study was conducted on 30 subjects including 28 males and two females (with mean age 56 years) who had undergone uncomplicated CABG. The subjects were randomly divided in 2 groups. Group A performed AVP with Incentive spirometry (IS) whereas group B performed breathing exercise with Positive Expiratory Pressure (PEP) with IS. Outcomes were recorded in the form of changes in Respiratory Rate (RR), Mucociliary Clearance Time (MCT) through Saccharin Test, Peak Expiratory Flow Rate (PEFR), Partial pressures of Oxygen and Carbon dioxide (PaO_2 and $PaCO_2$) through ABG analysis and arterial Oxygen Saturation (SpO_2) on the first and seventh post-operative day. Improvement in all respiratory parameters was found after treatment in both groups but significant improvement was found in PaO_2 with AVP group in comparison with PEP ($p = 0.038$). Hence AVP can be considered beneficial in improving respiratory outcomes following cardiac surgery if practiced properly on a long term basis.*

Keywords: Anulom Vilom Pranayam (AVP), Incentive Spirometry (IS), Positive Expiratory Pressure (PEP), Coronary Artery Bypass Grafting (CABG).

I. INTRODUCTION

Cardiovascular disease is a leading cause of death globally[1]. Coronary Artery Disease (CAD) is marked by a reduction or arrest of blood supply to the myocardium. The etiology happens to be the formation of atherosclerotic plaque in the Coronary arteries supplying the heart.

Treatment for CAD involves medications, combined with lifestyle modifications, undergoing invasive and/or surgical procedures like angioplasty and Coronary Artery Bypass Grafting (CABG). CABG is the definitive procedure for coronary artery disease which involves more than 2 vessels. Arterial or venous grafts are harvested from elsewhere in the body to bypass the atherosclerotic narrowing and improve the coronary circulation to the myocardium.

Respiratory Physiotherapy is used routinely for the prevention and treatment of pulmonary complications after CABG. There are many techniques used for that but it is unclear which technique are most effective[2]. All of these techniques aim to clear secretions, improve lung ventilation, prevent atelectasis and promote speedy recovery. These techniques augment normal mucociliary and cough clearance mechanisms of the lungs.[2]

This present study was conducted to compare two of such techniques i.e. Anulom Vilom Pranayama (AVP) and Positive Expiratory Pressure (PEP) in uncomplicated CABG cases.

II. METHODOLOGY

This hospital based prospective comparative randomized study was conducted to compare repiratory techniques in 30 subjects of uncomplicated CABG surgery cases done at CTVS department of Mahatma Gandhi Medical College and Hospital, Jaipur (Rajasthan) in year 2018.

For the study, subjects with the age of 30-65 years scheduled to undergo CABG surgery, were included in the study. Cases with Atrial fibrillation, previous cardiac valve surgery, unstable anemia and thoracic deformities were excluded from study. Cases with other chronic diseases were also excluded from study. Cases who had stroke in past 6 months or previous stroke with residual effect were also excluded from study. Cases who had some psychological disorder were also excluded from study.

Such 30 subjects were enrolled for the study were included in the study after obtaining personal consent from the individual subjects. These subjects were randomly divided into two group through chit box method. Group 'A' were taught Anulom Vilom Pranayam with Incentive spirometry (IS) and Group 'B' taught Positive Expiratory Pressure with its device along with Incentive spirometry (IS).

After subjects met the inclusion criteria they were randomly assigned in 2 groups. 15 subjects (14 male+1 female) were included in Group A and they were treated with AVP along with IS and 15 subjects (14 male+1 female) in Group B who were treated with PEP along with IS. Subjects in both groups were attended before the surgery by physiotherapist who explained the physiotherapeutic protocols and interventions to be done after the surgery. Routine physiotherapy maneuvers were also taught to the subjects, including IS.

Subjects in Group A were positioned comfortably in long sitting using pillow support as required, with the spine erect. They were made to do Incentive Spirometry on their own. They were instructed to hold the spirometer upright in front of the face and inhale slowly to raise and maintain the first and second chambers for 2-3 seconds.[3] This was repeated 5-6 times, every 2-hourly.

Anulom in Sanskrit means “Alternate”. It is also known as Alternate Nostril Breathing or Nadi Shodhana Pranayama. It can be practiced in any asana like Vajrasana, Sukhasana, Padmasana, preferably keeping the spine erect, mind relaxed. Alternate nostrils are closed using the right hand’s thumb, ring finger and little finger. The thumb is used for closing the right nostril and ring and little fingers are used to close the left nostril. The mouth is closed and not used for breathing. Breathing should be silent and relaxed both during inspiration and expiration.[4] Right nostril is closed using thumb, exhalation through the left nostril, followed by inhalation through the same. The left nostril is then closed by the ring finger and air is exhaled through the right nostril followed by inhalation through the same. It is advisable to have a ratio of inspiration to expiration equal to 1:2.[5] The cycle is repeated at a normal breathing rate. There should be no fatigue during the procedure.

After a quick demonstration by the therapist, they were instructed to perform AVP; beginning with inspiration through the left nostril, keeping the right nostril closed using the thumb of the right hand. After a deep inspiration, the left nostril was closed using the middle and ring fingers of the right hand, thereby allowing expiration through the right nostril now. This was followed by a deep inspiration through the right nostril again, and expiration through the left one. This constituted one cycle of AVP. The patients were instructed not to hold the breath at any instance of the cycle. Breathing was to be done slowly, deeply, at ease without causing fatigue.[6] In the beginning it was carried out for 2-3 min in one session, increasing upto 5-7 minutes by post op day 7. It was carried out for minimum 4 sessions per day.

Subjects in group 'B' were positioned upright similar to group 'A', and instruction for Incentive Spirometry were the same. This was followed by treatment with PEP Device, a blow-bottle in this case, in which subjects were asked to inhale deeply and then exhale through the mouth into the blow bottle deeply. This was repeated 10-30 times in one session.[7] 2 sessions per day were carried out.

Saccharin Test, basically designed by Anderson, is commonly used test of mucociliary function in the nasal cavity. Particles of saccharin are placed approximately 1cm behind the anterior end of the inferior turbinate. The particles will be swept backwards by the mucociliary action and a sweet taste will be perceived. The patient is instructed not to sniff, sneeze or cough during the test and report the sweet taste as soon as perceived. The time duration from the placement of saccharin crystal to the perception of sweet taste is the Mucociliary Clearance Time (MCT), which is recorded. If the sweet taste is not perceived after 60 min, the test is stopped. Any time longer than 45 min is considered as abnormal.[6]

Outcomes were recorded in the form of changes in Respiratory Rate (RR), Mucociliary Clearance Time (MCT) through Saccharin Test, Peak Expiratory Flow Rate (PEFR), Partial pressures of Oxygen and Carbon dioxide (PaO_2 and $PaCO_2$) through ABG analysis and arterial Oxygen Saturation (SpO_2) on the first and seventh post-operative day. $SpO_2$was measured using pulse oxymeter, RR was measured from medical Oxygen flow meter regulator, PaO_2 was measured from ABG analysis report. $PaCO_2$ was measured from ABG analysis report. MCT in seconds was measured by stop watch through Saccharin test and PEFR was measured by PEFR meter.

Statistical Analysis: Data were complied and statistically analyzed by using Microsoft excel 2010 worksheet. Results were expressed in percentages. All statistical data was collected and Paired t-test was applied to compare effectiveness of treatment in PaO_2, $PaCO_2$, RR, MCT, and PEFR in each group before and after treatment. Unpaired t-test was used to compare the effectiveness of two different techniques, namely AVP and PEP

III. RESULTS

In present study, out of total 30 subjects, 15 subjects were in AVP (Group 'A') and 15 subjects were in PEP (Group 'B'). Sex wise distribution was same in both the groups and mean age of both the group was comparable i.e. without significant difference. (Table 1)

Table 1
Age and sex wise distribution of subjects in both the groups

S. No.	Variables	AVP (Group 'A') (N=15)	PEP (Group 'B') (N=15)	P Value	LS
1	Age (Mean±SD) in Years	56.40 ± 5.60	54 ±4.80	0.218	NS*
2	Sex Ratio (M:F)	14:1	14:1	1	NS**

Unpaired 't' test**Chi-square test

When effect of AVP was observed on various parameters it was found significantly decrease in all the studied parameters (MCT, RR, PaO_2 and $PaCO_2$) except PEER which was significantly increased by this intervention. So in other word it can be concluded that AVP is effective in improving respiratory functions and mucociliary function in CABG cases. (Table 2)

Table 2
Effect of Anulom Vilom Pranayam (AVP) on various parameters

S. No	Outcome Measures	Before Treatment Mean±SD (N=15)	After Treatment Mean±SD (N=15)	*P Value	LS
1	**MCT**	245.13±66.26	104.73±53.37	**<0.001**	**S**
2	**PEFR**	49±43.33	161.33±24.45	**<0.001**	**S**
3	**RR**	30.73±3.28	20.86±2.94	**<0.001**	**S**
4	**PaO2**	153.93±54.98	117.53±10.83	**0.018**	**S**
5	**PaCO2**	42.40±12.38	34±2.64	**0.016**	**S**

**** Paired 't' test***

When effect of PEP was observed on various parameters it was found significantly decrease in MCT and RR whereas significantly increased in PEER by this intervention. And there was no significant difference in PaO_2 and $PaCO_2$. So it can be concluded that AVP is effective in improving mucociliary function but respiratory functions are partially improved in CABG cases. (Table 3)

Table 3
Effect of Positive Expiratory Pressure (PEP) on various parameters

S. No	Outcome Measures	Before Treatment Mean±SD (N=15)	After Treatment Mean±SD (N=15)	*P Value	LS
1	**MCT**	230.06±109.67	106.46±74.41	**<0.001**	**S**
2	**PEFR**	54±36.60	160.66±73.04	**<0.001**	**S**
3	**RR**	29.46±8.78	21.33±3.24	**0.002**	**S**
4	**PaO2**	123.06±40.96	105.13±19.19	**0.136**	**NS**
5	**PaCO2**	37±6.48	35.13±2.03	**0.295**	**NS**

**** Paired 't' test***

When effect of both techniques i.e. AVP and PEP were compared it was found without significant difference in various parameters studied except in PaO_2 where it was found significantly increased in AVP group than PEP group. So it can be concluded that AVP is more effective in improving respiratory functions than PEP in CABG cases. (Table 4)

Table 4
Comparison of Effect of AVP and PEP on various parameters (After Treatment Values)

S. No	Outcome Measures	AVP (Group 'A') Mean±SD (N=15)	PEP (Group 'B') Mean±SD (N=15)	*P Value	LS
1	**MCT**	104.73±53.37	106.46±74.41	**0.942**	**NS**
2	**PEFR**	161.33±24.45	160.66±73.04	**0.973**	**NS**
3	**RR**	20.86±2.94	21.33±3.24	**0.681**	**NS**
4	**PaO2**	117.53±10.83	105.13±19.19	**0.038**	**S**
5	**PaCO2**	34±2.64	35.13±2.03	**0.199**	**NS**

**** Unpaired 't' test***

IV. DISCUSSION

This study was designed to compare the effects of AVP+IS and PEP+IS on the variables PaO_2, $PaCO_2$, MCT, PEFR and RR in a randomized controlled trial on 30 cases who underwent CABG and were uncomplicated. All subjects successfully completed the study.

Present observations suggests that although both techniques were effective but on comparison AVP is significantly better than PEP in PaO_2 (p value<0.05).

The subjects in Group B showed significant improvement after treatment using blow bottle, with PEFR and MCT being highly significant (p value<0.001). They showed significant improvement in terms of RR but no statistically significant changes were observed in terms of PaO_2 and $PaCO_2$ after treatment which is the major difference between the findings observed in Group 'A'. However, these improvements were more or less similar to those that were found with Group 'A', that means, blow bottle and AVP were found equally effective, except in context of PaO_2, improvements in which were seen with Group 'A' subjects performing AVP.

On comparing readings before and after treatment with AVP+IS for group 'A', it was found that there was a significance difference in RR, PEFR and MCT values after treatment with AVP+IS (p value<0.001) in each of these. Also, PaO_2 and $PaCO_2$ values showed significant improvement after treatment (p value<0.05).

This is consistent with the results of a study titled "Comparative study of Respiratory Parameters in Savitri Pranayama and Alternate Nostril Breathing Practitioners" in which it was found that Respiratory Parameters increased with either practice of any one type of Pranayama.[8] The authors found significant increase in PEFR, Maximum Breathing Capacity, Breath Holding Time, and Expiratory Pressure in both the test groups after 12 weeks of Pranayama practice.

As it is seen that there is a significant improvement in Mucociliary clearance and PEFR value after treatment with AVP+IS, it can be said that it aids secretion removal and strength of cough. As we know removal of secretions is always associated with an improvement in arterial Oxygen saturation, which in turn causes improvement in PaO_2, so this is the possible reason behind improvement in PaO_2 after AVP.

From previous studies[9-12] reported that PEEP can prevent hypoxemia, with a significant increase in PaO_2 in post-cardiac surgery patients. Studies [13-14] also suggested that AVP decreases activation of both sympathetic and parasympathetic components. The reduction in sympathetic tone attained with Pranayama training may allow bronchodilatation by correcting abnormal breathing patterns and reducing the tone of both inspiratory and expiratory muscles. In response to this, a number of nervous system mechanisms as well as haemodynamic adjustments are also triggered.

However, there has been no previous evidence of changes in terms of ABG parameters with AVP. This calls for the need of a thorough research in this field.

V. CONCLUSION

Present study concludes that the result of this study suggests that AVP+IS is more effective in improvement of PaO_2. It also suggests that all other respiratory parameters (PEFR, RR, $PaCO_2$, and MCT) show improvement after treatment with AVP+IS as compared to that seen with PEP+IS. However, both the techniques are equally effective in context of other respiratory parameters considered in this study.

CONFLICT OF INTEREST

None declared till now.

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