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Original Article

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ABSTRACT

Objective: *The primary goal of this study is to examine the impact of incentive spirometry and peak expiratory flow meter on risks of cardiopulmonary sequelae following valve surgery.*

Methods: *A randomized controlled trial was carried out at the Ch. Pervaiz Ellahi Institute of Cardiology in Multan's ICU. The research period lasted from May 2022 to June 2023. This trial comprised 64 individuals ranging from 35 to 65 years. Cardiorespiratory parameters, rating of perceived effort, and SF8 quality of life questionnaire were all employed to assess outcome measures. Subjects were divided into two groups. In both groups, treatment was given five days a week for three weeks. The data was analyzed with SPSS V 23. For demographic data, bar graphs were created. To compare the groups, independent samples t-test was used.*

Results: *The mean SpO2 for group 1 was 95.15, for group 2 was 92.31. The mean RPE (Rating of perceived efforts) group 1 was 2.065 and 0.380, for group 2 was 1.968 and 0.932, with a p-value of 0.00 indicating statistically significant improvement.*

Conclusion: *Our study found that both inspiratory and expiratory muscle training were effective on cardiopulmonary parameters in patients who had undergone valvular surgery. Results also showed that (IS) is not superior to PEFR in treating postoperative complications following cardiac valve replacement.*

Keywords: *Heart surgery, valve surgery, incentive spirometry, peak expiratory flow meter, post-operative complications.*

1. INTRODUCTION

The heart is the main pumping organ, pressuring blood for circulation through the blood vessels. The heart's inner anatomy reveals two atria and two ventricles. The two ventricles are the lower chambers that largely pump blood, whereas the two atria are the top chambers that mostly serve as collecting chambers.[1]

High blood pressure, peripheral arterial disease, rheumatic and congenital heart illnesses, arrhythmia all are together referred to as cardiovascular disease (CVD). Compared to other cardiovascular diseases (CVDs), heart valve disorders (HVDs) have a higher mortality rate. These illnesses develop because of heart valve injury. Four valves—the aortic, pulmonary, mitral, and tricuspid valves—help to stop blood from flowing backward in the human heart. Better heart function depends on the proper heart valve opening and closing.[2]

After valve surgery, sudden cardiac death occurs in 15%–30% of patients, or 0.2%–0.9% annually, with arrhythmias being the main cause in most cases.[3] Patients who are recommended for cardiac surgery typically decline in their functional capacity including cardiovascular disease itself, symptoms like dyspnea or angina pectoris, respiratory comorbidities, anemia, malnutrition, muscle mass loss, sadness, or anxiety. This extendS postoperative hospital stay, adds to the burden of administering medications, and delays patient return to normal activities. As a result, it affects both the expense of healthcare and the quality of life for patients.[4] Dyspnea, ventilator restriction, inactivity, and weariness are brought on by peripheral and respiratory muscle dysfunction, which also lowers functional ability, quality of life, and even overall survival.[5] A sternotomy decreases the compliance of the chest wall and breathing capacity. Chest physiotherapy is meant to lessen the possibility of lung complications, functional capacity impairment, and length of hospital stay (LHS) caused by decreased pulmonary function in the early postoperative period.[6]

Incentive spirometry is the method to reduce pulmonary complications and stimulate lung capacity, increase alveolar hyperinflation aid in the muscular respiratory function and increase the effectiveness of pulmonary ventilation through patient resistance and rapid breathing.[7] It helps to strengthen the respiratory muscles, boost resistance, improve physical performance and enhance the quality of life. Lungs have a pressure threshold function that is used for inspiratory and expiratory muscle activities. The results of combining training for inspiratory and expiratory muscular strength are beneficial.[8]

Peak expiratory flow rate [PEFR] is used for lung function test because it is simple, accurate, and repeatable. The maximum flow rate at which air is compelled from the lungs is measured in L/min is known as the PEFR. The respiratory muscles' ability also affects the PEFR. The strength of the respiratory muscles and airway blockage are both very sensitively and accurately measured by PEFR. Peak flow meters are straightforward affordable handheld devices making it reasonably simple to test PEFR via peak flow meter.[9]Various studies on incentive spirometry exist. There is relatively little proof that a peak expiratory flow meter can train the expiratory muscles. This study was primarily conducted to determine whether a peak expiratory flow meter is beneficial for improving cardiopulmonary function and to compare the benefits of both the approaches.

2. METHODOLOGY

A single blinded randomized controlled study was carried out at the Ch. Pervaiz Ellahi Institute of Cardiology in Multan, Pakistan, from May 2022 to June 2023 Non-probability sampling was used. The

ethics and standards established by the ethical review board of the cardiology hospital Multan were followed throughout the trial. The sample size was determined to be 64 (32 in each group), using the formula n=2 [(α+b) 2 σ 2] / (μ1-μ2) 2 after adding 10% dropout. After approval from the Muhammad institute of medical and allied sciences Multan (Ref.NO: MIMAS/02/23/Farah) and intensive care unit department of Ch. Pervaiz Ellahi institute of cardiology, Multan. Ref.NO: PP/TP/131, research work was started.

Patient with both gender male and female with age ranges of (35-65) were included. Patients who had recently undergone heart valve surgery and who were able to comply with the instructions and sign the consent form and patients who underwent median sternotomy-based valvular surgery and hemodynamic ally stable were included. 10 Patients who needed to be intubated for more than 48 hours following surgery and re-intubation throughout the healing process were excluded from our study. Patients who had respiratory infection within the previous three months were also excluded.

Patients who underwent CABG surgery and with any neuromuscular disease, renal disease, smokers, alcohol, anemic and pregnant females were not included in this study. After signing consent papers baseline assessments were performed on all patients who met the qualifying criteria. Cardiopulmonary parameters HR, RR, B.P, and ABGs and SpO2 were measured by arterial line. Borg CR10 scale was used to evaluate rate of perceived exertions of patients. SF8 quality of life Questionnaire was used for evaluation of quality of mental and physical condition. Following initial testing, individuals were distributed at random to one of two groups: IS/group 1 (routine physiotherapy and IS) and PEFR/group 2 (routine physiotherapy and PEFR). The group distribution was unknown to the final results evaluators. Incentive spirometry was performed by asking the patient to lie flat on a bed or a chair.[10]The patient was asked to grasp a pillow to help brace the incision to lessen the pain on chest.

The patients were also being instructed to place the mouthpiece in their mouth and seal their lips tightly around it before slowly and fully exhaling. The next step was to ask the patients to inhale via their mouth slowly and deeply. The ball rose up when the breath was taken. Patients were asked to try to get the ball as high as possible. The patients were instructed to hold their breath for at least 10 seconds after receiving it. After that, they were asked to slowly exhale through their mouth. Next, take a 30- to 60-second break. It was repeated 10 times for 3 sets for 3 weeks. Expiratory muscle training was performed by using peak expiratory flow meter. Patients were asked to sit up straight. Make sure the red marker was located at the meter's base. The patient was asked to inhale deeply. The patient was asked to put the mouthpiece in his/her mouth and then presses their lips firmly against the mouthpiece of the peak flow meter. Then they were asked to expel all the air as quickly and forcefully as they can.

On the meter, the number next to the red marker was noted. At the conclusion of the 3rd week, patients were assessed again on the outcome monitoring tools. While training, patients were asked to rest for a minimum of 15 to 20 seconds. One set was made up of 3 repetitions of this exercise followed by a one-minute break.15 training breaths across 3 breath sets was completed Various investigators conducted the screening, comprehensive cardiopulmonary evaluation and outcome. Data was gathered over a three-week period. Data interpretation was done by using statistical package for social sciences version 23. After fulfilling the parametric assumptions (Kolmogorov-Smirnov), parametric tests were applied. Independent-t test was used to determine mean difference of variables between

groups. Within group differences were measured with the help of paired-t test.

3. RESULTS

Total 64 patients were divided into two groups. Group one contain 24 males (75%) and 8 females (25%), group two contains 21 males (66%) and 11 females (34%). The results of this study showed that the effect of incentive spirometry on heart rate, respiratory rate, oxygen saturation, ABGs, rate of perceived exertion, and mental and physical quality of life was statistically significant with (p value of < 0.001).

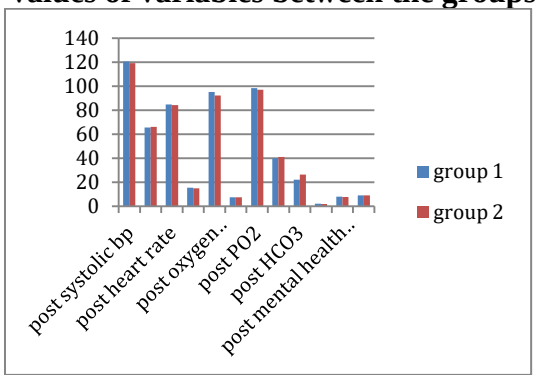
The result also showed that the effect of peak flow expiratory flow meter on respiratory rate, oxygen saturation, ABGs, rate of perceived exertion and mental and physical quality of life was statistically significant with (p value of < 0.001). When comparison analysis was done to assess which training technique was more helpful in reducing cardiopulmonary complications, it showed that no statistical significant differences were found in systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, pH, PCO2, mental and physical health component of quality of life, as both techniques had same effect on these variables. Incentive spirometry has a profound effect on oxygen saturation and partial pressure of oxygen with (p value of < 0.001) while HCO3 and RPE were improved significantly by peak expiratory flow meter with (p value < 0.001).

Table 1: Demographic data

Sr.no	Group 1 (n=32)	Group 2 (n=32)
Mean Age (year)	50	48
Male	24(75%)	21(66%)
Female	8(25%)	11(34%)
Weight (kg)	69	66
Surgery n(%)		
AVR	9(28.1%)	3(9.4%)
MVR	10(31.3%)	12(37.5%)
DVR	3(9.4%)	6(18.8%)
TVR	10(31.3%)	11(34.4%)
Co-morbidity: n (%)	4(12.5%)	3(9.4%)
Hypertension		
COPD	7(21.9%)	6(18.8%)
Atelectasis	5(15.6%)	5(15.6%)
IHD	6(18.8%)	2(6.3%)
Pleural effusion	4(12.5%)	5(15.6%)
Chronic kidney disease	3(9.4%)	6(18.8%)
Pulmonary hypertension	3(9.4%)	5(15.6%)
Source of Oxygen; n (%) NC	30(93.8%)	26(81.3%)
FM	2(6.3%)	6(18.8%)

AVR: Aortic valve replacement, MVR: Mitral valve replacement, DVR: Dual valve replacement, TVR: Tricuspid valve replacement, NC: Nasal cannula, FM: Face mask

Figure 1: Comparison of post mean values of variables between the groups.



4. DISCUSSION

Cardiac valve surgery causes systemic alterations that lead to poor postoperative outcomes. There is evidence that inspiratory and expiratory muscle exercise can prevent postoperative problems. In our study, respiratory metrics improved following inspiratory muscle exercise. The cardiovascular responses of patients generated by an EMST device (PEFR) were established in this investigation. The results revealed no significant changes in blood pressure or heart rate during or after a three-week program. Our study claims that functional performance improved in the group who participated in inspiratory and expiratory muscle training. When the literature was investigated, it was discovered that diverse respiratory muscle training (IS) enhanced the values of respiratory parameters.

Gopala Krishna Alaparthi et al.[12] did a study on 29 patients who had valve

replacement surgery. The study concluded that diaphragmatic breathing, flow or volume-oriented spirometers could improve pulmonary function in the postoperative phase. Hui Su et al.[13] studied individuals who suffered cardiorespiratory complications following cardiac surgery. The study concluded that pre and postoperative nurse-guided incentive spirometry enhanced the partial pressure of oxygen and oxygen saturation of arterial blood after the operation.

Pranjal Keny et al.[14] conducted research to see the effects of flow oriented incentive spirometer exercise on heart rate, respiratory rate, oxygen saturation, systolic blood pressure, and diastolic blood pressure following heart valve surgery. The p value for heart rate and oxygen saturation was statistically significant when flow-oriented incentive spirometer exercise was used. The differences in systolic and diastolic blood pressure were not statistically significant. In another study, Abdul Jalil Khan et al.[15] recruited individuals with cardiopulmonary problems, which are the leading cause of death and disability, including atelectasis. These patients received peak expiratory muscle training.

According to the pulmonary function scale, a significant difference in pulmonary function test with improvement was seen in the experimental group. Another study by Patricia V Burkhart et al. investigated the effect of peak flow monitoring on the quality of life of children with asthma. The findings revealed that asthma QOL improved considerably, and that persons with better asthma health outcomes had higher QOL scores. Dr. Aarsh Bhatt et al.[16] conducted a study to determine the immediate effect of respiratory muscle training on peak expiratory flow rate in post-thoracotomy patients. According to the findings, there was a statistically significant difference in PEFR after respiratory muscle training in post thoracotomy patients.

5. CONCLUSION

Our study demonstrates that the inspiratory muscle training and expiratory muscle training both were effective on cardiopulmonary parameters on patients who had undergone valvular surgery but no significant statistical differences were found when comparison of inspiratory muscle training (with incentive spirometry) and expiratory muscle training (by peak expiratory flow meter) was analyzed.

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