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Assess the Effectiveness of Deep Breathing Exercise with Incentive Spirometry on Respiratory Status of Patients who Undergone Cardiothoracic Surgery

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Abstract: Background: cardiac surgery is an effective treatment for patients with advanced coronary heart disease; it carries a risk for serious non-cardiac complications, such as pulmonary impairments. Pulmonary complications are common following heart surgeries and replacement of diseased valves is often associated with more significant morbidity, prolonged hospital stay and mortality. ***Aim:*** The aim of this study was to evaluate the effects of deep breathing exercises with Incentive Spirometry (IS) and preventing pulmonary complications following cardiothoracic Surgery. ***Methods*:** In a random clinical trial, 50 adult male and female patients, who had undergone cardiothoracic surgery, were randomly assigned into two equal groups. The first group allowed to mobilization and Active exercises of the upper limbs and thorax, breathing exercises with incentive spirometry and instructions in coughing techniques. Patients were mobilized as early as possible by the nursing staff and physiotherapists. The second group takes hospital routine care only. ***Results:*** Parameters of pulmonary function as regards VC and FVC differ significantly between study group post the deep breathing exercise with incentive spirometry and significant improvement was detected in study group after the program. There was no significant differences post deep breathing exercise with incentive spirometry of the study and control groups regards pulmonary complications. ***Conclusion:*** Deep breathing exercises with incentive spirometry is more effective in preventing postoperative complications following cardio-thorax surgery. Moreover, significant improvement was detected in pulmonary function test in study group after use of incentive spirometry .

Key words: Cardio-thorax surgery, Postoperative Pulmonary Complications, deep breathing exercise with incentive spirometry.

INTRODUCTION

Coronary heart disease is one of the most common causes of morbidity and mortality globally [1, 2]. Although cardiac surgery is an effective treatment for patients with advanced coronary heart disease, it carries a risk for serious non-cardiac complications, such as pulmonary impairments [3]. Pulmonary complications are common following heart surgeries and replacement of diseased valves is often associated with more significant morbidity, prolonged hospital stay and mortality[4,5]The most common postoperative pulmonary complication is atelectasis [6]

The factors affecting the development of postoperative pulmonary complications (POPC) are related to the prior health status of the patient, incidence rates of pulmonary complications after heart surgery vary dramatically [7]. The hazards of post operative pulmonary impairments increase with general disability, infections in the respiratory passage, lung disease, smoking, older age, and overweight (Body Mass Index, BMI >25) [8, 9].

Post surgery physiotherapy techniques comprise early ambulation, positioning, deep breathing exercises, effective and coughing technique, active cycle of breathing technique (ACBT) and utilize of a variety of mechanical devices such as incentive spirometer [10-12]. The purposes of physiotherapy are to enhance ventilation–perfusion matching, increase lung volume, improve mucociliary clearance, reduce pain and assist in sputum clearance and subsequently decrease arterial hypoxaemia. [13]

Incentive spirometers, also known as sustained maximal inspiration devices, are used to promote deep breathing. They measure the flow of air inhaled through the mouthpiece and enhance pulmonary ventilation, overcome the effects of anaesthesia or hypoventilation, loosen respiratory secretions, assist respiratory gaseous exchange, and help with re-expansion of collapsed alveoli. In this way, they help to avoid compromised inspiration and reduced tidal volume, which helps to prevent pneumonia. They are also valuable in providing patients with visual feedback of their respiratory effort [14]. Incentive Spirometry has been used to improve pulmonary function, prevent or diminish atelectasis, and treatment of respiratory complications in postsurgical patients. [15]

METHODS

Study Design: A Randomized clinical research design has been utilized.

Setting: This study conducted at cardiothoracic surgery center at Mansoura University Hospital. The collection of data lasted for a period of three months, starting from 1 December to 28 February 2016. Data were collected three days a week from 8.00 am to 10.00 pm with assistance from nursing staff.

Sample:

Purposive sample of all adult male and female patients, agreed to participate in the study aged (18-60 years old) who are admitted for performing cardio thoracic surgery during a period of three months were eligible for inclusion. They were accidentally divided into two equal groups, the first

group allowed to mobilization and Active exercises of the upper limbs and thorax, breathing exercises with incentive spirometry and instructions in coughing techniques. Patients were mobilized as early as possible by the nursing staff .The second group takes hospital routine care only.

Ruling out criteria: existing smoking, a history of a cerebrovascular accident, renal dysfunction, use of immunosuppressive treatments surgery, the existence of neuromuscular disorders or COPD, or a history of previous pulmonary surgery, cardiovascular instability or an aneurysm.

Data collection tools:

***Demographic and Clinical Data Sheet*:**
Developed by the researcher to record patient's demographic data, diagnosis, and medical history were assessed.

Lung function tests:

Done preoperatively and on the forth post-operative day using a spirometer . The vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume in one second (FEV1).

Pulmonary complications:

Once cardiothorax surgery done, pulmonary complication occurs as collapsed lungs; insufficient alveolar distention to activate the production of surfactant, a situation that potentiates alveolar collapse; retention of secretions; dyspnea , pneumonia and atelectasis.

Content validity: The tools were tested for content related validity by jury of 5 specialist in the field of medical-surgical nursing and coronary medicine from Mansoura University and the necessary modifications were done. A pilot study was conducted on 10 patients from each group after explain the nature and purpose of the study to test the feasibility and applicability of the tools.

Reliability: Reliability testing was done using split half methods and Cronbach's alpha that measures the degree of reliability for the entire form. Both techniques showed high reliability of the final version of the tool.(Alpha = .83).

Ethical consideration After obtaining the permission from Ethical Committee of Faculty of Nursing Mansoura University, An Official approval was obtained from hospital administrative authority to collect the necessary data after explanation of the aim and nature of the study. The researcher emphasized participation was absolutely voluntary and confidential. Anonymity, privacy, safety and confidentiality were absolutely assured throughout the whole study as well as the right to withdraw from the study at any time. Participant signed on written consent.

Procedure:

Preparatory phase:

The researcher preoperatively obtained demographic , clinical data , pulmonary function test from the patient medical record and measuring weight and height to calculate body mass index.

Implementation phase:

The nurse orally informed all participants about the importance of early postoperative mobilization, deep breathing exercises with IS, and daily active exercises of the upper limbs and thorax. The patients were mobilized as early as possible by the nursing staff. The patients were sitting out of bed or standing on the first postoperative day, walked in the room or a short distance in the corridor on the second day, and walking a longer distance in the corridor on the third postoperative day.

All the subjects in study group received basic postoperative respiratory physiotherapy including mobilization and Active exercises of the upper limbs and thorax, breathing exercises with IS and instructions in coughing techniques. The subjects were trained about breathing exercises using an incentive spirometer, two times daily with each sitting long lasting for 10 to 15 minutes until day 4. Throughout the sitting, the patients were informed to do diaphragmatic breathing at a rate of 13-19 breaths for each minute.

The patient is instructed to hold the spirometer in an upright position, exhale normally, Put the mouthpiece in your mouth and close your lips tightly around it. Do not block the mouthpiece with your tongue. Inhale slowly and deeply through the mouthpiece to raise the indicator. Try to make the indicator rise up to the level of the goal marker. When you cannot inhale any longer, remove the mouthpiece and hold your breath for at least 3 seconds then exhale slowly. Repeat these steps 10 to 15 times every session.

Figure 1: Subject Performing incentive Spirometry.

Evaluation phase:-

- Evaluate the occurrence of lung complications after cardio-thoracic surgery for study and control group.
- Evaluate any improvements of pulmonary function test after the program by Comparison between control and study group.

Statistical analysis Data was collected and analyzed by computer programmed SPSS (ver.16) Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and median for qualitative variables. Qualitative variables were compared using Wilcoxon Singed Ranks Z Test to determine significance for non-parametric variables. The critical value of the tests "P" was considered statistically significant when P less than 0.05.

RESULTS

Table (1): Socio-demographic characteristics of the study group and the control group:

Items	Study group		Control group		Total		Pearson Chi-Square X2 test (P)
	No=25	%	No=25	%	No=50	%	
Age (in years)							
20-34	1	4.0	4	16.0	5	10.0	2.043 (0.360)
35-44	4	16.0	4	16.0	8	16.0	
45-60	20	80.0	17	68.0	37	74.0	
Sex							3.945 (0.047)*
Male	17	68.0	10	40.0	27	54.0	
Female	8	32.0	15	60.0	23	46.0	
Marital status							4.514 (0.211)
Married	20	80.0	15	60.0	35	70.0	
Divorced	1	4.0	4	16.0	5	10.0	
Widowed	3	12.0	2	8.0	5	10.0	
Single	1	4.0	4	16.0	5	10.0	
Educational level							9.894 (0.042)*
No formal education	7	28.0	9	36.0	16	32.0	
Read& write	11	44.0	4	16.0	15	30.0	
Primary	4	16.0	1	4.0	5	10.0	
Secondary	1	4.0	4	16.0	5	10.0	
University &above	2	8.0	7	28.0	9	18.0	
Occupation							0.902 (0.637)
Not working	9	36.0	12	48.0	21	42.0	
Work on a part -time	5	20.0	5	20.0	10	20.0	
Work on a full -time	11	44.0	8	32.0	19	38.0	
Medical payment							6.356 (0.042)*
Totally reimbursed	22	88.0	14	56.0	36	72.0	
Totally self paid	1	4.0	4	16.0	5	10.0	
Partially reimbursed	2	8.0	7	28.0	9	18.5	

Table 1: shows the socio-demographic characteristics of the study and control groups. The majority of the sample of the study group (80.0%) ranged from 45 to 60 years, while (68.0%) in the control group ranged from 45 to 60years with no statistical significant differences (x^2=2.043), p= (0.360).

Males were more prevalent in the studied sample of the study group (68.0%). while females were more prevalent in the control group (60.0%), with significant differences between the two groups (x^2= 3.945), p= (0.047).

In study and control groups, 80.0% and 60.0% respectively were married with no significant differences between two groups (x^2= 4.514), p= (0.211).

Concerning level of education, reading and writing prevailed among 44.0% of the study group , while 36.0% of the control group were No formal education ,with statistical significant difference (x^2=9.894), p= (0.0420) .

Concerning medical payment, The majority of patient in the study and control groups (88.0% and 56.0%) respectively were totally reimbursed, with statestically difference (x2=6.356, p= (0.042).

Table (2): health relevant data of the both groups:

Items	Study group		Control group		Total		Pearson Chi-Square X2 test (P)
	No=25	%	No=25	%	No=50	%	
Diagnosis							4.444
-Ischemic heart disease	20	80.0	16	64.0	36	72.0	(0.108)
-Disease of the heart valves	0	0.0	4	16.0	4	8.0	
-Chronic heart failure	5	20.0	5	20.0	10	20.0	
Family history							
Yes	19	76.0	17	68.0	36	72.0	
No	6	24.0	8	32.0	14	28.0	7.562 (0.023)*
Body mass index							
Over weight	23	92.0	22	88.0	45	90.0	2.298
Obese	2	8.0	3	12.0	5	10.0	(0.317)
Median(Min-Max)	27.70(25.10-27.70)		27.40(25.10-30.10)				
Smoking							
Never	10	40.0	12	48.0	22	44.0	
Stopped	15	60.0	12	48.0	27	54.0	
Current	0	0.0	1	4.0	1	2.0	12.985 (0.011)*
Associated disease							
-Diabetes							22.222
Yes	24	96.0	21	84.0	45	90.0	(0.000)*
No	1	4.0	4	16.0	5	10.0	
-Hypertension							
Yes	25	100.0	25	100.0	50	100.0	a.
No	0	0.0	0	0.0	0	0.0	
-PTCA/ stent therapy							
Yes	4	16.0	1	4.0	5	10.0	22.222
No	21	84.0	24	96.0	45	90.0	(0.000)*

a. No statistics are computed because post pneumonia is constant

Table (2): Shows health relevant data among the study group and the control group. It is noticed that, ischemic heart disease was the most common diagnosis among the study group and the control group 80.0% and 64.0 % respectively.

Regarding family history, the majority of the studied samples in the study and control groups (76.0% and 68.0%) respectively were having family history. (x^2=7.562 , p= (0.023).

Concerning body mass index, the majority of the studied sample in the study and control groups (92.0% and 88.0%) respectively were overweight.

In relation to smoking, 60.0% and 48.0% of the study and control groups respectively were stopped smoking, while 40.0% of the study group and 48.0% of the control group were never smokers. (x^2=12.985, p= (0.011).

As regards associated disease, it was observed from this table that, all studied sample (100.0%) in the study and control group have hypertension, followed by diabetes mellitus; 96.0% of study group and 84.0% of the control group with significant difference (x^2= 22.222, p= (0.000).

Table (3): Pulmonary function test of the two groups' pre and post deep breathing exercise with incentive spirometry:

Pulmonary function test	Study group		Control group		Z test (p)[a]	Z test (p)[b]
	Pre	post	pre	post		
	Median(Min-Max)	Median(Min-Max)	Median(Min-Max)	Median(Min-Max)		
VC	77.00(60.00-80.00)	110.00 (83.00-120.00)	77.00(60.00-80.00)	83.00(77.00-119.00)	1.183 (0.237)	3.202 (0.001)*
Z test (p)[1]	4.37(0.000)*		4.392(0.000)*			
FVC	83.00(65.00-108.00)	97.00(80.00-120.00)	78.00(65.00-107.00)	83.00(70.00-120.00)	1.840 (0.066)	2.411 (0.016)*
Z test (p)[1]	4.068(0.000)*		2.844(0.004)*			
FEV1	83.00(74.00-110.00)	97.00(80.00-120.00)	78.00(74.00-110.00)	87.00(75.00-115.00)	1.098 (0.272)	1.280 (0.201)
Z test (p)[1]	2.006(0.045)*		1.753(0.080)			

Wilcoxon Singed Ranks Z Test (p) [1]: comparing pre program and after in each group.
Wilcoxon Singed Ranks Z Test (p) [a]: comparing study and control group pre the program.
Wilcoxon Singed Ranks Z Test (p) [b]: comparing study and control group post the program.
**significant at p≤0.05*

Table (3): illustrates the pulmonary function test of the study group and the control group pre and post deep breathing exercise with incentive spirometry. Parameters of pulmonary function as regards VC and FVC differ significantly between study and control groups post the deep breathing exercise with incentive spirometry. Were p= (0.001) and p= (0.016) respectively. On the other hand, there were no statistically significant differences between the two groups before applying deep breathing exercise with incentive spirometry regarding all parameters of pulmonary function.

All parameters of pulmonary function were increase post deep breathing exercise in two groups. Statistically significant change was detected in each group pre and post the deep breathing exercise with incentive spirometry regarding all pulmonary function except FEV1 in the control group where p= (0.080). Significant improvement was detected in study and control group after the program.

Table (4): Pulmonary complications of the study group and the control group post deep breathing exercise with incentive spirometry:

Post Complications	Study group		Control group		Pearson Chi-Square X2 test (P)
	No=25	%	No=25	%	
Dyspnea					
Yes	4	16.0	7	28.0	1.049 (0.306)
No	21	84.0	18	72.0	
Pneumonia					
Yes	0	0.0	0	0.0	a.
No	25	100.0	25	100.0	
Cough					
Yes	9	36.0	12	48.0	0.739 (0.390)
No	16	64.0	13	52.0	
Respiratory secretion					
Yes	9	36.0	12	48.0	0.739 (0.390)
No	16	64.0	13	52.0	
Atelectasis					1.049 (0.306)
Yes	4	16.0	7	28.0	
No	21	84.0	18	72.0	
Respiratory embolism					
Yes	0	0.0	0	0.0	a.
No	25	100.0	25	100.0	

b. No statistics are computed because post pneumonia is constant

Table (4): reveals pulmonary complications of the study group and the control group post deep breathing exercise with incentive spirometry. Cough and respiratory secretion are the common occurrence complications post the program in the study and control group (36.0% and 48.0%) respectively.

There was no significant differences post deep breathing exercise with incentive spirometry of the study and control groups.

Table (5): Relation between Socio-demographic characteristics and pulmonary function test of the study group post deep breathing exercise with incentive spirometry:

Socio-demographic characteristics	Pulmonary function test		
	VC	FVC	FEV1
Age (in years)			
35-44	101.12±13.49	90.80±19.65	84.52±5.186
45-60	105.84±13.36	103.93±14.08	97.95±14.23
Test of significance	X^2 =2.305 (0.316)	X^2 =1.427 (0.490)	X^2 =3.213 (0.201)
Sex			
Male	106.14±12.07	100.26 ±15.82	94.84±14.44
Female	99.97±16.65	104.55±14.16	99.63±13.78
Test of significance	Z =0.880 (0.379)	Z=0.323 (0.747)	Z=1.175 (0.240)

Table (5): show relation between Socio-demographic characteristics and pulmonary function test of the study group post deep breathing exercise with incentive spirometry , reveals that , an increased in all parameters of pulmonary function for studied patients with age group 45-60 years old than other age groups post deep breathing exercise with incentive spirometry, with no statistically significant relation.

Concerning gender, there was an increase in pulmonary function test for female more than male patient's regards FVC and FVC1, while VC increased in male , with no

statistical significant differences in the study group post deep breathing exercise with incentive spirometry.

DISCUSSION

The aim of current study is to evaluate the effect of deep breathing exercises with Incentive Spirometry (IS) and preventing pulmonary complications following cardiothoracic Surgery.

It is obvious from the present study that the majority of the study group and control group were in age group 45 to 60 years old and most patient in study group were males while in control group were female. This in line with ***(Sadeghi HA et al. 2016)***[16] who reported that Overall, 180 patients (92 males and 88 females) with a mean age of 49 ± 15.9 were studied, and ***Savc (2006)***[17] the results showed the average age of 55.2±8.5 57.2±8.9.

The results have shown that patients in the two study groups were similar in their body mass index with no statistically significant differences among them. This is in congruence with ***Shamsi (2014)***[18] who reported the mean of BMI in three groups 26.9±3.3, 27.2±3.4, 27.1±3.0 (0.093) with no significant difference among them.

The results show that, parameters of pulmonary function as regards VC and FVC differ significantly between study and control groups post the deep breathing exercise with incentive spirometry, with p= (0.001) and p= (0.016) respectively. On the other hand, there were no statistically significant differences between the two groups before applying deep breathing exercise with incentive spirometry regarding all parameters of pulmonary function.

All parameters of pulmonary function were increase post deep breathing exercise in two groups. There statistically significant change was detected in each group pre and post the deep breathing exercise with incentive spirometry regarding all pulmonary function except FEV1 in the control group where p= (0.080). Significant improvement was detected in study group after the program. This findings come in accordance with ***(Stock c et al, 2010)***[19] who noted that, patients who undergo upper abdominal and cardiac surgery, acquired relative decreases in all pulmonary capacities without clinically important changes in FEV1, FVC, but patients utilized incentive spirometer had more fast improvement of VC than those who received conventional treatment, but the two treatment groups showed related improvement in FVC and FEV.

The current study revealed that the majority of complications (36.0% and 48.0%) having pulmonary complications (Cough and respiratory secretion) respectively in the study and control group, with no statistical significant differences between two groups. This is in congruence with ***(Ahmed MA et al, 2015)***[20] who reported that 12% &48% in two groups having atalactasis and lung exudates. And ***(Brage et al, 2009)***[21] revealed that respiratory rehabilitation before surgery is extensively linked to a poor frequency of atelectasis after surgery of CABG by I S, deep berating technique. ***(Stock et al, 2010)***[19] showed that patients utilize respiratory rehabilitation with or without devices are linked with decreased frequency of postoperative pneumonia and atelectasis. This is in contrast with ***Weissman (2010)***[4] who said that, postcardiac surgery, there are decreases in forced vital capacity, (FEV1) and highest controlled ventilation than preoperative time.

CONCLUSION

Depending on the statistical investigation, it can be summarized that, deep breathing exercises with Incentive Spirometry is more efficient in preventing postoperative complications following cardio-thorax surgery. Moreover, significant improvement was detected in pulmonary function test in study group after use of incentive spirometry.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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