Effect of Implementing Respiratory Exercises on Patients' Hemodynamic Parameters Post Extubation in Cardiothoracic Intensive Care Unit

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Abstract

Background: The most critical time for the patient is the postoperative phase. During this period, complications following open heart surgery result in significant consequences so using respiratory exercises have long been a standard component of post-operative care. **Aim:** Evaluate the effect of implementing respiratory exercises on patients' hemodynamic parameters post extubation in Cardiothoracic Intensive Care Unit. **Design:** A quasi-experimental study was used. **Setting:** Cardiothoracic Intensive Care Unit in Tanta International Teaching Hospital affiliated to Tanta University Hospitals. **Subjects:** Purposive sample of 60 patients divided into two groups 30 in each. **Tools:** Three tools were utilized in this research. **Tool I**: Patients' Structured Assessment. **Tool II:** Cardiothoracic Rehabilitation Exercises Tolerance Checklist. **Tool III:** Patients' Respiratory Hemodynamic Parameters. **Result:** the mean of FEV1 in the study group at first day was 87.87±5.17 and for the second day was 93.63±3.43 with highly statistically significant, p value = 0.000. Comparison with the mean control group FEV1 was 56.30±4.21 for day one and 56.57±3.89for day two **.**the mean of FVC in the study group first day was 86.27±3.06 and for the second day was 92.60±3.58 with highly statistically significant p value = 0.000. A significant correlation between total exercises tolerance and heart rate and pao_2 among patients in study group on 2nd day with p value 0.005 and 0.003 respectively, while there no significant correlation between total exercises tolerance and BP, RR and $Paco_2$ with p value < 0.05. **Conclusion:** Combination of early activity and chest physiotherapy lead to better hemodynamic parameters such as oxygenation and ventilation indicators and stability of vital signs than the routine nursing care. **Recommendation:** Giving more training to nurses working in anesthesia care who deal with patients after open-heart surgery and encouraging nurses to using deep breathing exercise and incentive spirometer, shoulder mobilization and chest exercises and upper limb exercise.

Key words: Cardiothoracic Surgery, Hemodynamics Parameters, Respiratory Exercises

Introduction

The most critical time for the patient is the postoperative phase spent in cardiothoracic intensive care unit. Suppose the patients are not effectively handled during this period. In that case, complications following open heart surgery result in significant consequences such as prolonged hospitalization, ICU re-admission, massive treatment expenditures, and even death. **(Saravanan, 2024).** Cardiothoracic intensive care units include patients undergoing open-heart surgery. During this surgical procedure, an incision should be made into the heart, thus exposing one or more of the cardiac chambers. **(Hardin & Kaplow, 2025).**

It also requires the use of a heart-lung machine, a device that allows circulation and oxygenation of the blood to be maintained outside the patient's body. The most common open heart procedures are for the repair of valvular disease and for the correction of congenital heart defects, chiefly septal and valve defects. (**Saef & Ghobrial, 2021).**

The global average prevalence of respiratory complications post extubation following coronary artery bypass graft surgery was estimated to be 2-4% and the most common respiratory complications were reported as: atelectasis 27-95%, pleural effusion (16.6-88%) and phrenic nerve paralysis 30-75%. **(Wiratama, Yan Efrata Sembiring & Setiawan, 2024).**

Additionally, in Egypt a study stated that postoperative respiratory complications post extubation occurred in 7.82% of patients with coronary artery revascularization, 2.23% in patients with valvular replacement and 5.05% in patients with congenital heart diseases. **(Ahmed, Hassan, Mohamed, & Gamal, 2019).** Acute respiratory distress syndrome occurred in 3.35% of patients with a mortality rate of about 66.6%, pneumonia in 2.79%, atelectasis in 3.35%, pleural effusion in 2.22% and pneumothorax in 0.55 %. **(Odhah, Al-Qubati, Mohammed, Abd El-Aziz, & Mahgoub, 2020).**

Moreover, in cardiothoracic surgery department at Tanta university hospital in 2020, reported about 210 patients underwent cardiothoracic surgeries. A study conducted in the same sitting revealed that; the overall incidence of postoperative respiratory complications post extubation was 64.4% and the mortality rate was 45.8%. **(Salem, Ali, Hady, Taha, & Diab, 2020).**

After open heart surgery using general anesthesia and cardiopulmonary bypass, the patient's respiratory function such as; vital capacity, total

lung capacity, inspiratory capacity and functional residual capacity are decreased; so, after surgery patients are taken to cardiothoracic intensive care unit (CICU) for mechanical ventilation. **(Tang, Gong, Lu, Chen, Fang, & Liu, 2021).** Controlling tachycardia and hypertension which can occur due to catecholamine release from patients with endotracheal extubation, is important to protect myocardium and prevent potential complications. **(Tarwade, & Smischney,. J. 2022).**

Both intubation and extubation can increase the concentration of catecholamine in the blood by stimulating the sympathetic nervous system, and resulting in severe hemodynamic changes. However, during intubation, agents such as opioids and propofol can effectively inhibit airway stimulation by laryngoscopy and intubation. **(Qiao, Wang, Shen, Xing, & Yuan, 2024).** Although hemodynamic changes during post-operative period are normally well-tolerated by healthy individuals, such changes may be detrimental in hypertensive patients, leading to hemodynamics instability life-threatening complications such as myocardial ischemia, cardiac arrhythmias, and cerebrovascular hemorrhage. **(Hulme, & Kong, 2005).**

Respiratory exercises especially chest physiotherapy has long been a standard component of post-operative care. **(Xu Cheung, Smith, Lai, & LinL, 2022).**

Techniques used include early mobilization, positioning, exercise of shoulder and neck mobilization, incentive spirometer and deep breathing exercise with or without mechanical devices. **(Amin, Alaparthi, Samuel, Baireparedy, Raghavan & Vaishali. 2021).**

Manual techniques such as percussion and vibration may be hazardous in cardiac surgery patient, because of the risk of sternum instability and no positive effects have been found. **(Hautalathi,. 2019)**

The critical care nurse has a vital role in the postoperative care of open-heart surgery patients. They should educate the patients preoperatively about the importance of regular chest exercises and early mobilization to improve hemodynamic status instructions concerning the frequency and duration of each exercise after cardiac surgery vary notably in clinical practice. **(Köse, & Avşar, 2021).**

Moreover, critical care nurses are mostly responsible for monitoring and assessing the cardiovascular, respiratory, and renal status to create an effective care plan or guidelines. **(Sole, Klein, & Moseley, 2020).**

They provide the patients with comfort and safety, encourages mobility and prevents complications. The nursing role is crucial in reducing the incidence of morbidity and mortality and shortening the length of stay in intensive care unit. Thus, the aim of the current study is to evaluate the effect of respiratory exercises on Patients' hemodynamic parameters post extubation in cardiothoracic intensive care unit**.**

Significance of study

During clinical observation in cardiothoracic intensive care unit, it was found that postoperative hemodynamics and functional capacity have important implications for patient recovery after cardiac surgery; respiratory related exercise may reduce postoperative complications related to hemodynamics instability such as; myocardial ischemia, cardiac arrhythmias and cerebrovascular hemorrhage and improves postoperative physiological functional capacity.**(Mahmoud, Gamil, Al-mashtoly, El Khonizy & Refaie,. 2020)**. Early participation in prescribed postoperative exercise programs is an integral component of rapid recovery protocols leading to optimal surgical outcomes

Aim: Evaluate the effect of implementing respiratory exercises on patients' hemodynamic parameters post extubation in cardiothoracic intensive care unit.

Research Hypothesis

The study group who received respiratory exercises are exhibit better hemodynamic parameters such as oxygenation and ventilation indicators and stability of vital signs than the control group.

Subjects and methods

Research design

A quasi-experimental research design was utilized.

Setting

The study was conducted at the Cardiothoracic Intensive Care Unit in Tanta International Teaching Hospital which is affiliated to Tanta University Hospitals. This unit was equipped with 9 bed capacity and includes advanced technology and manpower required for patients' care.

Subjects

A purposive sample of 60 patients with open heart surgery was collected from the previously mentioned setting. Based on Epidemiological Information Program (EPI info) and the total patients admitted per year according to review of Tanta University Hospital statistical records in 2020 were 210 patients this conducted form (Statical analysis of Tanta

University Hospital, 2020)., and the sample size was calculated as the following:

Z= confidence level 95%, d= Error proportion (0.05), P= population (50%). The sample was divided into two equal groups 30 patients in each group as the following:

Study group: consisted of 30 adult patients who received the respiratory exercise as agreed by the treating physician and implemented by the researcher.

Control group: consisted of 30 adult patients who received the routine nursing care as prescribed by the physician which include using of incentive spirometer and chest percussion.

Subjects have been chosen regarding to the following criteria:

- Adult patients aged 21-60 years old of both sex within the first two hours, post extubation, able to communicate.

Exclusion criteria

- Unconscious patients, Patients with history of chronic respiratory diseases, neuromuscular diseases such as Guillain-Barre syndrome, amyotrophic lateral sclerosis, muscular dystrophy, myasthenia gravis, and spinal muscular atrophy

Tools of data collected: - Three tools were used in this study:

Tool I: **Patients' Structured Assessment**: It was developed and structured by the researcher after reviewing of related literature, it included 3 parts as follow: - Part**(A): -** Patients' socio-demographic characteristics such as age, sex, educational level, residence, marital status, and occupation. **Part (B): Patients' health relevant data**; it included, smoking history, past medical, surgical history, and current medical history such as diagnosis, type of surgery and chief complaints. **Part (C):** Patients' extubation assessment, such as types of the tube, mode of mechanical ventilator before extubation, friction of inspired oxygen, gag, and cough reflexes. **(Nadi, Azizi-Fini, & Izadi-Avanji, 2020)**

Tool II: **Cardiothoracic Rehabilitation Exercises Tolerance Checklist;** This tool was developed by **García et al (2014)** to assess postoperative respiratory exercises open heart surgery patients which included two parts as follows:

Part (A): Respiratory physiotherapy, it consisted of 10 steps; incentive spirometer includes 6 steps, deep breathing includes 4 steps. **Part (B):** Sternal and upper limb exercises, it consisted of 22 steps; upper limb exercises include 15 steps and sternal precautions include 7 steps.

Scoring system: The maximum score value was composed of 32 item respiratory physiotherapy (10 item) point and sternal and upper limb exercises (22 item) each item was observed, categorized, and scored into either done =1 or not done= 0 on all items of the checklist. Then These scores were classified as unsatisfactory level (less than 60%), and satisfactory level (more than 60%).

Too III: - Patients' Respiratory Hemodynamic Parameters

This tool was developed by the researcher after reviewing related literature review **(Boone, T. (2020).** it was used to assess patient's hemodynamic parameters three times daily for two days post extubation. It is comprised from three parts as the following:

Part (A): Patients' vital signs, such as heart rate, respiratory rate and blood pressure**. Part (B):** Patients' oxygenation indicators, such as oxygen saturation which measured using pulse oximeter and arterial blood gases which include partial pressure of oxygen, partial pressure of carbon dioxide and oxygen saturation. **Part (C):** Patients' ventilatory indicators; such as forced expiratory volume in 1 second, forced vital capacity and maximum voluntary ventilation.

Scoring system

The maximum score value was 10 which distributed as the following patients' vital signs (3 items) patients' oxygenation indicators (4 items) and patients' ventilatory indicators (3 items) each item was observed, categorized, and scored into either normal =0 or abnormal= 1 on all items of the checklist. After completing the data tabulation, the researcher gave the statistics specialist the natural numbers and results to develop a general perception of the mean and standard deviation of the results to demonstrate the effect of Implementing Respiratory Exercises on Patients' Hemodynamic Parameters Post Extubation in Cardiothoracic Intensive Care unit as protocol.

Method

1. **Official Permission** to carry out the study obtained from the responsible authorities at the study setting.
2. **Ethical and legal consideration:**

a) Approval of ethical committee was obtained code 27/12/2021 and the approval code number of faculty of medicine was 22/1/2022

b) Informed consent was obtained from every patient after explanation of the aim of the study and assuring them confidentiality of collected data.

c) Patients were informed that participation is voluntary and that

they could withdraw at any time of the study.

d) Confidentiality and Privacy of the studied patients was maintained by the use of code number instead of the patient's name.

3. Tool development: Tool I was developed by the researcher and Tool II was developed by **(García et al 2014),** and was adapted by the researcher. Tool III was developed by the researcher after reviewing related literature review.

4. Tools Validity

All tools were tested for content validity by seven jury of experts in the field of critical care nursing cardiothoracic and biostatistics Tanta University before conducting the study.

5. Reliability

The study tool (II) was tested for reliability by using Cronbach's alpha test, it was computed and found was (0.71) and tool (III) were tested for reliability were (0.74)

6. A pilot study

It was conducted before the actual study on 10% of the patients (10 patients), in order to test the clarity, feasibility and applicability of the different items of the developed tools Modifications, rephrasing and some additional terms were done by the researcher before the main study. Data obtained from those patients were excluded and not included in the current study.

7. Data collection

Data were collected over a period of 6 months, started from March 2022 to September 2022. The present study was conducted through.

8. Phases of the study

The present study conducted through four phases as follow:

1-Assessment phase: The researcher used tool I to assess patients in both study and control groups immediately post extubation to collect baseline data to assess the patients who met the inclusive and exclusive criteria.

2-Planning phase: - This phase was formulated based on assessment phase and expected outcome criteria. The expected outcome was prescribed when planning patient care which include:

- Improve patients' oxygenation and ventilation parameters.
- improve stability of patients' vital sign.

Educational aids and strategies were used during the session which include, one to one instruction, demonstration used as teaching method. Also, teaching aids such as booklet and videos using lab tops and smart phones. A booklet and video were prepared by the researcher. The booklets and video were distributed to the patients participated in the study at the end of sessions.

3- Implementation phase

A. Control group: they received the routine nursing care as prescribed by the physician which includes using incentive spirometer and chest percussion.

B. Study group: During this phase, a respiratory related exercise implemented by the study group during sessions. During the first- and second-day post extubation, patient was started respiratory related exercises after physician permission in three sessions and the duration of each session will be 20-30 minutes during the first- and second-days post extubation as the following*:*

A. The first session: It included deep breathing exercise and incentive spirometer as follows*:*

Deep breathing exercise; assessed patient condition before exercise, place patient in semi fowler position and the researcher encouraged study group to inhale deeply through the nose and then hold the breath for 2-3 seconds then exhale through pursed lips 10 times every 2 hours for two post-operative days during daytime*.*

Incentive spirometer; place patient in semi fowler position, then hold incentive spirometer straight at eye level, put mouthpiece in patient mouth and close patient lips tightly around it to create a seal, then the patient will deeply and slowly breathe in through mouth to raise the balls and then patient hold the breath for 5 seconds then turn the spirometer upside down and exhale in the mouthpiece to raise balls again for 4 times daily during daytime for two post-operative days*.*

B. The second session: It consisted of shoulder mobilization and chest exercises as follows*:*

Shoulder shrugs; patient will be instructed to bring shoulders up to the ears then relax shoulders down for 10 times every 4 hours for two post-operative days.

Shoulder circles; sitting patient upright, roll shoulder in a smooth motion up, back and down in a circle for 10 times every 4 hours for two post-operative days*.*

Trunk twist; slowly encourage patients rotate his trunk to the right, looking over his shoulder. Hold and stretch. Then rotate his trunk to the left, hold and stretch. For 10 times every 4 hours for two post-operative days.

Chest stretch; Place patient hands behind his head while sitting upright. Move his elbows back until he feels stretch, hold. Relax elbows forward to rest for 10 times every 4 hours for two post- operative days*.*

C. **The third session:** It consisted of upper limb exercise as follows*:*

Forward arm raises; the patient sitting in upright posture, straightening his arm with his thumb facing up. Raise his arm up to the front over his head. Patient

elbow should be next to his ear and will be repeated with other arm for 10 times every 4 hours for two post-operative days.

Side arm raises; the patient holds his arms straight out to his side with his thumb up. Patient will raise his arm up to the side over his head, hold and stretch and will be Repeated with other arm for 10 times every 4 hours for two post-operative days.

4- Evaluation phase: - Evaluation was done for both study and control groups using tools II and III three times daily for two consecutive days post extubation.

Results

Table (1) Illustrating distribution of the studied patients according to their socio-demographic characteristics. (n=60)

It was observed that, the majority (80 % and 93.34 %) of patients in both study and control groups were aged between 50-60 years old with Mean ± SD of (54.73±5.085 and 53.17±5.045) respectively, about two-thirds (63.33% and 66.67%) of patients in both study and control groups were male, the majority (80% and 90%) of patients in both study and control groups were married.

Regarding educational level, one third (30%) of patients in the study group had university education while half (50%) of the control group patients had university education. In relation to residence, two -thirds (66.67%) of the study patient group were rural and less than two -thirds (60%) of control group were urban. more than half (60%) of patients in control group were employee compared to less than quarter (20 %) of study patients.

Table (2): Shows distribution of the studied patients regarding their present medical history (n=60)

It can be seen that, the most common diagnosis (70.00% and 73.00%) among patients in both study and control group was myocardial infarction. In addition, more than half (53.33% and 73.33%) of patients of both study and control group had CABG respectively.

Regarding patients' chief complaints, it was observed that the most common complaints (80.00%) among patients in the study group was chest pain and the least common complain (3.33%) was shortness of breath while that the most common complain (76.67 %) among patients in control group was shortness of breath and the least common complain (20.00%) was fatigue.

Table (3) Reveals distribution of the studied patients regarding their past medical history. (n=60)

It was found that one third (33.33 %) of study group had history of asthma and (36.67%) of them had hypotension and ischemic heart disease while

(46.67%) of control group had diabetes mellitus and hypertension and (20%) of them had valve heart disease. Regarding previous hospitalization it was noticed that more than half (60%) of the studied patient had not admitted in hospital.

Table (4) Reveal distribution of the studied patients regarding their past surgical history. (n=60)

It was found that the most common (10.00%) past surgical history among patients in both study and control group was related to appendectomy while, the least common (3.33 %) past surgical was related to hysterectomy inguinal hernia and pilonidal sinus.

Table (5) Illustrates distribution of the studied patients regarding their smoking history. (n=60)

It was observed that less than half (46.67 %) of patients in the study group and more than half (56.67%) of patients in the control group were cigarette smoker with Mean ± SD (26.43±9.321 and 21.41±3.163) respectively.

Table (6); Reveals distribution of the studied patients regarding their mode of mechanical ventilation.

It was noticed that all (100%) patients of the study and control group had SIMV mode

Table (7) Shows total mean scores of cardiothoracic rehabilitation exercises tolerance domains among studied patients throughout the study. (n=60)

It was observed that there were highly statistically significant differences among study and control groups regarding physiotherapy, Sternal precautions and upper limb Exercises and Cardiothoracic Rehabilitation Exercises' tolerance throughout period of study with P = 0.000.

Table (8): Reveals mean scores of vital signs indicators among patient of both studied groups. (n=60). It was observed that there were highly statistically significant differences among study and control groups related HR, BP, O_2, RR, PaO_2 with p = 0.000, while there no significant difference was observed among control and study group related their items except respiratory rate

Table (9): Presents mean scores of ventilator indicators among studied groups throughout the study period

This table revealed that mean± SD of FEV1 during the 1st postoperative day was 87.87±5.17 and it was 88.71±5.17 during 2nd post operative day in study group and it was 56.30±4.21 and 56.57±3.89for the control group respectively. while FVC during the 1st postoperative day was 86.27±3.06 and 92.60±3.58 at 2nd day for study group while it was 56.57±4.46 and 56.30±3.72 for the control group respectively and MVV during the 1st

postoperative day was 110.50±15.19 and 117.50±17.20 at 2nd day for study group and it was 63.40±3.82 and 64.77±4.84 for the control group respectively. Statistically significant differences were found between the two groups regarding FEV1 and FVC where p value = 0.000

Table (10): Illustrates correlation between Total exercises tolerance and their vital signs indicators.

It was observed significant correlation between total exercises tolerance and heart rate and pao_2 among patients in study group on 2nd day with p value 0.005 and 0.003 respectively while there no significant correlation between total exercises tolerance and BP, RR and $Paco_2$ with p value > 0.05

Table (11): Shows correlation between Total exercises tolerance and their ventilator indicators.

It was observed that there was no significant correlation between total exercises tolerance and ventilator indicators of both groups with p > 0.05 throughout period of study

Table (1): Distribution of the studied patients of both groups according to their socio-demographic characteristics.

Characteristics	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
Age (in years)					
- (30-<40)	1	3.33	1	3.33	2.974 0.226
- (40-<50)	5	16.67	1	3.33	
- (50-60)	24	80.00	28	93.34	
Range	**(38-60)**		**(33-60)**		F=1.435
Mean ± SD	**53.17±5.045**		**54.73±5.085**		P=0.236
Gender					
- Male	19	63.33	20	66.67	FE
- Female	11	36.67	10	33.33	1.00
Marital status					
- Married	24	80.00	27	90.00	FE
- Widow	6	20.00	3	10.00	0.472
Educational level					
- Illiterate	3	10.00	6	20.00	
- Read & write	9	30.00	0	0.00	1.501
- Secondary	9	30.00	9	30.00	0.059
- University	9	30.00	15	50.00	
Residence					
- Urban	10	33.33	18	60.00	FE
- Rural	20	66.67	12	40.00	0.069
Occupation					
- Manual Work	6	20.00	7	23.33	
- Employee	6	20.00	18	60.00	2.188 0.057
- Technical work	4	13.33	5	16.67	
- House-wife	7	23.33	0	0.00	
- Not work	7	23.33	0	0.00	

FE:Fisher' Exact test

Table (2): Distribution of the studied patients regarding their present medical history

Present medical history	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
Current Diagnosis					
- Benign lung tumor	1	3.33	2	6.67	
- Myocardial infarction	21	70.00	22	73.33	0.642
- Mitral stenosis	8	26.67	6	20.00	0.725
Type of cardio-thoracic surgery					
- CABG	16	53.33	22	73.33	
- Mitral Valve Replacement	10	33.33	6	20.00	2.614
- Lobectomy	4	13.33	2	6.67	0.271
Chief complains					
- Chest Pain	24	80.00	22	73.33	
- Shortness of breath	1	3.33	23	76.67	
- Fatigue	23	76.67	6	20.00	
- Dyspnea on exercise	13	43.33	0	0.00	3.665
- Palpitations	4	13.33	0	0.00	0.288

CABG: Coronary Artery Bypass Graft

Table (3): Distribution of the studied patients of both groups regarding their past medical history.

Past medical history	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
I. Respiratory diseases					
- Asthma	10	33.33	2	6.67	
- Benign lung tumor	3	10.00	0	0.00	
- Chronic obstructive pulmonary disease	1	3.33	0	0.00	2.001 0.064
- Lung cancer	4	13.33	0	0.00	
- Lung tumor	0	0.00	2	6.67	
- Respiratory failure type 1	1	3.33	0	0.00	
II. Liver and metabolic diseases	1	3.33	0	0.00	
- Cholethliasis	1	3.33	0	0.00	
- Fatty liver	1	3.33	0	0.00	-
- Hepatitis c	3	**10.00**	**0**	**0.000**	
III. Kidney diseases	1	3.33	0	0.00	
- Chronic kidney disease	1	3.33	0	0.00	
- End stage renal diseases.	1	3.33	0	0.00	-
- Kidney stones	3	**10.00**	**0**	**0.00**	
IV. Other diseases	**30**	**100**	**28**	**93.33**	
- Diabetic mellitus	6	20.00	3	10.00	
- Hypertension	11	36.67	0	0.00	2.216
- Diabetic mellitus and Hypertension	2	6.67	14	46.67	0.062
- Ischemic heart disease	11	36.67	5	16.67	
- Valvular heart diseases	0	0.00	6	20.00	
Previous hospitalization (in days)					
V. None	18	60.00	0	0.00	
- (<5)	7	23.33	10	33.33	2.085
- (5-10)	5	16.67	13	43.33	0.064
- (>10)	0	0.00	7	23.33	
Range	(0-8)		(2-15)		F=1.993
Mean ± SD	1.73±2.463		7.00±4.136		P=0.054

FE: Fisher' Exact test * Statistically significant at level P<0.05

Table (4): Distribution of the studied patients of both groups regarding their past surgical history.

Past surgical history	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
- **Appendectomy**	3	10.00	3	10.00	3.750 0.586
- **Cholecystectomy**	2	6.67	2	6.67	
- **Hysterectomy**	1	3.33	0	0.00	
- **Inguinal hernia**	1	3.33	0	0.00	
- **Pilonidal sinus**	1	3.33	0	0.00	
- **Tonsillectomy**	2	6.67	0	0.00	

Table (5): Distribution of the studied patients regarding their smoking history

Smoking history	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
- **None-smoker**	16	53.33	13	43.33	FE 0.606
- **Smoker**	14	46.67	17	56.67	
Duration of smoke (in years)					
Range	(10-40)		(15-27)		t=2.085
Mean ± SD	26.43±9.321		21.41±3.163		P=0.056
Number of tobaccos consumed (per day)					
- **(<10)**	1	3.33	0	0.00	3.850 0.050
- **(10-20)**	10	33.33	5	16.67	
- **(>20)**	3	10.00	12	40.00	
Range	(5-40)		(20-40)		F=2.571
Mean ± SD	19.29±8.739		30.29±8.380		P=0.055

FE: Fisher' Exact test

Table (6): Distribution of the studied patients of both groups regarding their mode of mechanical ventilation

Extubation assessment	The studied patients (n=60)				χ^2 P
	Study group (n=30)		Control group (n=30)		
	N	%	N	%	
Mode of Mechanical ventilation - **SIMV**	30	100.0	30	100.0	-
Range **Mean ± SD**	(100-100) 100.00±0.00		(100-100) 100.00±0.00		-

Table 7: Total mean scores of cardiothoracic rehabilitation exercises tolerance domain among studied patients throughout the study

Cardiothoracic Rehabilitation exercises tolerance domains	The studied patients (n=60) / Range / Mean ± SD					
	Study group (n=30)		t_P	Control group (n=30)		t p
	Day1	Day2		Day1	Day2	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
A. Respiratory physiotherapy	(5-10) 8.50±1.6	(5-10) 8.50±1.6	0.00 1.00	(4-4) 4.00±0.0	(4-4) 4.00±0.0	
Study group Vs. Control group **t** **p**	14.703 0.000**	14.703 0.000**				
B. Sternal precautions and upper limb Exercises	(12-22) 18.20±2.69	(12-22) 18.23±2.67	0.048 0.962	(6-7) 6.33±0.47	(6-7) 6.33±0.47	0.00 1.00
Study group Vs. Control group **t** **p**	23.735 0.000**	23.992 0.000**				
C. Cardiothoracic Rehabilitation Exercises' tolerance	(21-32) 26.70±3.06	(22-32) 26.73±3.05	0.043 0.966	(10-11) 10.33±0.47	(10-11) 10.33±0.47	0.00 1.00
Study group Vs. Control group **t** **P**	**28.903** **0.000****	**29.519** **0.000****				

** high significant p value = 0

Table (8): Mean scores of vital signs indicators among patient studied group

Vital signs indicators	The studied patients (n=60) Range Mean ± SD					
	control group (n=30)		t P	study group (n=30)		t P
	Day1	Day2		Day1	Day2	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
1. Heart Rate	(75-110) 90.33±9.35	(77-107) 91.07±7.49	0.335 0.739	(69-87) 76.03±4.65	(72-96) 84.10±6.74	5.411 0.000*
2. Blood Pressure - **Systolic**	(100-140) 124.97±10.23	(111-140) 126.40±7.34	0.623 0.53	(92-126) 112.67±9.85	(100-125) 117.40±6.48	2.198 0.032*
- **Diastolic**	(75-98) 86.30±6.76	(67-96) 84.90±6.22	0.834 0.408	(49-86) 73.47±10.85	(59-83) 73.47±8.54	0.00 1.00
3. Respiratory Rate (RR)	(17-31) 24.33±3.98	(18-34) 26.80±4.43	2.265 0.027*	(17-19) 18.00±0.78	(26-34) 29.30±2.26	25.846 0.000*
4. O2 saturation	(97-100) 98.60±1.03	(97-100) 98.97±0.44	1.798 0.077	(93-98) 95.60±1.33	(96-99) 97.50±0.90	6.573 0.000*
5. PaO2	(83-105) 93.17±6.49	(80-110) 94.63±7.46	0.815 0.419	(139-401) 284.70±91.48	(61-119) 91.53±1.45	11.476 0.000*
6. PaCo2	(30-45) 36.97±3.09	(33-44) 37.97±2.85	1.301 0.198	(30-46) 38.33±3.80	(33-45) 39.50±3.68	1.220 0.228

Table (9): Mean scores of ventilator indicators among studied groups throughout the study period

Ventilatory indicators	The studied patients (n=60) Range Mean ± SD					
	Study group (n=30)		t P	Control group (n=30)		t P
	Day1	Day2		Day1	Day2	
1. **FEV1**	(81-98) 87.87±5.17	(87-98) 88.71±5.17	5.086 0.000**	(51-65) 56.30±4.21	(50-65) 56.57±3.89	0.254 0.800
2. **FVC**	(80-92) 86.27±3.06	(85-98) 92.60±3.58	7.355 0.000**	(49-65) 56.57±4.46	(50-64) 56.30±3.72	0.251 0.802
3. **MVV**	(87-140) 110.50±15.19	(88-141) 117.50±17.20	1.671 0.100	(56-72) 63.40±3.82	(59-72) 64.77±4.84	1.222 0.227

FEV1: Forced Expiratory Volume in 1 second

FVC: Forced Vital Capacity

MVV: Maximum Voluntary Ventilation

**Statistically significant at level P<0.05

Table (10): Correlation between Total exercises tolerance and their vital signs indicators.

Vital signs indicators	The studied patients (n=60) Total exercises tolerance							
	Study group (n=30)				Control group (n=30)			
	Day 1		Day 2		Day 1		Day 2	
	r	P	R	P	r	P	r	P
I. Pulse (HR)	0.262	0.161	**0.495**	**0.005***	0.323	0.082	0.171	0.367
II. Blood Pressure								
Systolic	0.111	0.558	0.088	0.645	0.061	0.750	0.067	0.727
Diastolic	0.094	0.623	0.029	0.879	0.203	0.282	0.003	0.988
I. Respiratory Rate (RR)	0.006	0.976	0.107	0.573	0.091	0.631	0.223	0.237
II. O_2 saturation	0.061	0.750	0.270	0.149	0.166	0.382	0.320	0.085
PaO_2	0.245	0.192	**0.522**	**0.003***	0.205	0.277	0.067	0.725
$PaCo_2$	0.043	0.823	0.007	0.971	0.088	0.643	0.080	0.675

* Statistically significant at level P<0.05

Table (11): Correlation between Total exercises tolerance and their ventilator indicators.

Ventilatory indicators	The studied patients (n=60) Total exercises tolerance							
	Study group (n=30)				Control group (n=30)			
	Day 1		Day 2		Day 1		Day 2	
	r	P	R	P	r	P	r	P
1. FEV1	0.102	0.592	0.084	0.660	0.153	0.418	0.043	0.821
2. FVC	0.127	0.503	0.073	0.702	0.107	0.572	0.000	1.000
3. MVV	0.004	0.983	0.176	0.352	0.095	0.619	0.110	0.564

Discussion

Open heart surgery is the most operation that done in 10 past years. Patients' respiratory capacity declines, muscle oxygen transmission deteriorates, and exercise tolerance deteriorates may be as a result of this postoperative **Colquhoun., et al (2021)**.

In addition to reducing the risk of lung problems during the recovery phase, exercises involving deep breathing and coughing also prevent secretion accumulation, promote oxygen transfer to cells, balance body and brain functions, consciousness, and sympathetic-parasympathetic system functions. Additionally, preoperative rehabilitation using an Incentive Spirometer is linked to a lower incidence of post-operative pulmonary complications. Especially after open heart surgery (**Faleh, AL-Fayyadh, 2022)**

Discussion will be presented in 4 parts:

Part(I): Socio-demographic characteristics of studied patient

Regarding socio-demographic characteristics of studied patients, it was revealed that the majority of studied patients were 50-60 years with the mean ages of 53.17±5. 045.This may be due that aging is association with many health and disease conditions, including heart disease, as a result of life stresses. This was in line with **Kinas, and Bilgic (2024).** who revealed that average age of the studied sample who had open heart surgery was 50 to 60 with the mean age of 63.08±8.20 .Moreover a study

conducted by **Fahmy, Ibrahim, & Kandeel. (2021).** revealed that the average age of the studied sample was 51 to 61 with the mean age of 48.6 ± 12.2.

In relation to gender, less than two third of studied patients were male. This may possible because men always work in professions that require alertness and under intense physiological and psychological pressure, and that men smoke more than women and are more nervous at different times of work due to the demands of life. This finding was consistent with a study done by **El-gafour., et al., (2021)** who stated that less than two third of studied patients were male.

Regarding marital status, the present study revealed that, the majority of studied patients were married. This may result in increasing pressures on financial life, which requires a lot of continuous work. This finding was supported by a study done by **Fahmy, Ibrahim, & Kandeel, (2021).** The effect of passive range of motion exercises on hemodynamic parameters of mechanically ventilated patients. . which revealed that most of samples were married.

Concerning residence, the current study showed that less than two thirds of studied patients were urban, this may be environmental pollution, such as smoking fumes, cars, lack of oxygen, and a stressful life, this result is not the same line with **El-gafour., et al., (2021)** who found that less than half of studied patients were from urban.

Regarding educational level, the findings of the present study revealed that half of the studied patients had university education this because university education will lead to jobs that require a lot of work and constant pressure. This was supported by **Mortensen, et al., (2024).** Who found that patients with low education levels, earlier myocardial infarction, or have a two-fold chance of sick leave>6 months after open heart surgery. This result was not supported by **Awad., et al., (2018).** who found that about one third of sample had secondary education.

Regarding occupational status, the finding of the present study revealed that, about less than two thirds of studied patients were employed due to exposure to psychosocial work stressors especially that are associated with poor organizational outcomes, including sickness absence and presenteeism. This was supported by **Taouk, et al., (2020).** Who reported that Psychosocial work stressors increase risk of coronary heart disease mortality

Also, **Hany, Ali & Abdel-Azeem (2019).** in study about "Effect of deep breathing technique on severity of pain among postoperative coronary artery bypass graft patients" reported that, higher coronary heart disease incidence rates were found among employed patients.

Part II: Medical and surgical history of studied patient.

In relation to smoking history, the present study showed that half of studied patients were smokers. This may be one of the main causes of deaths and open-heart surgeries, because smoking leads to blockage of arteries and pulmonary alveoli and leads to serious heart and devastating lung diseases such as pneumonia and others. This finding was consistent with a study done by **Duncan, et al., (2019).** Who reported in study "associations of smoking cessation with subsequent risk of cardiovascular disease". They found that there was a significantly higher risk of coronary vascular disease CVD within 5 years in heavy smokers and also supported by **Brescia.** (**2019**). Who reported in study Impact of prescribing on new persistent opioid use after cardiothoracic found that tobacco use is be a higher risk for cardiovascular diseases that lead to open heart surgery.

Concerning medical history, the results of the present study showed that, one third of studied patients had hypertension and ischemic heart disease. This finding was supported by a study done by **de la Figuera, et al., (2018).** titled "Clinical characteristics and management of patients with atrial fibrillation treated with direct oral anticoagulants according to blood pressure control". reported that, most of the samples was ischemic heart diseases.

In relation to current diagnosis, the present study showed that less than three quarters of studied patients had myocardial infarction that considered one of the most common reasons of open-heart surgery. This finding was consistent with a study done by **Smit, Coetzee & Lochner, (2020).** "The pathophysiology of myocardial ischemia and perioperative myocardial infarction. ". who reported that perioperative myocardial infarction (P MI) is considered the causes of perioperative open-heart surgery

Regarding type of cardio-thoracic surgery, the present study showed that half of studied patients were CABG. This finding was consistent with a study done by **Ruel, et al., (2024).** who found that CABG is the operation most commonly performed by adult cardiac surgeons

In relation to chief complaints after cardiac surgery, the present study showed that majority of studied patients had chest pain. This finding was consistent with a study done **Gulati, et al., (2021).** guideline for the evaluation and diagnosis of chest pain. stated that the majority of studied patients had chest pain. especially that had no previous cardiac surgery.

Part III: Extubating assessment of study patient:

Regarding mode of mechanical ventilation, the present study showed that all of studied patients were on SIMV mode with ETT. This mode is considered the most important parameters by which weaning is performed for the patient. This finding was in line with a study done by **Manjunath, et al., (2021).** who found that less than two thirds of studied patients were on SIMV mode.

Part IV: Total mean scores of cardiothoracic rehabilitation exercises tolerance domains of studied patient.

It was observed that there were highly statistically significant differences among study and control groups regarding physiotherapy, Sternal precautions and upper limb Exercises and Cardiothoracic Rehabilitation Exercises' tolerance throughout period of study

The significant improvements observed in the study group regarding adherence to physiotherapy, compliance with sternal precautions, performance of upper limb exercises, and overall cardiothoracic rehabilitation exercise tolerance are consistent with findings from recent research emphasizing the benefits of structured rehabilitation protocols.

For example, a randomized controlled trial investigated the addition of integrated core and graduated resistance upper limb exercises to inpatient cardiac rehabilitation for patients with acute sternal instability following coronary artery bypass grafting **(CABG)**. The intervention group demonstrated significant reductions in sternal separation and pain, along with improved activities of daily living **(ADL)** scores compared to the control group, suggesting that incorporating targeted upper limb exercises can enhance sternal healing and functional recovery post-CABG **El-Ansary et al., (2019).**

Despite these positive outcomes, considerable variation exists in clinical practice regarding sternal precautions and upper limb exercise prescriptions following median sternotomy. Surveys have highlighted inconsistencies in the type and timing of exercise restrictions, often guided by patient-reported pain rather than standardized

protocols. For instance, a web survey conducted among Australian physiotherapists revealed significant variability in upper limb exercise guidelines within outpatient cardiac rehabilitation programs, with only 43% reporting screening for sternal instability and management primarily based on clinical experience **Balachandran et al., (2014).**

Similarly, a study assessing the immediate effects of upper limb exercises with and without deep breathing on lung function after cardiac surgery found that while simultaneous deep breathing induced a greater increase in tidal volume during exercises, it also triggered a transient rise in pain, exertion, and dyspnea compared to exercises performed without deep breathing **Reinhart, et al., (2024).**

It was observed that there were highly statistically significant differences among study and control groups related to **HR, BP, O_2, RR, PaO_2,** while there no significant difference was observed among control and study group related their items except respiratory rate

Concerning Pulse (**HR**), the results of the present study showed that there are highly significant differences between studied group throughout period of study. This finding was consistent with a study done by **(Köse& Avşar 2021).** In study titled by Impact of early and regular mobilization on vital signs and oxygen saturation in patients undergoing open-heart surgery. Who found that the pulse value was decreased and there was a highly significant correlation before and after mobilization after open heart surgery. Also, in another study by **Sivrikaya, (2023).** Titled "Vital Signs, Pain and Difficulty of Patients During Mobilization found that there was a significant correlation in heart rate before and after mobilization

Regarding Blood Pressure, the present study showed that it was high in control group and normal in study group. This finding is in the same line with the study of **Amiri, et al., (2023).** In the study titled the effect of using virtual reality technology on anxiety and vital signs before surgery in patients undergoing open heart surgery. Who found there were a significant correlation in blood pressure before and after mobilization. On the other hand, the researcher found in his present study showed that the respiratory rate was high in two days with control group and normal with study group. This finding was contraindicated with study of **Helwani., et al., (2024).** In the study of A 3-hour fast-track extubation protocol for early extubation after cardiac surgery who found that normal

respiratory rate in two group post-operative surgery and in the same line with another study that done by **Yılmaz (2020).** In the study of the effect of progressive breathing relaxation training on preoperative anxiety and surgical stress response.

Regarding O_2 saturation, the present study showed that there were normal range of O_2 with study group with significant correlation between studied groups in O_2 saturation. This finding is supported by **Esfandiari (2022).** In study "Evaluation of the effect of white noise on anxiety level, vital signs, hemodynamic indices of patients undergoing open heart surgery who found significant correlation in O_2 saturation between studied groups Also **Derakhtanjani, et al., (2019).** In the study of Comparison, the effect of active cyclic breathing technique and routine chest physiotherapy on pain and respiratory parameters after coronary artery graft surgery. stated a significant correlation in O_2 saturation between studied groups

Concerning Pao_2, the results of the present study showed that increasing in pao_2 level especially with study group in first day due to using mechanical ventilation for this patient highly significant study this finding was consistent with a study done **Kinas & Bilgic (2024).** In study "Impact of breathing exercises in patients who had open heart operation on respiratory function and exercise tolerance. "Who found that there was significant difference between studied group in also in another study supported these results by. **Afxonidis., et al., (2021)** In study of Efficacy of early and enhanced respiratory physiotherapy and mobilization after on-pump cardiac surgery: a prospective randomized controlled trial. This result may be because breathing exercise increase blood perfusion form the heart to all the body.

Concerning $PaCo_2$, the results of the present study showed normal range of $PaCo_2$ that there no significant between study and control group this may be due to using a mechanical ventilation as oxygenation tool that in the same line with **Afxonidis, et al., (2021)** In study of Efficacy of early and enhanced respiratory physiotherapy and mobilization after on-pump cardiac surgery: a prospective randomized controlled trial. found there were no change in $PaCo_2$.

Regarding mean scores of ventilator indicators among studied groups throughout the study period the researcher found increased in respiratory function due to increase of anxiety, using respiratory muscles and exhaustion of patient due to bed ridden

that there was a significant correlation between FEV1 and FVC among studied groups for both parameters about, this result are in the same line with **Fayazi., et al., (2021).** In study The Effect of Open-Heart Surgery on FVC, FEV1 and FVC/FEV1 of Patients found significant correlation between FVC, FEV1 After Surgery and also supported by another study by **Mgbemena., et al., (2022).** In study Acute changes in handgrip strength, lung function and health-related quality of life following cardiac surgery who found significant correlation between FEV1 and FVC in Pre-operative and physiotherapy discharge patient who had open heart surgery

Regarding the correlation between total exercises tolerance and blood pressure it was found a significant correlation between two groups. this finding is supported by **Kinas& Bilgic (2024)**. In study about Impact of breathing exercises in patients who had open heart operation on respiratory function and exercise tolerance and found that there was a significant correlation with Blood pressure and exercise between experimental and control group with in preoperative ,2_{nd} and 3_{rd} day post open-heart surgery

Finally., in another study this result in the same line with **Iriart., et al., (2020)** in study titled by heart rate response during exercise predicts exercise tolerance in adults with transposition of the great arteries and atrial switch operation found that there was a significant correlation between heart rate and $\dot{V}O_2$ max during physical exertion.

Conclusion

The current study showed that cough augmentation techniques have positive impact on airway clearance of mechanically ventilated patients. The intervention resulted in more hemodynamic stability, oxygen saturation, blood gases exchange and breathing stability resulting from airway clearance.

Recommendations

- Using Cough Augmentation Techniques as a part of the daily care in managing cases complains of secretions in intensive care unit.
- Continuous training sessions and set new policies about recommendations of airway clearance for patients receiving care on a result.
- The same study could be replicated in more hospitals with a larger probability sample for further research.

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