RESEARCH ARTICLES

Impact of breathing exercises in patients who had open heart operation on respiratory function and exercise tolerance

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ABSTRACT

Objective: This study aims to determine the effect of deep breathing and coughing exercise training before surgery on respiratory functions and exercise tolerance in patients with open-heart surgery in the postoperative period.

Background: The decrease in respiratory functions and activity tolerance of patients after open heart surgeries reveals the need to improve this situation with effective interventions.

Methods: The quasi-experimental study was conducted with 80 patients undergoing open-heart surgery. Data were collected using the patient information form and the patient follow-up form. The patients were taught deep breathing and coughing exercises before the open-heart surgery and were supported in exercising regularly before and after the surgery. The patients' respiratory functions and exercise tolerance were measured and recorded via the patient follow-up form.

Results: It was determined that the respiratory capacity, distance, time, and walking speed of the patients in the experimental group during the postoperative period were significantly higher than the control group.

Conclusion: Substantially, deep breathing and coughing exercise training administered before surgery to patients undergoing open heart surgery improved respiratory functions and exercise tolerance in the postoperative period. It is recommended that nurses working in open-heart surgery clinics should plan deep breathing and coughing exercise training in the preoperative period and administer them regularly to the patients.

Implications for research, policy, and practice: Patients who will undergo open heart surgery should be trained by nurses in the preoperative period. Nurses should teach these patients deep breathing and coughing exercises. In the postoperative period, it should be checked regularly whether the patients do exercises or not.

What is already known about the topic?

- It is important to teach and practice breathing exercises in patients who will have open heart surgery.
- Respiratory training given by nurses in the preoperative period contributes to the management of the postoperative process.

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What this paper adds:

- This article demonstrates the importance of preoperative education for patients undergoing open heart surgery.
- In this study, it is shown that open heart surgery has a negative effect on the respiratory capacity and exercise tolerance of the patients.
- In addition, in this study, it is shown that the respiratory capacity and exercise tolerance of the patients who were taught preoperative breathing exercises and who performed the exercises in the postoperative period increased in the postoperative period.

Keywords: breathing exercises, exercise tolerance, open heart operation, respiratory function

INTRODUCTION

Coronary artery disease is among the leading causes of disability and death worldwide.[1] Coronary artery bypass grafting (CABG) is an important surgical procedure that improves symptoms, survival, and quality of life for patients with coronary artery disease.[2] The aim of CABG surgery is to bypass the blocked coronary arteries of the heart and restore normal blood flow.[3] However, sternotomy, anaesthesia, and analgesia applied during this surgery may reduce the lung volume of the patients and cause pulmonary complications.[4] The most common pulmonary complications include chest infections, pneumonia, respiratory failure, acute respiratory distress syndrome, and the need for postoperative mechanical ventilation.[5] These postoperative pulmonary complications lead to a decrease in the respiratory capacity of the patients, deterioration in muscle oxygen transmission, worsening exercise tolerance,[6] and increased costs associated with postoperative hospitalisation, morbidity, and even mortality.[7] Therefore, it is extremely important to provide effective care to improve the lung function of patients who will undergo heart surgery.[8]

Existing literature reports that deep breathing and coughing exercises balance body and brain functions, consciousness status, and sympathetic-parasympathetic system functions, prevent secretion accumulation, facilitate oxygen transfer to cells, and thus are effective in reducing lung problems that may occur in the postoperative period.[9] Thus, interventions such as breathing exercises, effective coughing techniques, and inspiratory muscle training in patients undergoing cardiac surgery are recommended to prevent reductions in lung volume and atelectasis, increase oxygenation,[10,11] improve respiratory performance, decrease hospital stay,[12] and increase functional capacity.[13]

Impairment in respiratory functions in patients undergoing cardiac surgery causes a decrease in patients' recovery capacity and independence besides a reduction in their physical activities and, consequently, exercise tolerance.[14] In these patients, 6MWT (6-Minute Walk Test), an easy-to-apply and well-tolerated test, is used to evaluate functional capacity and recovery in the preoperative and postoperative periods.[6,15-17] Previous works have reported that applying breathing exercises increases the 6MWT walking distance and enables patients to show higher performance.[17] In a study, it was determined that patients who received inspiratory muscle training had significant improvements in 6MWT, maximum inspiratory pressure, and quality of life.[18] It was also found that respiratory exercises increased the distance walked and oxygen saturations at 6MWT and showed positive results on heart rate, mechanical ventilation time, dependence on oxygen therapy, and postoperative hospital stay.[18]

Nurses have a vital role in providing necessary training to patients about the care and recovery process in the preoperative and postoperative periods.[19] Discernibly, the training given before the surgery helps to minimize minimise the development of possible complications by providing health-related information and preparing the patients for the surgery.[20] However, in a study conducted, it was concluded that nurses do not regularly perform patient training.[21] Similarly, in the study of Unver et al., (2018) it was reported that surgical patients did not receive adequate training on deep breathing exercises before the surgery, and most of them received this training only after their surgery.[20] However, especially considering the adverse effects of heart surgeries on the lungs, it is important to teach and apply effective interventions such as breathing exercises in the preoperative period. This helps prevent pulmonary complications that patients may encounter and improve pulmonary functions.[22-23] Therefore, it is inevitable that breathing and coughing exercises, which are included in nursing care, should be taught and applied in the preoperative period. Consistent with all this information, this study aims to determine the effect of deep breathing and coughing exercise training given before surgery on respiratory functions and exercise tolerance in the postoperative period in patients who underwent open-heart surgery.

METHODS

DESIGN

The research is a quasi-experimental study with experimental and control group design. The research questions are as follows:

1. Is there a difference in respiratory capacity between patients who are assisted with deep breathing and coughing exercise training as opposed to those who are not?
2. Is there a difference in exercise tolerance between patients who are assisted with deep breathing and coughing exercise training as opposed to those who are not?

SETTING AND SAMPLE

The research was carried out in a public hospital's cardiovascular surgery intensive care unit and cardiovascular surgery clinic between October 2019 and April 2020. The power analysis method was used to determine the study's sample size. The data from a previous similar study was used as the basis of the analysis. In this study, the pre-test 6-MWD mean score for patients in the experimental group was 516.0 ± 114.8, while the post-test mean score was 502.4 ± 112.8.[23] As a result of power analysis, at 0.95 test power, 95% confidence (1-α), and 0.87 effect level, the sufficient sample size was determined as 72 patients, 36 in the experimental and 36 in the control group. Due to anticipated attrition, the sample size was expanded by 10%, with 40 patients in each group recruited. Within the scope of the research, eighty patients, aged 18 years and over, open to communication and cooperation, whose cognitive abilities were not impaired, and who volunteered to participate in the study and were hospitalised in the cardiovascular surgery clinic for open-heart surgery were included in the study.

DATA COLLECTION TOOLS

The study data were collected using the patient information form and the patient follow-up form.

Patient Information Form

The form included sociodemographic characteristics of the patients, such as age, gender, educational status, marital status, employment status, BMI, and surgery-related information such as duration of anaesthesia and intubation and discharge time.

Patient Follow-up Form

The form included the patients' preoperative, postoperative first, and third day follow-ups. These follow-ups consisted of measurements of vital signs, respiratory functions, and 6MWT.

MEASURED OUTCOMES

The primary result of this study is to determine the effect of breathing exercises on respiratory functions of patients undergoing open-heart surgery. Literature indicates that patients often endure severe pain in the initial day following CABG, gradually subsiding within two to three days.[24] It is known that this pain experienced in the postoperative period restricts the patient's activity, especially by causing reflex muscle tension, and thus can cause shortness of breath, decreased respiratory capacity, as well as atelectasis, pneumonia, pleural effusion and pneumothorax.[25-26] It has also been reported in the literature that the use of nursing interventions such as the use of intensive spirometer (IS) and deep breathing and coughing exercises, especially during this period, are effective in reducing and preventing pulmonary complications.[27] In the literature, the pain and postoperative fear felt intensely, especially in the first 48-72 hours, due to the change in lung mechanics as a result of CABG, affect regular deep inspiration and effective coughing, causing alveolar collapse and deterioration in gas exchange.[26] For these reasons, the study focused on the first three days postoperative. There are studies in the literature focusing on the first two to three days postoperative.[26,28-30] In this study, we focused on the first three postoperative days when there was severe pain. Therefore, in the study, patients were taught preoperative deep breathing and coughing exercises and the use of triflow, and their practices were provided in the preoperative and postoperative periods. Respiratory functions of the patients were measured with a spirometer.

The secondary aim of this study is to assess the impact of breathing exercises on exercise tolerance in patients undergoing open-heart surgery. Literature suggests that respiratory function issues following heart surgery can lead to reduced physical activity and subsequently affect exercise tolerance.[14] Consequently, patients underwent evaluation using the 6MWT in both preoperative and postoperative phases.

DATA COLLECTION PROCEDURE

Research data were collected after obtaining the necessary institutional and ethical permissions. Patients hospitalised for open-heart surgery and who met the criteria for inclusion in the study were interviewed at least 24-48 hours before the operation and informed about the study's purpose, scope, duration, and method. Written consent was obtained from the participants. In the implementation of the study, first, data were collected from the patients in the control group to prevent the experimental and control group patients from being influenced by each other. Therefore, the first 40 patients who agreed to participate in the study were included in the control group, and the next 40 patients were included in the experimental group. Before open heart surgery (before 24-48 Hours), the patients in both groups were asked to fill out the Patient Information Form. Patient vital signs were initially recorded, followed by the assessment of their respiratory functions through spirometry, and the execution of the 6MWT. Patients in the experimental group received instructions on deep breathing and coughing exercises as well as guidance on using triflow. Further, it was ensured that the patients performed them correctly. Patients were instructed to perform deep breathing and coughing exercises, as well as use triflow, 10-15 times a day until the time of surgery. In the control group, only the service routine was applied. Service routines consist of echocardiography, respiratory function tests, chest radiography, laboratory results, anaesthesia consultation, and taking vital signs.

In the postoperative period, after waking up in the intensive care unit, the patients in the experimental group were allowed to continue their triflow work with 15-20 deep breathing and coughing exercises at 2-hour intervals. Each patient was followed up individually and encouraged to do the exercises, and the routine practices in the unit continued. In the control group, standard hospital procedures were followed. Nurses from the unit conducted routine practices which involved mobilising patients three times in the morning and evening, applying tapotement before mobilisation, and administering triflow ten times per hour. This situation did not make it entirely possible to exclude patients in the control group from these exercises. However, these routine exercises were not administered to the control group patients in a regular and controlled manner. It was not ethically appropriate to refrain from implementing the hospital routine on patients in the control group. Thus, the study enabled the teaching and implementation of respiratory and coughing exercises to the experimental group patients in a controlled and consistent manner, which they would not have received under normal circumstances. In addition, this situation provided an opportunity to assess the effectiveness of the interventions. In addition to routine practices, vital signs for patients in both groups were assessed on the 1st and 3rd postoperative days, followed by respiratory function evaluations using IS and the 6MWT.

Deep breathing and coughing exercise intervention

For the deep breathing exercise, patients were asked to place one hand on their chest and the other hand on their abdomen while in a sitting position. Then, the patients were asked to take a slow and deep breath through their nose, hold it for two or three seconds, and then exhale slowly by pursing their lips. For the coughing exercise: The patient was asked to hold his breath for two to three seconds after taking their fifth breath and then cough twice in a row.

Measurement of vital signs

Blood pressure was measured using a calibrated manual sphygmomanometer in accordance with the guidelines of the World Health Organization. For this purpose, measurements were made using a blood pressure monitor of appropriate size for the patient while the patient was in bed and their arm was at heart level. A pulse oximeter device was used to measure pulse rate and oxygen saturation. The respiratory rate was determined by observing the patient's chest movements.

Intensive Spirometry (IS) intervention

A portable volume-focused spirometer (peak flow meter) was used to measure respiratory capacity. Peak Expiratory Flow Rate (PEF) of the patients was measured. The respiratory capacities of the patients were measured preoperative and postoperative on the first and third day. A disposable mouthpiece was attached to the device for measurement. The patient was asked to breathe normally and then take a deep breath and exhale quickly and forcefully into the mouthpiece. The test was terminated when the patient breathed again. The test was performed three times in a row, and the best result was recorded.

6-Minute Walk Test (6MWT) intervention

6MWT was administered to the patients on preoperative, postoperative day one, and day three by the researcher, who also worked as a nurse. In the cardiovascular surgery service, the corridor length of 30 meters served as the designated walking track. However, in the intensive care unit, the distance between the nurse's desk and the unit wall, approximately 21 meters, was used as the track length. Each of these walking tracks was marked and numbered every three meters, and the starting and finishing points were clearly indicated. As a result, in the cardiovascular surgery service, a full lap was considered to be a total walking distance of 60 meters, encompassing 30 meters out and 30 meters back. In the intensive care unit, a complete lap was defined as a total walking distance of 42 meters, comprising 21 meters out and 21 meters back. Furthermore, a chair was positioned in the corridor where the test took place, providing patients with the option to sit if necessary. Before commencing the test, it was ensured that patients had rested for a minimum of ten minutes, were dressed in comfortable attire and shoes. Walking commenced once the patient was prepared, with the allowance for the patient to stop or slow down at their discretion, and they were encouraged to resume walking as soon as they felt able. The test duration was set for 6 minutes; however, it was necessary to prematurely terminate the test for patients exhibiting symptoms such as sweating, pallor, chest pain, or a notable decrease in oxygen levels. The 6MWT results were calculated based on the recorded distance walked and the time taken. Vital signs and the patients' PO_2 values were measured both before and after the walk to ensure the safe administration of the 6MWT. A portable finger pulse oximeter was used for the assessment of oxygen saturation.

DATA ANALYSIS

The data obtained from the research were analysed using the SPSS 22.0 package program. Descriptive statistics such as number, percentage, mean, and standard deviation were used to evaluate demographic data. In evaluating the similarity of the two groups, Student's t-test was used for continuous variables, and the chi-square test and Fisher Exact test were used for nominal variables. The Friedman Test and Wilcoxon Signed Rank Test were used to compare the repeated measurements within the group, while the Mann-Whitney U test was utilised to compare the patient measurements between groups. Statistical significance $p < 0.05$. was accepted as a breakpoint.

ETHICAL CONSIDERATION

Ethics committee permission (TUTF-BAEK 2019/294, decision number: 15/22) obtained from the Scientific Research Ethics Committee whereas the necessary institutional permission was received from the public hospital. The patients were informed about the research, and written permission was obtained from them before data collection.

RESULTS

The mean age of the patients participating in the study was 63.08±8.20 years. 70% of the patients were male, 68.8% were primary school graduates, 87.5% were married, 53.8% were retired, and 46.2% were overweight. The mean duration of anaesthesia of the patients participating in the study was 258.10±42.42 minutes, the mean intubation time was 711.13±165.45 minutes, and the mean postoperative discharge time was 7.12±1.17 days. There was no statistically significant difference between the patients in the experimental and control groups in terms of individual characteristics and surgical characteristics (p>0.05), except for the mean age. When the mean age of the patients was compared, it was determined that the mean age of the patients in the experimental group was significantly higher (p<0.05; Table 1).

When the measurements of the patients' vital signs (systolic, diastolic blood pressure, pulse, and respiratory rate) and PO_2 (partial oxygen pressure) values were compared between the groups, no statistically significant difference between the experimental and control group patients was found (p>0.05) (Table 2).

TABLE 1. INDIVIDUAL AND SURGICAL CHARACTERISTICS OF THE PATIENTS (N=80)

Characteristics	Experimental Group (n=40) n(%) / X±SD	Control Group (n=40) n(%) / X±SD	Total (N=80) n(%) / X±SD	*p*
Age (year)	64.94±7.55	61.20±8.48	63.08±8.20	**0.039***
Gender				
Female	15 (37.5)	9 (22.5)	24 (30.0)	0.143**
Male	25 (62.5)	31 (77.5)	56 (70.0)	
Education				
Primary school	29 (72.5)	26 (65.0)	55 (68.8)	0.687‡
Middle school	3 (7.5)	6 (15.0)	9 (11.2)	
High school and above	8 (20.0)	8 (20.0)	16 (20.0)	
Marital status				
Married	34 (85.0)	36 (90.0)	70 (87.5)	0.499**
Single/divorced	6 (15.0)	4 (10.0)	10 (12.5)	
Working status				
Employee	6 (15.0)	13 (32.5)	19 (23.8)	0.100**
Retired	22 (55.0)	21 (52.5)	43 (53.8)	
Housewife	12 (30.0)	6 (15.0)	18 (22.4)	
Body Mass Index				
Normal (18-24)	7 (17.5)	6 (15.0)	13 (16.3)	0.377**
Overweight (25-29)	21 (52.5)	16 (40.0)	37 (46.2)	
Obesity (>30)	12 (30.0)	18 (45.0)	30 (37.5)	
Anesthesia time (minute)	251.62±42.30	264.57±42.07	258.10±42.42	0.280*
Intubation time (minute)	731.25±199.75	691.02±121.32	711.13±165.45	0.908*
Post-op discharge time (day)	7.12±0.99	7.12±1.34	7.12±1.17	0.562*

* Student T Test, **Pearson Chi-square Test, ‡Fisher Exact Test. Statistically significant values (p<0.05) are shown in bold.

TABLE 2. REPEATED MEASUREMENTS OF THE VITAL SIGNS AND PO2 VALUES OF THE PATIENTS

Characteristics	Pre-op[1] X±SD	Post-op First Day[2] X±SD	Post-op Third Day[3] X±SD	*p*
Systolic Blood Pressure (mm/Hg)				
Experimental Group	123.75±18.35	117.85±16.27	123.30±15.08	0.194*
Control Group	122.50±14.09	117.05±14.63	118.85±16.37	0.246*
p	0.765¥	0.900¥	0.104¥	
Diastolic Blood Pressure (mm/Hg)				
Experimental Group	72.25±10.97	65.17±10.50	73.10±8.04	**0.000*** 2<1 ve 3**
Control Group	72.50±9.54	67.32±11.46	70.60±9.19	0.064*
p	0.864¥	0.488¥	0.234¥	
Pulse (minute)				
Experimental Group	74.67±12.89	97.40±13.24	96.80±11.28	**0.000*** 1<3 ve 2 **
Control Group	79.30±13.73	95.90±14.41	93.12±15.30	**0.000*** 1<3<2**
p	0.105¥	0.516¥	0.170¥	
Respiratory rate (minute)				
Experimental Group	21.37±1.71	23.27±3.28	22.65±2.39	**0.019*** 1< 3 ve 2**
Control Group	20.85±2.51	23.17±3.60	22.50±3.06	**0.030*** 1< 3 ve 2 **
p	0.234¥	0.771¥	0.380¥	
PO_2				
Experimental Group	97.07±1.32	95.70±2.98	95.27±2.28	**0.007*** 1>3 ve 2 **
Control Group	96.82±1.29	95.17±3.16	94.72±2.95	**0.013*** 1>3 ve 2 **
p	0.335¥	0.473¥	0.584¥	

Notes: PO_2 = Partial Oxygen Pressure, *Friedman Test, ** Wilcoxon Signed Ranks Test, ¥Mann Whitney U Test.
Statistically significant values (p<0.05) are shown in bold.

TABLE 3. COMPARISON OF THE PFT AND 6 MWT RESULTS OF THE PATIENTS

	Pre-op[1] X±SD	Post-op First Day[2] X±SD	Post-op Third Day[3] X±SD	*p*
PFT				
Experimental Group	328.75±104.64	153.25±66.23	245.50±89.98	**0.000*** 1>3>2**
Control Group	385.50±136.62	140.75±55.34	209.00±81.13	**0.000*** 1>3>2**
p	**0.031**¥	0.463¥	**0.034**¥	
6MWT (distance)				
Experimental Group	315.55±89.88	122.92±50.52	203.62±80.28	**0.000*** 1>3>2**
Control Group	370.35±148.23	94.37±36.56	163.65±55.85	**0.000*** 1>3>2**
p	0.095¥	**0.018**¥	**0.021**¥	
6MWT (time)				
Experimental Group	350.42±24.68	336.70±49.70	355.07±23.42	**0.018*** 2<3**
Control Group	351.47±35.26	304.00±75.88	341.10±49.01	**0.000*** 2<1 ve 3**
p	0.326¥	**0.016**¥	0.082¥	
Walking Speed				
Experimental Group	0.89±0.23	0.36±0.14	0.57±0.21	**0.000*** 1>3>2**
Control Group	1.05±0.43	0.31±0.10	0.47±0.13	**0.000*** 1>3>2**
p	0.109¥	0.196¥¥	**0.039**¥	

Note: PFT = Pulmonary Function Test, *Friedman Test, 6 MWT = 6-Minute Walk Test, ** Wilcoxon Signed Ranks Test, ¥ Mann Whitney U test.
Statistically significant values (*p*<0.05) are shown in bold.

When the repeated measurements of the patients' vital signs (systolic, diastolic blood pressure, pulse, and respiratory rate) and PO_2 values were compared within the group; it was determined that there was a significant difference in the experimental group in terms of diastolic blood pressure. It was determined that the patients in the experimental group had the lowest diastolic blood pressure on the first postoperative day. In addition, there was a significant difference in the repeated measurements of both the experimental and control groups in terms of pulse, respiratory rate, and PO_2 ($p<0.05$). An examination of the results revealed that the pulse and respiratory rate values of the patients were the lowest in the preoperative period, and the PO_2 value was the highest in the preoperative period (Table 2).

In the comparison of the mean PFT (pulmonary function test), 6MWT (time, distance), and walking speed of the patients between the groups, it was determined that the PFT values of the patients in the control group were higher in the preoperative period, and the PFT values of the patients in the experimental group were higher on the postoperative third day. In addition, the 6MWT distance value of the experimental group patients was higher on the postoperative first and third day, the 6MWT time value was higher on the postoperative first day, and their walking speed on the postoperative third day was higher than the values of the control group ($p<0.05$ Table 3).

In the group comparison of the intra-group repeated measurements of the patients' PFT, 6MWT (time, distance), and walking speed averages; it was determined that the change in the mean of PFT, 6MWT distance, 6MWT time, and walking speed of the patients in both the experimental and control groups were statistically significant ($p<0.05$). Furthermore, patients in both the experimental and control groups had the highest mean in the preoperative period in terms of PFT, 6MWT distance, and walking speed, followed by the postoperative on the third and first day, respectively ($p<0.05$). In terms of the 6MWT average time, the patients in the experimental group walked less on the postoperative first day than on the postoperative third day, while the patients in the control group walked the least on the first postoperative day (Table 3).

DISCUSSION

After CABG surgery, lung infections such as atelectasis, pneumonia, and bronchitis, as well as postoperative pulmonary complications like pleural effusion, pulmonary edema, and respiratory failure, frequently occur.[26] These complications cause deterioration in muscle oxygen transmission by reducing the respiratory capacity of the patients, thus worsening the exercise tolerance of the patients[6,31] and even causing death.[8] Contrarily, it has been reported that pulmonary rehabilitation significantly improves respiratory muscle strength and lung function in patients undergoing CABG surgery and improves exercise tolerance, activities of daily living, and the quality of life of patients.[8-32] Therefore, it is important to teach pulmonary physiotherapy in preoperative and postoperative care to prevent pulmonary complications in patients undergoing cardiac surgery, present a better prognosis for the patient, and provide positive contributions to treatment.[8] Correspondingly, this study aimed to determine the effect of deep breathing and coughing exercise training taught in the preoperative period on respiratory functions and exercise tolerance in patients with open-heart surgery.

When the individual and surgical characteristics of the patients included in the study were compared, it was found that there was no statistically significant difference between the groups except the mean age, and both groups had similar characteristics in terms of these individual characteristics. Notably, there was no difference between these findings regarding individual characteristics in the study which shows that conjugation was achieved between the experimental and control group patients. When the mean age was examined, it was observed that the mean age of the patients in the experimental group was higher. Studies have reported that advanced age is an important risk factor for CABG surgery and that older patients have higher postoperative outcomes and mortality risks.[33-36] In this study, it was thought that the fact that the older patients were in the experimental group in which the intervention was performed showed that these patients were at higher risk in terms of surgery and postoperative complications but would not adversely affect the results of the study.

Stress and pain that occur in patients after cardiac surgeries stimulate the sympathetic system, causing blood pressure, pulse, and respiratory rate to increase, become superficial, hypothermia, and decrease tissue perfusion. This increases the body's need for oxygen and puts pressure on the heart muscle.[37-38] In addition, failure to control blood pressure during this period is an important risk factor for cardiac, renal, cerebral, and metabolic dysfunction.[39] Adequate oxygenation of tissues and organs and regular heart rhythm are important in balancing the cardiovascular system in the postoperative period.[40] Thus, in heart surgeries, basic vital signs are important in monitoring the patient's condition, risk of complication development, and recovery. Moreover, it is necessary to measure, evaluate, follow up regularly, and record patients' vital signs.[41] In the study, it was determined that there was no statistically significant difference between the groups in the recurrent vital signs and SPO_2 values of the patients in all three measurements. However, there were differences in the changes within the group. In addition, diastolic pressure was the lowest on the postoperative first day, pulse and respiratory rate were the lowest in the preoperative period, and PO_2 was the highest in the preoperative period. Although these findings are compatible with the physiological changes expected to occur in the patients after CABG surgery, they also appear to be within the normal range of values.

Although developments in surgical techniques and care given to cardiac surgeries improve the condition of patients, morbidity and mortality rates due to the development of pulmonary complications are high.[15] Intubation and sedation, especially during CABG surgery, and the presence of chest tubes cause incision pain and the inability to breathe adequately and effectively in the postoperative period leading to pulmonary complications by negatively affecting the patient's lung functions.[42] It is very important to have patients do deep breathing and coughing exercises to prevent these complications.[43-44] Chen et al. (2019) reported that inspiratory muscle training reduces the rate of pulmonary complications and length of hospital stay.[45] Khosravive et al. (2023) stated in their study that breathing exercises improve respiratory functions.[46] In the systematic review and meta-analysis study conducted by Cordeiro et al. (2023), it was determined that inspiratory muscle training improved respiratory muscle strength, tidal volume, peak expiratory flow, and reduced hospital stay.[47] Matheus et al. (2012) determined that breathing exercises effectively restored the tidal volume and vital capacity values of the patients.[48] In another similar study, it was determined that deep breathing and coughing exercises prevent postoperative respiratory complications such as atelectasis and pneumonia and therefore are important for early discharge from the hospital.[49] This finding is similar to preliminary literature and revealed that deep breathing and coughing exercises effectively increase the respiratory capacity of patients who have undergone open-heart surgery.

Nursing care for CABG patients covers the preoperative, intraoperative, and postoperative phases.[41] In this process, nurses can continuously monitor patients compared to other health professionals, allowing them to observe any early-stage changes. Respiratory problems are among the most significant changes that may occur in patients undergoing CABG. Nurses are skilled in implementing interventions like deep breathing exercises, coughing techniques, and the use of Incentive Spirometry (IS) to address potential respiratory issues in patients undergoing CABG.[8] These nurse-led interventions are both easy to implement and effective in preventing postoperative complications.[50] Literature indicates that providing deep breathing and cough exercise training to patients before CABG surgery is crucial for enhancing respiratory activity, expediting patient recovery, and reducing potential respiratory complications.[30] In their study, Hashim et al. (2021) stated that structured deep breathing exercise training performed by nurses positively affected postoperative results.[29] In the study conducted by Su et al. (2022) it was reported that IS training given to patients by nurses reduced the incidence of postoperative complications. Moreover, there is an emphasis on the necessity of preoperative education for improved postoperative outcomes.[51] The findings of this study highlight the effectiveness of nursing care in improving patient outcomes by demonstrating the positive effects of respiratory exercises, coughing techniques, and IS training on postoperative respiratory functions.

Postoperative respiratory muscle weakness in patients undergoing open-heart surgery causes shortness of breath, inability to exercise, and a decrease in functional capacity. As a result, the patient's exercise tolerance worsens.[17] Existing literature states that breathing exercises increase the walking distance of patients and thus have a positive effect on 6MWT results.[17,23] In addition, there is a relationship between lung functions and functional capacities of patients, and it is appropriate for patients to receive inspiratory muscle training during the rehabilitation process.[17] Similarly, in the study conducted by Dos Santos et al. (2021) on patients who had undergone CABG surgery, it was stated that the short-term respiratory rehabilitation program positively affected the walking distance of the patients.[52] In the study of Mohammed et al. (2019) it was reported that nursing interventions such as deep breathing, coughing, encouraging the use of spirometry, and early movement led to an increase in the walking distance of patients after cardiac surgery.[53] In addition, adequate levels of breathing exercises by patients are effective in improving lung function, restoring respiratory muscle strength, improving coughing ability, and improving activity capacity.[54] Girgin et al. (2021) revealed that pulmonary rehabilitation is effective for patients to regain their functional capacities faster.[8] In a study, patients were given IS use, diaphragmatic breathing, and coughing exercises, and, it was determined that the oxygen saturation and functional capacity of the patients were better, and they performed better in the postoperative 6MWT.[18] Another study reported that respiratory exercises and the use of spirometry in patients undergoing CABG surgery improved the pulmonary function values and functional capacities of the patients, increasing the 6MWT value in the patients.[15] In this study, it is thought that the differences in intragroup measurements are due to the effect of the surgery on the body. The intergroup comparisons determined that the patients in the experimental group recorded higher in terms of walking distance, time, and speed. In this context, the study's finding, consistent with previous literature, reveals that deep breathing and coughing exercises are effective in increasing the activity tolerance of patients with open-heart surgery.

CONCLUSION

It is known that the respiratory functions and activities of patients undergoing open-heart surgery are adversely affected. However, it is an undeniable fact that the contribution of the nursing care given during the surgery process to patient recovery is of great importance. As a result of this study, it was determined that teaching and applying breathing and coughing exercises to patients, starting from the preoperative period, increased the patients' respiratory capacity and walking distance, time, and speed. These findings are important in terms of showing that breathing and coughing exercises contribute positively to the respiratory functions and activities of the patients. It is predicted that especially administering these exercises in the preoperative period contributes to the patients' learning of the exercises, ensuring permanence, and ensuring recovery by continuing the exercises effectively in the postoperative period. Subsequently, it is recommended that nurses train patients on subjects such as deep breathing and coughing exercises, starting from the preoperative period.

LIMITATIONS

The limitations of the study include the inability to implement randomisation. Due to the inability to prevent interactions among patients in the clinic where the study was conducted, data from the control group were collected first, followed by data from the intervention group, which prevented randomisation. Additionally, it was not ethically possible not to administer any respiratory or coughing exercises to patients in the control group. Another limitation is the presentation of data limited to the first three days postoperative, reflecting only early postoperative results. Furthermore, the inability to generalise the results is due to the study being conducted in a single institution.

RECOMMENDATIONS

In future studies, ensuring randomisation and following patients even after discharge, including the post-discharge period, is recommended. To strengthen the evidence, there is a need for increased sample sizes and more advanced studies conducted in larger populations. Considering the significance of nursing care on patient outcomes, it is suggested that clinical nurses regularly provide patients with training on deep breathing and coughing exercises and subsequently track their progress in this regard. Institutions are advised to regularly provide in-service training on the importance of training nurses to enhance their education rate in the subject matter.

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