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RESEARCH ARTICLE

Effects of Positive Expiratory Pressure Breathing on Functional Outcomes in patients with Chronic Obstructive Pulmonary Disease after Major Abdominal Surgeries: Randomized Controlled Trial

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Abstract

Introduction: Disturbances in pulmonary function (PF), blood gases and functional capacity (FC) are most common postoperative complications in patients with chronic obstructive pulmonary disease (COPD). **Methods:** 44 COPD patients with major abdominal surgeries were randomly assigned into group-A received Positive Expiratory Pressure Breathing (PEPB) plus Traditional Physical Therapy program (TPTP) or group-B received TPTP only. **Results:** Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), arterial oxygen pressure (PaO_2), carbon dioxide pressure ($PaCO_2$) and six minute walk test (6MWT) were evaluated pre-operative (baseline), one week post-surgical (midpoint) and after 4 weeks. At the end of the study; FVC and percentage of improvement (%) for the groups A and B were 2.55 ± 0.5 L, (30.97 %) and 2.03 ± 0.34 L, (10.65 %) respectively. FEV1 and (%) for the groups A and B were 1.56 ± 0.34 L, (18.82 %) and 1.36 ± 0.25 L, (9.13 %) respectively. PaO_2 and (%) for the groups A and B were 69.58 ± 3.38 mmHg, (12.12 %) and 64.86 ± 2.88 mmHg, (4.07 %) respectively. $PaCO_2$ and (%) for the group A and B were 41.61 ± 2.76 mmHg, (6.63 %) and 43.19 ± 2.16 mmHg, (2.7 %) respectively. 6MWT and (%) for the group A and B were 352.13 ± 43.82 m, (41.92 %) and 312.62 ± 44.58 m, (25.99 %) respectively. **Conclusions:** PEPB program is effective in improving PF, arterial blood gases and FC in COPD patients with major abdominal surgeries.

Introduction

High incidence of post-operative pulmonary complications is tightly related to abdominal and thoracic surgeries, resulting in longer hospital stays and increased mortality (Serejo et al., 2007). Chest physiotherapy is an essential post-operative care component, aiming to prevent and reduce complications (Fagevik-Olsen, 1997 and Pasquina et al., 2006). Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disorder in which the airway obstruction is progressive and not fully reversible (Rabe et al., 2007). COPD is characterized by abnormalities in pulmonary mechanics and gas exchange, resulting in chronic cough, sputum production and dyspnea (Fernanda et al, 2006 and Corbridge et al., 2012).

Even with recent advances in treatment, COPD remains a severely debilitating condition that progressively obstructs expiratory airflow (Foresman and Jaffe, 2011). COPD places a substantial burden on patients by associated symptoms, reduced pulmonary function (Shepperd et al., 1998), and poor functional status (Mannino et al., 2003). Expiratory flow limitation in COPD patients that resulted from dynamic lung hyperinflation is believed to accelerate ventilatory limitation and exercise termination, so exercise and activity intolerance are the two main characteristic features of COPD patients (O'Donnell, 2001).

Abdominal and thoracic surgeries are associated with the risk of pulmonary complications that are increased in patients with respiratory disorders (Chetta et al., 2006). Existence of COPD is an important factor for development of post-operative (Kroenke et al., 1993) as well as intraoperative complications (Mandras et al., 2011), most frequently in form of bronchospasm, hypoxemia (Abr et al., 2007) and hypercapnia which correlates more significantly to post-operative complications than do hypoxemia (Milledge and Nunn, 1975). Respiratory muscles dysfunction secondary to abdominal surgery contributes to a reduction in many pulmonary values, disturbed gas exchange and increased ventilation/perfusion (V/Q) mismatch (Siafakas et al., 1999). Both forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) are obviously deteriorated following abdominal surgery (Cralg, 1981).

Pulmonary complications after surgery are a leading cause of postoperative morbidity and mortality; with the atelectasis, pneumonia, respiratory failure, and exacerbation of underlying chronic lung disease are the most morbid postoperative pulmonary complications (Qaseem et al., 2006). Postoperative pulmonary complications have been reported to occur in 5-10 % of the general patient population and in 4-22 % of patients undergone abdominal surgery (Lawrence et al., 1995). Presence of airflow limitations and intense dyspnea sensations that limit COPD patients functional capacity and exercise performance (Puente-Maestu et al, 2005) and may become clearly apparent during low and moderate intensities exercise or even at rest, all these factors directed researchers to seek alternative and complementary procedures that effectively and safely benefit COPD patients. Lung expansion techniques and chest physiotherapy play significant role in prevention of post-operative complications in patients with COPD (Qaseem et al., 2006).

Positive pressure breathing device is used primarily to facilitate lungs expansion, clearance of pulmonary secretions and prevent atelectasis (Darbee et al., 2004), so it is useful in the hospital setting to prevent and treat postoperative pulmonary complications (Pasquina et al., 2006), especially to facilitate the recovery of patients with COPD (Patterson et al., 2007).

Although many studies have focused on the effect of PEPB in patients with pulmonary diseases (Van der Schans et al., 1991); but still there is a need for more evaluations to verify the benefit of the treatment on COPD patients underwent abdominal surgeries. Possibly there are many positive effects, but they have not yet been all proven. This study will stimulate elaboration of new researches regarding the postoperative PEPB treatment in patients with respiratory disorders because the treatment effects of PEPB were previously evaluated only during the first postoperative days, so long-term and follow-up treatment evaluations are required (Orman and Westerdahl, 2010). Until now- and up to our knowledge and available literature- none of them investigated the effects of PEPB on ventilatory functions, arterial blood gases and functional capacity in COPD patients with abdominal surgeries. Understanding such effects could lead to establishment of proper treatment protocol.

Material and Methods

Subjects

Forty four sedentary, volunteer male patients with COPD and major abdominal surgeries were recruited from the general surgery department in the Kaser EL Aini Hospital; Cairo, Egypt. All patients fulfilled the inclusion criteria of the study and had no exclusion criteria. This study was carried out according to the principles of the Declaration of Helsinki 1975, revised Hong Kong 1989 and was approved by the department council and ethics committee of the Faculty of Physical Therapy, Cairo University.

Inclusion criteria:

Patients with partially reversible airway obstruction and mild to moderate COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) Criteria, able to perform six-minute walk test (6MWT), were clinically stable and free of exacerbations for more than four weeks, age ranged between 50-60 years, were independent of long term oxygen or domiciliary non-invasive positive pressure ventilation, intended for major abdominal surgery, with midline vertical abdominal incision, and have not been involved in any type of any training program within the previous 6 months.

Exclusion Criteria:

Patients with transverse abdominal and pelvic incisions, longer incision extending to the xiphoid process or pubic symphysis, patients who underwent previous major abdominal surgeries, patient with significant or unstable cardiac, musculoskeletal or psychological problems, sever postoperative complication that could affect or interfere with their performance or affect their safe participation, clinical or laboratory signs of active inflammation or sepsis and immobility before surgery.

All patients were initially aware about and fully understand the purpose and procedures of the study and so an informed consent was obtained from each patient; giving agreement to participation and publication of the results of the study. All patients received the same medical care, traditional physical therapy program (TPTP) and education during the study and were asked to maintain their regular diet, normal daily activities and lifestyle throughout the study. To avoid a type II error, a preliminary power analysis (power = 0.95, α = 0.05, effect size = 0.46) determined a sample size of 44 for this study. This effect size was chosen because it yielded a realistic sample size.

Patients were randomly assigned into two groups through two stages by a person who did not share any other part of the study. First; eligible patients who fulfilled the inclusion criteria were initially recorded. Secondly; all reported patients were randomly assigned to either PEPB or the control group through random number generation using an online random permutation generator from http://www.randomization.com.

Evaluation:

Patients in both groups underwent an identical battery of tests; preoperative (baseline; evaluation-1), one week after surgery (midpoint; evaluation-2) and at the end of the study (after the following 4 weeks; evaluation-3). All tests were conducted at the same time of the day (between 9-11 am). Tests were selected pulmonary functions (FVC and FEV1 in Liter), Arterial blood gases (PaO2 and PaCO2 in mmHg), and Functional capacity (6MWT in meter). Weight in Kg and height in cm were also evaluated using a standard laboratory scale. Involvement and assessment of the patients was conducted after agreement of their physician and surgical team.

Selected pulmonary function evaluation:

Evaluations of pulmonary function were carried out according to the American Thoracic Society (ATS) standards (Shah et al., 2013). FVC and FEV1 were evaluated for each patient using portable computerized pulmonary function testing unit (Spiro Analyzer ST 250; Fukuda, Sangyo, Japan). Each patient's best trial outcome from among three expiratory efforts was used in the analysis. Calibration of the Spiro Analyzer was done periodically.

Arterial blood gases evaluation:

Arterial blood samples were collected on room air. A Corning 278 blood gas analyzer (Ciba-Corning Diagnostics Co, Walpole, MA, USA) was used to perform arterial blood gas analysis including PaO2 and PCO2 according to standardized protocol (Verma and Roach, 2010). Blood sample was withdrawn from the radial artery where the patient's arm was placed palm-up on a flat surface, with the wrist dorsiflexed at 45, then the blood sample was delivered for analysis promptly.

Functional capacity evaluation:

The assessment of functional capacity was done using 6MWT, conducted according to a standardized protocol (Rabinovich et al., 2004). Patient was asked to walk at his own maximal pace from end to end of a 40 meter flat, straight corridor marked every one meter with side cones, in order to cover as much ground as possible while maintaining a steady pace without running during the allowed time. Patients were encouraged every 60 seconds using one of the two Phrases, “You are doing well” and “Keep up the good work”. Patients were informed verbally every 2 minutes of the remaining time. The patients were allowed to stop, but they were instructed to resume walking as soon as they able to do so within the allocated 6 minutes, distance covered in 6 minutes was then recorded in meter. For patient safety; Oxygen saturation and heart rate were monitored during the 6MWT by pulse oximeter (3301; BCI International Co, Waukesha, WI, USA) as the test was to be terminate if the patient reaches 85% of their maximal heart rate levels (estimated from Karvonen formula "220-age"). No adverse events were recorded.

Interventions:

Each group adhered to the prescribed regimen throughout the study. After the surgical team permission; TPTP was applied early postoperatively for both groups on twice daily basis (morning and late afternoon) and lasted throughout the study. Additionally; PEPB group (group-A) received PEPB program started at the beginning of 2nd postoperative week and lasted throughout the study.

PEPB Treatment:

PEPB treatment was performed only by group-A, guided by standardized protocol (Urell et al., 2011) using the PEPB equipment (Astra Tech, Molndal, Sweden) and scheduled on the following sequences: At the 2nd

postoperative week; The PEPB group performed 30 deep breaths each 2 hours; three sets of 10 cycles of PEPB were performed with a 30-60 second pause between each set. At the following 4 postoperative weeks; the maneuver was performed twice daily (morning and late afternoon). The PEPB maneuver was performed while the patient sits comfortably and upright, holding the mouthpiece tightly between his lips, with a nose clip was put on. An expiratory airway pressure indicator is inserted into the system to visually confirm pressure range of 10–20 cmH_2O. Resistance was adjusted so that after taking in a larger than normal tidal breath, but not to total lung capacity (the patients were instructed to end the expiration before emptying the lungs), the patient expired against a pressure of 10–20 cmH_2O, reaching an inspiration-to-expiration ratio of 1:3 to 1:4, or longer.

Traditional Physical Therapy program (TPTP):
Composed of deep breathing exercise, active range of motion and stretching exercise for upper and lower extremities closely monitored; symptoms limited ambulation, cough education and activities of daily living. TPTP was identical for both groups throughout the study.

Statistical Analysis
All data were examined using SPSS version 16.0. Data were collected and statistically analyzed using repeated measures ANOVA to test hypothesis and to control both within and between variabilities. Results were reported as means and standard deviations. For all procedures, significance was accepted at the alpha level of < 0.05.

Result

For this study, fifty seven patients with mild to moderate COPD, admitted to perform abdominal surgeries were identified as eligible for enrollment in this study. Of them; thirteen patients were withdrawn or excluded. Thus, of the original pool, forty four COPD patients with abdominal surgeries were included and completed the study.(**Fig.1)**

Patients' characteristics
The general characteristics of the participants of the two groups before training are shown in (Table I). Results revealed that there were non-significant differences in age, weight, height, body mass index (BMI), type of surgeries, anesthetic duration, and average length of hospitalization between the two groups (P > 0.05) (Table I). In this study; data were collected and were compared both within and between groups.

Table I: Demographic data of participants and surgical procedures for of the two groups (pre- study).

Variables	PEPB group (Group A) (N=23)	Non- PEPB group (Group B) (N= 21)	T value	P value☼
Age (year)	54.1 ± 3.49	55.24 ± 3.11	1.106	0.275 **
Height (m)	1.7 ± 0.65	1.68 ± 0.67	0.452	0.654**
Weight (kg)	69.26 ± 5.4	70.33 ± 9.57	1.139	0.261 **
BMI (Kg/m^2)	23.95 ± 1.97	34.1 ± 1.17	1.351	0.184**
Cigarette pack/year	37.17 ± 8.19	38.19 ± 8.94	0.394	0.696 **
Average Length of Hospitalization (days)	14 ± 1	14.76 ± 1.84	1.726	0.092 **
Anesthetic duration	3.06 ± 1.02	3.09 ± 0.82	0.104	0.918 **

Level of significance at P<0.05. * = significant ** = non-significant

Within groups:
At evaluation-2 (one week postoperative): results revealed that there were significant decreases in FVC, FEV_1, PaO_2, and 6MWT and significant increase in $PaCO_2$ mean values within both groups. (P-value < 0.05), (Table II). At evaluation-3 (at the end of the study): results revealed that there were significant increases in FVC, FEV_1, PaO_2, and 6MWT and significant decrease in $PaCO_2$ mean values within both groups. (P-value < 0.05), (Table II)

Table II. FVC, FEV1, PaO2, PaCO2, and 6MWT mean values of both groups.

		PEPB group (Group-A) (N=23)			Non-PEPB group (Group-B) (N=21)		
		Eval-1	**Eval-2**	**Eval-3**	**Eval-1**	**Eval-2**	**Eval-3**
PaO2 (mmHg)	**Mean ± SD**	71.5 ± 3.06	62.07 ± 2.74	69.58 ± 3.38	70.92 ± 2.68	62.33 ± 2.8	64.86 ± 2.88
	F, p value	74.79, <0.05$^{\Psi}$*					
		1423.02, <0.05 *			1660.44, <0.05*		
			455.09, <0.05 *			87.03, <0.05*	
		1807.18, <0.05 *			828.45, <0.05 *		
	(%)	- (13.19 ± 1.6)			- (12.12 ± 1.42)		
			12.12± 2.78			4.07 ± 2.01	
PaCO2 (mmHg)	**Mean ± SD**	41.24 ± 2.41	44.57 ± 2.48	41.61 ± 2.76	41.81 ± 2.36	44.38 ± 1.99	43.19 ± 2.16
	F, p value	12.49, <0.05$^{\Psi}$*					
		204.865, <0.05*			183.4, <0.05*		
			86.799, <0.05*			113.64, <0.05*	
		100.68, <0.05*			95.16, <0.05*		
	(%)	- (8.12 ± 2.86)			- (6.24 ± 2.35)		
			6.63 ± 3.36			2.7 ± 1.2	
FVC (L)	**Mean ± SD**	2.69 ± 0.47	1.95 ± 0.38	2.55 ± 0.5	2.64 ± 0.33	1.84 ± 0.33	2.03 ± 0.34
	F, p value	58.46, <0.05 $^{\Psi}$*					
		293.17, <0.05*			192.25, <0.05*		
			240.28, <0.05*			179.19, <0.05*	
		149.72, <0.05*			186.48, <0.05*		
	(%)	- (27.6 ± 5.95)			- (30.35 ± 8.63)		
			30.97 ± 8.72			10.65 ± 3.82)	
FEV1 (L)	**Mean ± SD**	1.67 ± 0.34	1.32 ± 0.3	1.56 ± 0.34	1.65 ± 0.27	1.25 ± 0.22	1.36 ± 0.25
	F, p value	17.85, <0.05$^{\Psi}$*					
		217.05, <0.05*			162.81, <0.05*		
			76.85, <0.05*			127.92, <0.05*	
		112.89, <0.05*			108, <0.05*		
	(%)	- (20.99 ± 5.47)			- (24.27 ± 7)		
			18.82 ± 10.23			9.13 ± 3.04	
6MWT (M)	**Mean ± SD**	382.35 ± 41.49	248.35 ± 31.06	352.13 ± 43.82	382.52± 40.69	248.24 ± 35.92	312.62 ± 44.58
	F, p value	1138.75, <0.05$^{\Psi}$*					
		1338.11, <0.05*			960.61, <0.05*		
			626.32, <0.05*			760.55, <0.05*	
	(%)	- (35.07 ± 3.14)			- (35.23 ± 4.64)		
			41.9168 ± 7.53			25.99 ± 2.81	

* Significant, ** Non significant, (%) Percentage of change, $^{\Psi}$ Degree of freedom (DF) = 2, 41.

Between groups:

At evaluation-1: Results of between groups comparison revealed that there were non-significant differences in the FVC, FEV_1, PaO_2, $PaCO_2$ and 6MWT mean values. (P-value < 0.05), (Table III), (Fig. 2-5). At evaluation-2: Results of between groups comparison revealed that were non-significant differences in the FVC, FEV_1, PaO_2, $PaCO_2$ and 6MWT mean values. (P-value > 0.05), (Table III), (Fig. 1-5). At evaluation-3: Results of between groups comparison revealed that there were significant differences in the FVC, FEV_1, PaO_2, $PaCO_2$ and 6MWT mean values but in favor of PEPB group. (P-value < 0.05), (Table III), (Fig. 2-5).

Pulmonary function

The mean values of FVC and FEV1 are reported in Table II. Mean values of FVC at evaluation-1 and at evaluation-2 for PEPB group and the control group were 2.69 ± 0.47 L, 1.95 ± 0.38 L and 2.64 ± 0.33 L, 1.84 ± 0.33 L respectively, mean values of FEV1 were 1.67 ± 0.34, 1.67 ± 0.34 and 1.65 ± 0.27, 1.25 ± 0.22 for PEPB group and control group respectively. By comparing the mean values at the two evaluation points; there was statistically significant decrease in FVC and FEV1 between evaluation-1 and evaluation-2 mean values by about - (27.6 + 5.95) %, - (20.99 + 5.47) % and - (30.35 + 8.63) %, - (24.27 + 7) % for PEPB and control groups respectively. (Figure 2, 3)

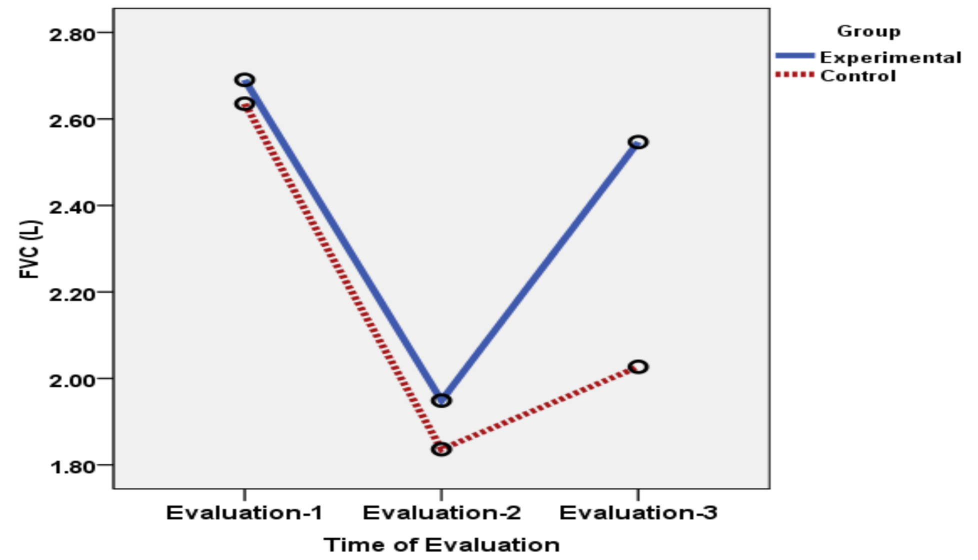

Figure (2): Mean values of FVC (L) for both groups.

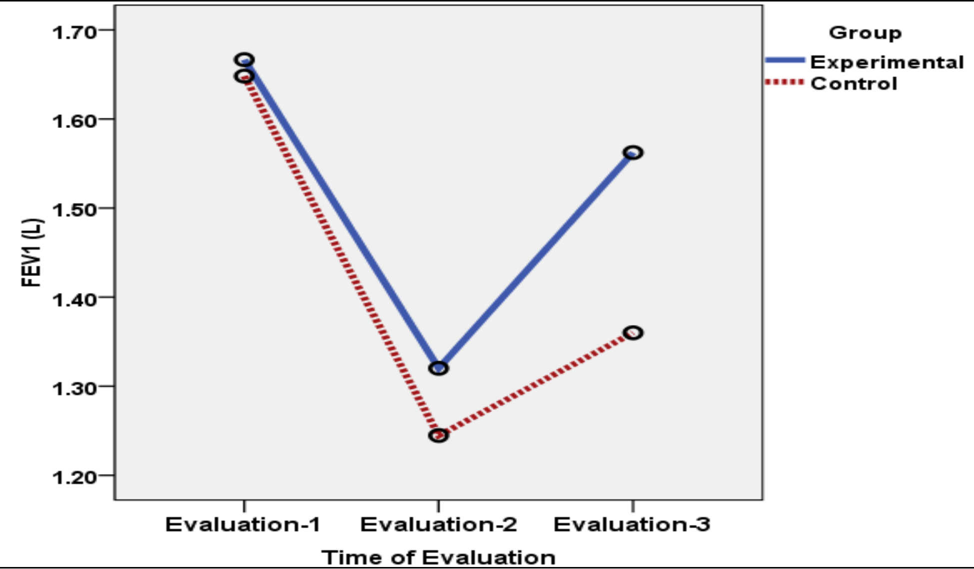

Figure (3): Mean values of FEV1 (L) for both groups.

There was a significant increase in FVC and FEV1 at evaluation-3 in both groups but in favor of the PEPB group as compared with evaluation-2 of both groups. At the end of the study; FVC and FEV1 for PEPB group and the control group were 2.55 ± 0.5 L vs. 2.03 ± 0.34 L and 1.56 ± 0.34 L vs 1.36 ± 0.25 L respectively. The percentage of

improvement of FVC and FEV1 for PEPB group and the control group were 30.97 % vs 10.65 % and 18.82 % vs 9.13 % respectively. (Figure 2, 3)
Comparison of the FVC and FEV1 mean percent change revealed significant increase in FVC and FEV1 in the PEPB group compared to the control group. Although at the end of the study there was statistically more significant increase in FVC and FEV1 in the PEPB group compared to control group; pulmonary functions were not completely recovered in the PEPB group as compared with the baseline value in pre-operative stage. (Figure 2, 3)

Arterial blood Gases:
The mean values of PaO_2 and $PaCO_2$ are reported in Table II. Mean values of PaO_2 at evaluation-1 and at evaluation-2 for PEPB group and the control group were 71.5 ± 3.06 mmHg, 62.07 ± 2.74 mmHg and, 70.92 ± 2.68 mmHg, 62.33 ± 2.8 mmHg, mean values of $PaCO_2$ were 41.24 ± 2.41 mmHg, 44.57 ± 2.48 mmHg and 41.81 ± 2.36 mmHg, 44.38 ± 1.99 mmHg for PEPB group and control group respectively. (Figure 4, 5)

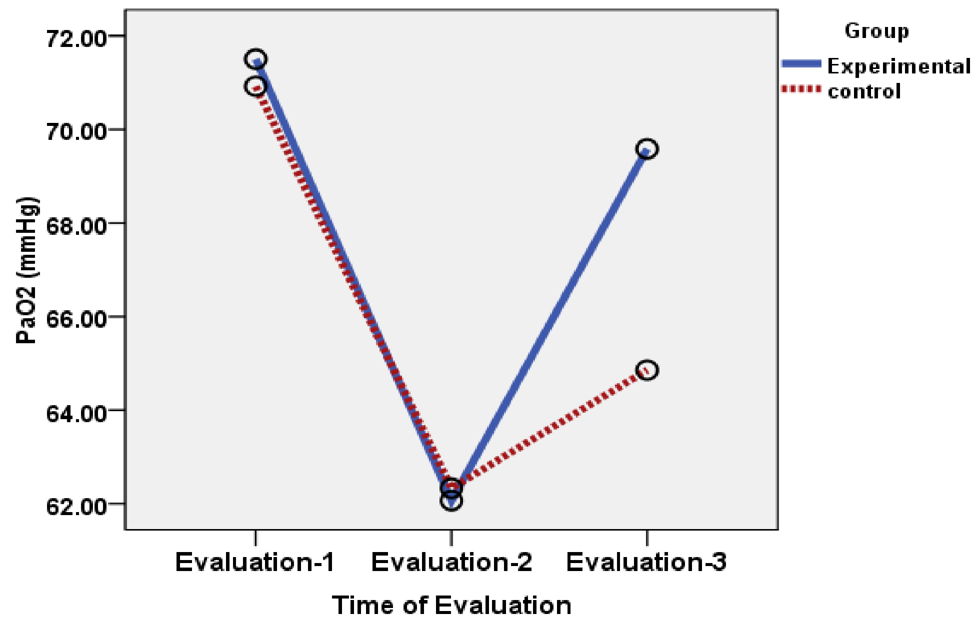

Figure (4): Mean values of PaO2 (mmHg) for both groups.

By comparing the mean values at the two evaluation points; there was statistically significant decrease in PaO_2 and significant increase in $PaCO_2$ between evaluation-1 and evaluation-2 mean values by about – (13.19) %, 8.12 % and - (12.12) %, 6.24 % for PEPB and control groups respectively.

There was a significant increase in PaO_2 and significant decrease in $PaCO_2$ at evaluation-3 in both PEPB and control groups but in favor of the PEPB group as compared with evaluation-2 values. At the end of the study; PaO_2 and $PaCO_2$ for PEPB group and the control group were 69.58 ± 3.38 mmHg vs. 64.86 ± 2.88 mmHg and 41.61 ± 2.76 mmHg vs 43.19 ± 2.16 mmHg respectively. The percentage of improvement of PaO_2 and $PaCO_2$ for PEPB group and the control group were 12.12 % vs 4.07 % and 6.63 % vs 2.7 % respectively. (Figure 4, 5)
Comparison of the PaO_2 and $PaCO_2$ mean percent change revealed significant increase in PaO_2 and $PaCO_2$ in the PEPB group compared to the control group**.** Although there was more statistically significant increase in FVC and FEV1 in the PEPB group compared with control group at the end of the study; arterial blood gases were not completely recovered in the PEPB group as compared with the baseline value in pre-operative stage.

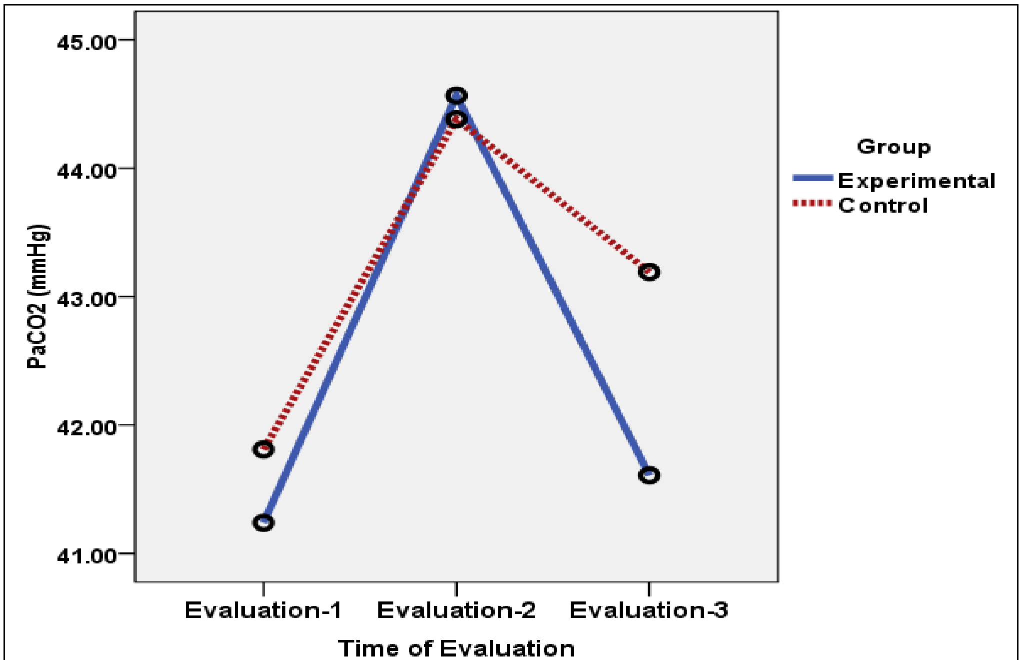

Figure (5): Mean values of PaCO2 (mmHg) for both groups.

Functional capacity (6MWT):
The mean values of 6MWT are reported in Table II. Mean values of 6MWT at evaluation-1 and at evaluation-2 for PEPB group and the control group were 382.35 ± 41.49 m, 248.35 ± 31.06 m and 382.52± 40.69 m, 248.24 ± 35.92 m respectively. By comparing the mean values at the two evaluation points; there was statistically significant decrease in 6MWT between evaluation-1 and evaluation-2 mean values by about - (35.07 ± 3.14) % and - (35.23 ± 4.64) % for PEPB and control groups respectively.

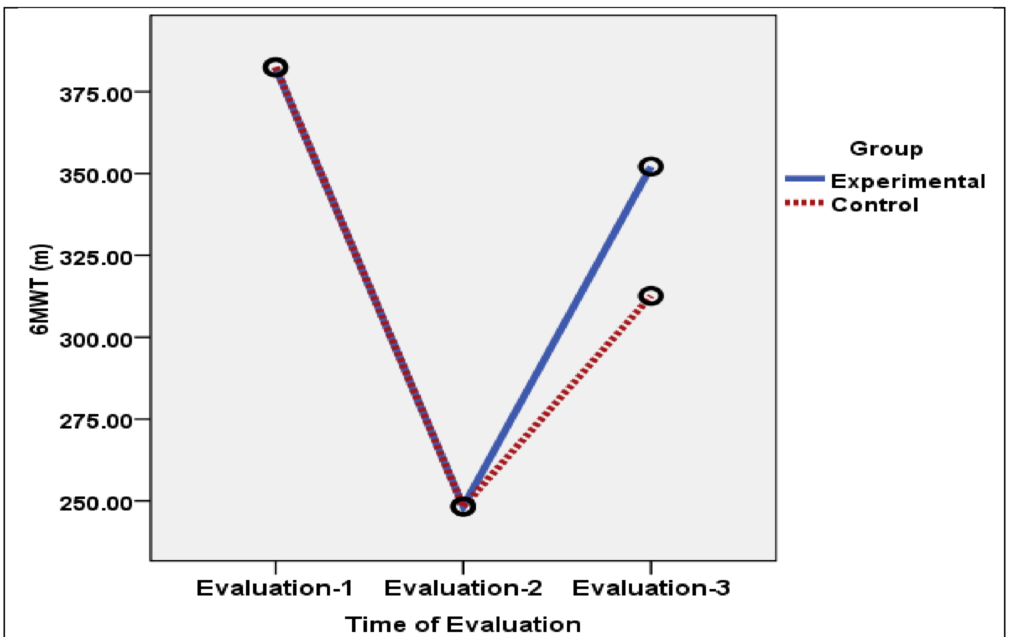

Figure (6): Mean values of 6MWT (m) for both groups.

There was significant increase in 6MWT evaluation-3 in both PEPB and control groups but in favor of the PEPB group as compared with midpoint values. At the end of the study; 6MWT for PEPB group and the control group were 352.13 ± 43.82 m vs. 312.62 ± 44.58 m respectively. The percentage of improvement of 6MWT for PEPB group and the control group were 41.9168 % vs 25.99 % respectively.

Comparison of the 6MWT mean percent change revealed significant increase in 6MWT in the PEPB group compared to the control group. Although at the end of the study there was statistically more significant increase in 6MWT in the PEPB group compared with control group; functional capacity was not completely recovered in the PEPB group as compared with the baseline value in pre-operative stage.

Table III. Between groups comparison of FVC, FEV1, PaO2, PaCO2, and 6MWT (T & P values).

Variable	Pre-Operative (evaluation-1)	1 week post-operative (evaluation-2)	After 4 weeks training (evaluation-3)
PaO2 (mmHg)	0.668, 0.508**	0.321, 0.75 **	4.963, <0.05*
PaCO2 (mmHg)	0.791, 0.433**	0.27, 0.788 **	2.103, 0.041 *
FVC (L)	0.447, 0.657**	1.034, 0.307 **	4.032, <0.05*
FEV1 (L)	0.199, 0.834**	0.885, 0.381 **	2.214, 0.032 *
6MWT (m)	0.014, 0.989**	0.011, 0.991 **	2.693, 0.005 *

* Significant; P< 0.05 ** Non significant; P> 0.05

Discussion

The purpose of this study was to investigate the effect of PEPB program on FVC and FEV1, PaO_2 and $PaCO_2$ and 6MWT in COPD patients after major abdominal surgeries. The results of this study revealed that adding PEPB to the postoperative rehabilitation program produced significantly positive results.

Patients with COPD are frequently experiencing reduced exercise capacity and physical deconditioning that impairs their functional status and quality of life. Pulmonary impairments occurring after abdominal surgery persist as a major problem (Lawrence et al., 2006), as a result of anesthesia and immobilization (Smetana et al., 2006). Abdominal and thoracic surgeries are associated with a high incidence of postoperative pulmonary complications, which are increased in patients with respiratory disorders (Chetta et al., 2006). Postoperative pulmonary complications as atelectasis, pneumonia, respiratory failure, sputum retention and shortness of breath (Smetana et al., 2006) constitute over a quarter of postoperative complications (Kulaylat and Dayton, 2012) and are the leading causes of postoperative longer hospital stays, medical consumption (Serejo et al., 2007), increased morbidity and mortality (Davis SP, 2012) and negative health outcomes (Westwood et al, 2007) after major abdominal surgeries. COPD is a well-known independent risk factor for the development of postoperative complications after thoracic or non-thoracic surgeries (Fuster et al., 2006).

PEPB is a form of chest physiotherapy, it's is an expiratory technique in which the patient expires against a resistance. Although its effectiveness in surgical instances; but there is no scientific evidence regarding the optimal technique to increase lung volumes and prevent pulmonary complications in patients with abdominal surgeries (Johansson et al., 2013). In patients with COPD; the degree of airflow obstruction is related to the risk of postoperative pulmonary complications, so spirometry as well as blood gas analysis are usually requested in COPD patients planning to undergo abdominal and thoracic surgeries (Chetta et al., 2006). Spirometry is often used because of its high degree reproducibility and ease of interpretation (Bernstein, 2012). Lung function is typically measured as FVC and FEV1 because the integrity of all components of pulmonary mechanism can be reflected through FVC values that measure the maximal volume output of the respiratory system (Braun et al., 1984), FEV1 values can be used to evaluate how much the preserved function of expiratory muscles because it depends mainly on the strength of the expiratory muscles and the diameter of the upper airways (Kelly and Luce, 1991).

The 6-minute walk test has been validated for use in the preoperative (Sinclair et al., 2012) and postoperative periods as a measure of recovery and physical capacity. The test is not merely a walking activity, but a trial of muscle and aerobic endurance, coordination, and capacity at a level consistent with the activities of daily living (Moriello et al., 2008).

PEPB program utilized in our study was guided by previously published studies utilizing PEPB technique in postoperative COPD cases. To obtain optimal results; hourly treatment was most often recommended during the first postoperative days (Johansson et al., 2013). The number of breaths with PEP per treatment varied from 5 to 30 breaths hourly. The frequency of sessions during the day also differs, from hourly treatment sessions to training once a day (Westerdahl et al., 2005), with a higher frequency of breaths during a session gains more improvement in oxygenation in the initial phase after surgery (Urel et al., 2011). The duration of treatment sessions ranges between 5 and 40 min per session (Haeffener et al., 2008 and Borghi-Silva et al., 2008). PEPB pressure of 10-20 cm H_2O was typically recommended postoperatively (Ricksten et al., 1986).

Postoperative results of our study were consistent with previous studies reported that pulmonary functions are deteriorated after abdominal surgeries. FVC and peak flows are often reduced to half, and the functional residual capacity (FRC) to below 70% of the preoperative values, this may be in part due to reduction of the transverse area and volume of the chest (Alexander et al., 1973). Postoperative respiratory dysfunction are often occurs as a result of pain, residual effects of anesthesia and muscle relaxants (Craig, 1981), diaphragmatic fatigue, and neural reflexes (Aubier et al., 1981), Adding to that; surgical incision of the chest or abdominal wall affects the integrity of the respiratory muscles and thus directly affects their function. Anesthesia affects the contraction of respiratory muscles, surgery or pharmacological agents such as sedatives affect the neural structures of the respiratory muscles and influence their performance (Siafakas et al., 1999). Postoperative respiratory muscle dysfunction and impaired physical capacity are associated with the development of postoperative pulmonary complications (McCool et al., 2012 and Kim et al., 2010), postoperative cranial shift of the diaphragm (Simonneau et al., 1983) that significantly reduces its contraction efficacy, and produces impairment of diaphragmatic function which in turn contributes to the reduction in FVC (Dureuil et al., 1986).

Disturbances in blood gases postoperatively are partially contributed to opioids administration that may cause episodic airway obstruction and consequent hypoxaemia (Wheatley et al., 1990). Post-operative airways and alveolar collapse, decreased forced residual capacity (FRC) are significantly responsible for arterial hypoxaemia (Alexander et al., 1973).

The risks and severity of postoperative complications after abdominal surgery can be reduced by the proper use of therapeutic maneuvers that improve lung volume. Physiotherapy procedures are effective in preventing postoperative pulmonary complications (Brooks et al., 2001). chest Physiotherapy is a standard component of postoperative care for prevention or minimizing (Pasquina et al., 2006) or even reducing the frequency of complications (Fagevik et al., 1997) such as atelectasis, pneumonia, sputum retention, decreased lung volumes and decreased oxygenation (Herdy et al., 2008 and Renault et al., 2008). Multiple manually assisted (Rman and

Westerdahl, 2010), (Bott et al., 2009) as well as mechanically assisted (Oikkonen et al., 1991) PEPB techniques are valid techniques for reducing postoperative complications (Holland and Button, 2006). PEPB therapy is commonly used by physiotherapists in the treatment of patients with cardiorespiratory conditions (Johnston et al., 2013), as expiratory resistance is thought to slow down expiration and increase lung volume (Urell et al., 2011).

The most commonly stated rationale for using PEPB treatment in COPD patients following abdominal surgery was primarily to prevent (Campbell et al., 1986) and treat (Mahlmeister et al., 1991) postoperative pulmonary complications, reduce atelectasis, promote secretion mobilization (Pryor and Prasad, 2002), increase functional residual capacity (FRC) and optimize the breathing pattern (Mahlmeister et al., 1991). The other major factor for justifying use of PEPB in COPD patients post-abdominal surgery was that applying resistance during expiration increases the pressure in the airways and slows expiration and so increase resting lung volumes (Ricksten et al., 1986).

Results of this study were consistence with results obtained from twice daily, individually tailored expiratory pressure application via PEP mask for 12 months in COPD patients, which resulted in significant increase in FEV1, reduction in medication use and COPD exacerbations (Christensen et al., 1991). Even in sever COPD cases; temporary PEPB is effective in improving FVC and FEV1 (Nicolini et al., 2014 and Venturelli et al., 2012). Also PEPB with a low positive pressure (5cmH2O) enhances exercise capacity (6MWT) in moderate to severe COPD patients (Nicolini et al., 2013). Utilization of PEPB in COPD patients increases inspiratory capacity, reduces lung hyperinflation and improves exercise endurance (Padkao et al., 2010). Furthermore; Diaz et al., as well as Jones et al., reported that 3 weeks of none invasive positive pressure ventilation (NIPPV) significantly reduces $PaCO_2$ and increase PaO_2 in hypercapnic COPD patient (Diaz et al., 2005 and Jones et al., 1995). Even in patients with respiratory failure; 6 months of nocturnal nasal positive pressure ventilation (NNPPV) significantly improve pulmonary function, arterial blood gases and exercise capacity (Chiang et al., 2006).

The application of PEPB beneficially affects COPD patients with major abdominal surgeries. PEPB is efficiently stabilizes airways, prevents premature airway closure, improves ventilation and reduces gas trapping (Darbee et al 2004), so PEPB therapy has been recommended as a therapeutic procedure for patients with chronic respiratory disease (Langer et al 2009 and Lee et al 2008) and postoperative candidates (Orman and Westerdahl, 2010), (Urell et al 2011), (Campbell et al 1986) because application of PEPB therapy proved to improve secretion clearance and functional residual capacity in mentioned populations (Darbee et al 2004 and Urell et al 2011). PEPB in patients with moderate COPD increases the efficiency of ventilation at rest and during exercise since the same work load is achieved with less ventilation (Van der Schans et al., 1994). Application of PEPB in COPD patient yielded many physiological changes including decreased respiratory rate, increased tidal volume, and increased arterial oxygen saturation. The beneficial gain is due to diminution of the airway collapse found in COPD patients (Mueller et al., 1970).

Although PEPB is an expiratory method; but its benefits for post-operative patients include both inspiratory and expiratory aspects as it facilitates inspiration because expiration is preceded by maximal inspiration during PEPB maneuver (Johansson et al., 2013), furthermore; increased expiratory load in PEPB may induce a reflex leading to an increased contraction of the expiratory as well as the inspiratory muscles, leading to a higher tidal volume (Van der Schans al., 1993), so gained improvement in pulmonary function and blood gases in COPD patients post-abdominal surgery can be explained by reflex activity of the expiratory muscles (Campbell and Howell, 1963), (Campbell et al., 1961), as well as increased inspiratory muscle activity (CampbeU et al., 1961). PEPB augments phasic respiratory muscle activity (which brings about a change in the volume of the thorax and thus to airflow) more than the increase in tonic respiratory muscle activity (which employed to maintain a certain lung volume) and so influence ventilation by increasing flow and preventing lung hyperinflation (Van der Schans et al., 1993).

Our study results was contradicted with a study conducted by Christensen et al, who reported that there were non-significant differences between application of 10 cm H_2O PEP versus placebo treatment for 15 minutes, over 6 months utilizing a mask in COPD patients (Christensen et al., 1991). This contradiction can be resolved by considering the differences in PEPB application methodology and utilized devices.

The major limitations of our study were the limited participation of male patients only, limited time for follow-up after treatment cessation.

The results of this study have clinical significance to physical therapists treating post-surgical COPD patients. The PEPB program used in this study can be easily adapted to clinical practice and serve as guidelines of rehabilitation of post-surgical COPD patients.

Conclusion

For a long time, chest physiotherapy has been an established form of treatment for pulmonary complications after abdominal surgery. PEPB proved to be an effective, safe therapeutic modality for COPD patients with abdominal surgery. Participation in PEPB program is effective in improving pulmonary function, blood gases and functional capacity in rehabilitation of COPD patients with abdominal surgeries.

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