e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2022; 12 (8); 56-62

Original Research Article

To Evaluate the Effect of Deep Breathing Exercises and Incentive Spirometry on Peak Expiratory Flow Rate and FEV1/FVC Ratio in Patients Undergoing Laparoscopic Cholecystectomy

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Received: 03-06-2022 / Revised: 08-07-2022 / Accepted: 20-07-2022

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Conflict of interest: Nil

Abstract

Background: Respiratory exercise and flow breathing spirometer is an exercise of importance for patients with upper abdominal surgery. Postoperative pulmonary complications have been found to be lower in patients with laproscopic cholecystectomy who receive physiotherapy and respirator compared to those who do not take it. Aim: To evaluate the effect of deep breathing exercises and incentive spirometry on Peak expiratory flow rate and FEV1/FVC ratio in patients undergoing laparoscopic cholecystectomy. Methodology: The study was carried out in S.N Medical College, Agra, starting from December 2016 to September 2018. Eligible patients were selected based on the inclusion and exclusion criteria. Results: In all groups there was a statistically significant decrease in peak expiratory flow rate (PEFR) on the 1st and 2nd post-operative day as compared to the preoperative period. Conclusion: Pulmonary function (FVC, FEV1, and PEFR) in all experimental groups (Flow Incentive Spirometry group and deep Breathing Exercise group) showed a greater improvement than the control group on 2nd postoperative day in comparison to the 1st postoperative day.

Keywords: Breathing Exercise, Laparoscopy, Abdominal Surgery, Pulmonary Function

Introduction

Respiratory exercise and flow breathing spirometer is an exercise of importance for patients with upper abdominal surgery. Endoscopic surgeries include structures such as gallbladder, colon, intestine, stomach and liver (denehy, 2007). Chest physiotherapy is a common practice in patients undergoing cardiothoracic and abdominal surgery. Abdominal surgery that was previously performed via a large incision is now more commonly performed laparoscopically [1]. General anesthesia and surgery related pain may lead to changes in the ventilation pattern resulting in the patient taking shallow breaths which reduce the ability to clear sputum from the chest [2-4].

Studies have reported altered pulmonary function after both conventional and laparoscopic abdominal surgeries [5-10].

Pulmonary dysfunction leads to pulmonary complications which includes atelectasis, pneumonia, tracheobronchial Infection, and respiratory failure. These may have an adverse effect on the length of hospital stay [2].

Postoperative pulmonary complications have been found to be lower in patients with laproscopic cholecystectomy who receive physiotherapy and respirator compared to those who do not take it (chomillas *et al*., 1998 and ambrosino 2012).

Deep breathing exercises are used in order to augment deep descent while inhalation and deep ascent while expiration. The beneficial effects of deep breathing are as follows: inflation of the alveoli, reversing postoperative hypoxemia, improvement of ventilation and oxygenation, decreasing the work of breathing, and increasing the degree of excursion of the diaphragm [11, 12].

Many mechanical ventilation devices have been used to improve pulmonary function of the patients postoperatively. The flow-oriented incentive spirometer (triflow device) consists of three chambers in series, each of which contains a ball. When the patient's effort generates a subatmosphere pressure above the ball, it rises in the chamber. An inspiratory flow of 600 ml/s is required to raise the first ball, an inspiratory flow of 900 ml/s is required to elevate the first and second balls, and a flow of 1200 ml/s is required to elevate all three balls.

There is scarcity of studies on comparing the clinical efficacy of deep breathing exercise and flow and volume incentive spirometry pulmonary function on the post operative days, especially 1st and 2nd day post laparoscopic cholecystectomy. The index study has been designed to compare the effect of deep breathing exercise, flow and volume incentive spirometry, on pulmonary function and diaphragm excursion, following laparoscopic surgery.

Methodology

The study was carried out in S.N Medical College, Agra, starting from December 2016 to September 2018. Eligible patients were selected based on the inclusion and exclusion criteria. The purpose of study made clear to each patient and a written informed consent was taken prior to involving them in the study. Randomization carried out by using sealed envelop method.

Inclusion Criteria

1) Subjects of either gender.

2) Age group of 25 to 55 years

3) Elective laparoscopic cholecystectomy.

Exclusion Criteria

1. Patients with unstable hemodynamic parameters (arterial pressure <100 mmHg systolic and <60 mmHg for diastolic and mean arterial pressure (MAP) <80 mmHg).
2. Patients with postoperative complications requiring mechanical ventilation.
3. Patients with inadequate inspiration characterized by vital capacity <10 mL/kg.
4. Patients who had history of open abdominal surgery and laparoscopic obstetrics and gynecological surgery.

The patients were divided into three groups:

- Deep breathing exercise group. –group DBE
- Flow-oriented incentive spirometry group (Triflow device). Group FIS
- Control group. group C (those who are unable to understand the intervention procedure and those who refuse to do any intervention are included in control group)

120 patients (of either sex) aged 25-55 years and who were to undergo elective laparoscopic cholecystectomy at S.N.M.C. hospital surgery department participated in the study.

The rationale and procedures for the study were explained to the subjects and their consent were obtained. Subject who met the inclusion criteria were assigned to either group A, B or C. Predicted values for pulmonary function tests were related to age, sex, height & weight according to the normal values reported. American Thoracic Society 1994 describe, PFTs in a general sense can be used to evaluate virtually every physiological aspect of breathing. PFTs serve as a diagnostic guide, assist in the formulation and evaluation of specific treatment plans, to follow the course of a disease and can predict the outcomes.

Pulmonary function tests (PFT) measured the following variables: Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Peak Expiratory Flow Rate (PEFR). These were taken on the preoperative day Day 1, 1st and the 2nd postoperative day, for all groups, day 2 and 3 respectively.

Results

Table 1: Comparison of mean difference and percentage change in Peak Expiratory Flow rate (PEFR) before and after the laparoscopic abdominal surgery in the intervention groups and the control group

Mean difference between pre-operative and post-operative 1st day				p-value
Mean difference	1.58 ±0.41	2.11 ±0.62	1.65 ±0.53	<0.0001
% Change	28.73	38.64	31.25	
Mean difference between pre-operative and post-operative 2nd day				
Mean difference	0.80 ±0.31	1.16 ±0.48	1.02 ±0.44	0.001
% Change	14.55	21.25	19.32	
Mean difference between post-operative 1st day and post-operative 2nd day				
Mean difference	-0.78 ±0.20	-0.95 ±0.55	-0.63 ±0.23	0.001
% Change	-19.90	-28.36	-17.36	

Table 2: Comparison of FEV1/FVC ratio before and after the laparoscopic abdominal surgery in the intervention groups and the control group

FEV1/FVC	DBE (N=40)	FIS (N=40)	Control (N=40)
Pre-operative (Mean ±SD)	0.98 ±0.14	0.80 ±0.13	1.03 ±0.23
Post- operative 1st day (Mean ±SD)	0.83 ±0.15	0.75 ±0.21	1.04 ±0.29
Post- operative 2nd day (Mean ±SD)	0.90 ±0.12	0.76 ±0.13	1.02 ±0.23
f-value	11.965	1.078	0.063
p-value	<0.0001	0.344	0.939

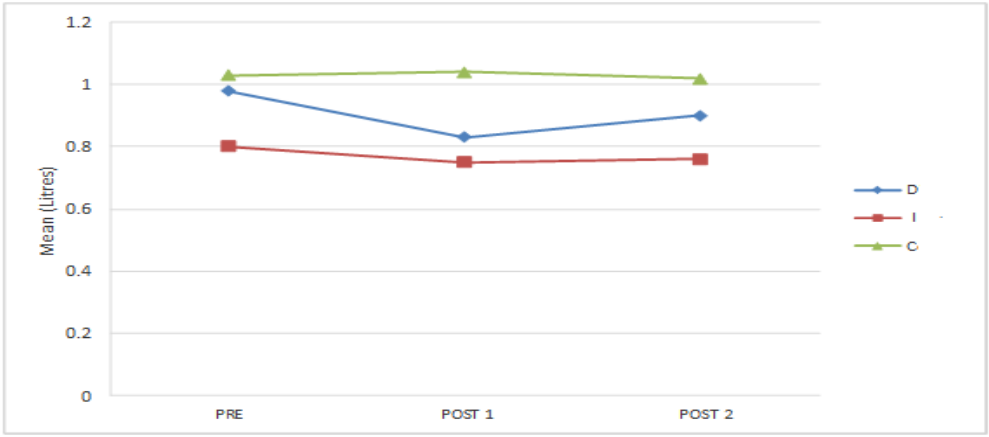

Figure 1: Graphical Representation of Comparison of FEV1/FVC ratio before and after the laparoscopic abdominal surgery in the intervention groups and the control group

Table 3: Comparison of FEV1/FEC ratio before and after the laparoscopic abdominal surgery in the intervention groups and the control group

Mean difference between pre-operative and post-operative 1st day				P value
Mean difference	0.15±0.11	0.05±0.13	-0.01±0.09	
% Change	15.31	6.25	-0.97	<0.0001
Mean difference between pre-operative and post-operative 2nd day				
Mean difference	0.08±0.08	0.04±0.03	0.01±0.06	<0.0001
% Change	8.16	5.00	0.97	
Mean difference between post-operative 1st day and post-operative 2nd day				
Mean difference	-0.07±0.08	-0.01±0.14	0.02±0.08	0.001
% Change	-8.43	-1.33	1.92	

There was a statistically significant decrease in Forced Vital Capacity (FVC) in the 1st and 2nd post-operative period when compared with the preoperative period in all groups.

In all groups there was a statistically significant decrease in peak expiratory flow rate (PEFR) on the 1st and 2nd post-operative day as compared to the preoperative period . The mean difference the between preoperative and the 1st postoperative day in the Deep Breathing Exercise group was 1.58 (28.73%), the Flow Incentive Spirometry group was 2.11(38.64%), the and in the control group was 1.65 (31.25%).The mean difference between the preoperative and the 2nd postoperative day in the Deep Breathing Exercise group was 0.80 (14.55%), the Flow Incentive Spirometry group was 1.16 (21.25%), and in the control group was 1.02 (19.32%). The mean difference between the 1st postoperative day and the 2nd postoperative day in the Deep Breathing Exercise group is -0.78 (-19.90%), the Flow Incentive spirometry group was -0.95 (-28.36%), and in the control group was -0.63(-17.36%).

FEV1/FVC RATIO were compared with in intervention groups and control group before and after laparoscopic cholecystectomy.

The mean difference the between preoperative and the 1st postoperative day in the Deep Breathing Exercise group was 0.15 (15.31%), the Flow Incentive Spirometry group was 0.05(6.25%), the and in the control group was 0.01(0.97%).The mean difference between the preoperative and the 2nd postoperative day in

the Deep Breathing Exercise group was 0.08 (8.16%), the Flow Incentive Spirometry group was 0.04 (5.00%), and in the control group was 0.01 (0.97%).

The mean difference between the 1st postoperative day and the 2nd postoperative day in the Deep Breathing Exercise group is -00.07 (-8.43%), the Flow Incentive spirometry group was -0.01 (-1.33%), and in the control group was 0.02(1.92%).

Discussion

The main purpose of this study is to compare deep breathing exercise, Flow incentive spirometry on pulmonary function in patients undergoing laparoscopic cholecystectomy surgery.

The difference in Forced Vital Capacity (FVC) between the preoperative and 2nd post-operative day of patients in the deep breathing exercise group (9.63%) and was found to be significantly less than those in the flow-incentive spirometry group (10.53%) and the control group (15.56%)

The difference in Peak Expiratory Flow Rate (PEFR) between the preoperative and the 2nd post-operative day of patients in the deep breathing exercise group (14.55%) and was found to be significantly less than those in the flow -incentive spirometry group (21.25%) and the control group (19.32%).

In our study pulmonary function (FVC, FEV1, and PEFR) and in the intervention groups (deep breathing exercise and incentive spirometry group) was nearly equivalent to those of the preoperative values when compared to the control group. Several studies have shown that pulmonary function after laparoscopic abdominal surgery returns to normal values in around 5 days [3].

Our findings are similar to those reported in a study carried out on pulmonary function following in patients who had undergone laparoscopic cholecystectomy where exercise was compared to the pulmonary function of a control group and found to be significantly better [13,14].

In our study, the deep breathing exercise group showed a significant improvement in pulmonary function {Forced Vital Capacity [FVC] (14.55%), Forced Expiratory Volume in one second [FEV1](26.01%), Peak Expiratory Flow Rate [PEFR] (19.90) on the 2nd postoperative day when compared to the 1st postoperative day.

Pulmonary function (FVC, FEV1, and PEFR) in all experimental groups showed a greater improvement from the 1st postoperative to the 2nd postoperative day than was observed in the control group.

To summarized, systematically compared the effects of breathing techniques on pulmonary function in subjects undergone laparoscopic surgery and it was found that pulmonary function was found to be better preserved in the deep breathing exercise group and incentive spirometry group when compared to the pulmonary function in control group.

The present study showed that the Deep breathing exercise group was able to improve pulmonary mechanics thus leading to a beneficial effect on pulmonary function (FVC). Deep breathing exercise improves diaphragmatic descent and diaphragmatic ascent during inspiration and expiration respectively. Slower deep inspiration ensures more even distribution of air throughout the lung, particularly to the dependent lung [11].

The physiological effects of diaphragmatic breathing exercise is that breathing through full vital capacity and holding for 3-5 seconds, ensures full inflation of the lungs thus opening up alveoli which have low volume and stimulating the production of surfactant. It will also decrease activity of accessory muscles, ensure that breathing patterns are as close to normal as possible and also reduce the work of breathing [11,15].

Webber and Menkes *et al*. found that diaphragmatic breathing exercise will improve tidal volume and also facilitate secretion removal [16,17].

Blaney *et al*. Observed that tactile stimulation over the subject's lower costal margin as well as verbal instruction served to significantly increase diaphragmatic movement during diaphragmatic breathing execrises [18].

Manzano *et al*. found that diaphragmatic breathing exercise was able to improve pulmonary mechanics and lead to beneficial effect on Forced Vital Capacity (FVC).

Grams *et al*. evaluated the efficacy of diaphragmatic breathing exercise for the prevention of postoperative pulmonary complications and for the recovery of pulmonary mechanics and found that diaphragmatic breathing exercise appeared to be more effective [19].

Conclusion

According to our study pulmonary function (FVC, FEV1, and PEFR) in all experimental groups (Flow Incentive Spirometry group and deep Breathing Exercise group) showed a greater improvement than the control group on 2nd postoperative day in comparison to the 1st postoperative day.

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