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Original Research Article

A Prospective Study to Evaluate the Effect of Deep Breathing Exercises and Incentive Spirometry on Pulmonary Functions in Patients before and After Laparoscopic Cholecystectomy

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Abstract

Introduction: 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 compare the effect of deep breathing exercise, flow 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. Randomization carried out by using sealed envelops method.

Results: There was a statistically significant decrease in Forced Vital Capacity (FVC) in the 1st day when compared with the preoperative period in all groups. The mean difference in values between the preoperative and the 1st postoperative day in the Deep Breathing Exercise group was 0.57 (21.11%), the Flow Incentive Spirometry group was 0.67 (25.19%), and in the control group was 0.85 (37.78%).

Conclusion: There is a significant decrease in pulmonary function {Forced Vital Capacity (FVC), Force Expiratory Volume in the first one second (FEV1), and Peak Expiratory Flow Rate (PEFR)} and on the 1st postoperative day when compared to the pre-operative day in laparoscopic cholecystectomy surgery patients.

Keywords: FVC, FEV1, Pulmonary Function, Laparoscopy, Cholecystectomy

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Background

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). This effect is the result of the application of various forms of lung expansion and secretion removed techniques. So, lung expansion and cough exercises, changing the patient's position and assisting in early mobilization are responsible for the reduction in postoperative pulmonary complications (ambrosino and gabrielle 2010) [1].

Respiratory exercise like deep breathing and flow breathing spirometer is an exercise of importance for patients with upper abdominal surgery.

The incentive spirometry (is) technique was used to encourage the patient to take maximum and long inspiration, and slow deep breathing using a device to measure flow or sound. Exposure to maximal inspiration during three seconds may increase pulmonary transit pressure thereby improving inspiratory volumes and inspiratory muscle performance (do nascimento *et al*., 2014) [2].

In laparoscopy, intraoperative pulmonary changes are due to decreased pulmonary compliance secondary to upward movement of the diaphragm during insufflation and to changes in carbon dioxide (co2) homeostasis secondary to absorption of insufflated co2 from peritoneum [3]. Reduction of pulmonary function, forced vital capacity (fvc), and forced expiratory vital capacity (fev1) have been reported on the basis of functional alterations [4].

Mechanical breathing device such as the incentive spirometry (is) has been introduced into clinical practice [4]. Incentive spirometry encourages the patient to take long, slow deep breath mimicking natural sighing and also provides a visual positive feedback.

There are no retrievable studies that have been done on the clinical efficacy of deep breathing exercise and flow and volume incentive spirometry after laparoscopic abdominal surgery. With this background the present study aim is 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 envelopes 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 was 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: Demographic characteristic

Variables	Intervention group		Control (N=40)	p-value
	DBE(N=40)	FIS(N=40)		
Age(yrs) (Mean ±SD)	42.60±6.33	42.50±5.27	44.90±8.38	0.206 ^{NS}
Gender (n) M:F	29:11	23:17	25:15	
Height (cm) (Mean ±SD)	165.60±6.26	165.10±7.10	163.90±6.30	0.494 ^{NS}
Weight (kg) (Mean ±SD)	65.30±7.17	67.30±5.20	65.10±7.45	0.270 ^{NS}
BMI (Mean ±SD)	23.97±3.78	24.81±2.80	24.24±2.66	0.472 ^{NS}

Table 2: Comparison of Forced Vital Capacity (FVC) before and after the laparoscopic abdominal surgery in the intervention groups and control group

FVC(LITRE)	DBE (N=40)	FIS (N=40)	Control (N=40)
Pre-operative (Mean ±SD)	2.70±0.39	2.66±0.30	2.25±0.35
Post- operative 1st day (Mean ±SD)	2.13±0.38	1.99±0.29	1.40±0.29
Post- operative 2nd day (Mean ±SD)	2.44±0.33	2.38±0.27	1.90±0.32
f-value	24.105	55.012	70.874
p-value	<0.0001	<0.0001	<0.0001

Table 3: Comparison of mean difference and percentage change in Forced Vital Capacity (FVC) before and after the laparoscopic abdominal surgery in the intervention groups and control group

Mean difference between pre-operative and post-operative 1st day				P value
Mean difference	0.57±0.19	0.67±0.09	0.85±0.14	<0.0001
% Change	21.11	25.19	37.78	
Mean difference between pre-operative and post-operative 2nd day				
Mean difference	0.26±0.13	0.28±0.08	0.35±0.13	0.002
% Change	9.63	10.53	15.56	
Mean difference between post-operative 1st day and post-operative 2nd day				
Mean difference	-0.31±0.10	-0.39±0.10	-0.50±0.09	<0.0001
% Change	-14.55	-19.60	-35.71	

Table 4: Comparison of mean difference and percentage change in Forced Expiratory Volume in one second (FEV1) before and after the laparoscopic abdominal surgery in the intervention groups and control group

Mean difference between pre-operative and post-operative 1st day				P value
Mean difference	0.89±0.18	0.64±0.26	0.84±0.11	<0.0001
% Change	33.72	30.33	37.17	
Mean difference between pre-operative and post-operative 2nd day				
Mean difference	0.44±0.11	0.31±0.07	0.38±0.09	<0.0001
% Change	16.48	14.69	16.81	
Mean difference between post-operative 1st day and post-operative 2nd day				
Mean difference	-0.45±0.11	-0.33±0.25	-0.46±0.09	0.001
% Change	-26.01	-22.45	-32.39	

There was a statistically significant decrease in Forced Vital Capacity (FVC) in the 1st day when compared with the preoperative period in all groups. The mean difference in values between the preoperative and the 1st postoperative day in the Deep Breathing Exercise group was 0.57 (21.11%), the Flow Incentive Spirometry group was 0.67 (25.19%), and in the control group was 0.85 (37.78%).

In all groups there was a statistically significant decrease in Forced Expiratory Volume at the end of the first second (FEV1) on the 1st and 2nd post-operative day when compared to the preoperative period. The mean difference in FEV1 between the preoperative and the 1st postoperative day in the Deep Breathing Exercise group was 0.89 (3.72%), the Flow Incentive Spirometry group was 0.64 (30.33%), and in the control group was 0.84 (37.17%). The mean difference in FEV1 between the preoperative and 2nd the postoperative day in the Deep Breathing Exercise group was 0.44 (16.48%), the Flow Incentive Spirometry group was 0.31 (14.70%), and in the control group was 0.38 (16.81%).

Discussion

The main purpose of this study was to compare deep breathing exercise, Flow incentive spirometry on pulmonary function in patients undergoing laparoscopic cholecystectomy surgery. There were 40 patients included in each group and there were three groups, and all three groups were homogenous in terms of all demographic parameters. In the present study, reduced pulmonary function (FVC, FEV1 and PEFR) in postoperative laparoscopic cholecystectomy surgery subjects might be due to postoperative pain, location of surgical ports, along with anaesthetic, analgesic usage [5,6].

The effects of general anaesthesia on distribution of ventilation, and chest wall and lung mechanics leads to ventilation-perfusion mismatch, increased dead space, shunt and hypoxemia [7-9].

Narcotic/opioid analgesics and other drugs affect the central regulation of breathing, changing the neural drive of the upper airway and chest wall muscles; which lead to hypoventilation, a diminished sensitivity of the respiratory center to carbon dioxide stimulation, an increase of obstructive breathlessness, the suppression of the cough reflex and irregular mucus production [10].

The location of surgical ports involves trauma near the diaphragm and chest wall/ribs, leading to postoperative incisional pain and reflex inhibition of the phrenic nerve and diaphragmatic reflex paresis resulting in functional disruption of respiratory muscle movement. In addition, when patients remain lying down for long periods during the postoperative period their abdominal content limits diaphragmatic movement [11,12].

Several studies found that diaphragmatic dysfunction is due to gas insufflation in the abdominal cavity which might also be responsible for the increase of resistance and reduced diaphragmatic excursion, leading to reduced lung volume [13].

Our results are in accordance with Ford *et al*., who showed that reduction in inspiratory muscle activity, mainly the diaphragm was the main determinant of impaired pulmonary function. Diaphragm dysfunction may be due to reflex inhibition of efferent phrenic activity [14].

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.

Conclusion

There is a significant decrease in pulmonary function {Forced Vital Capacity (FVC), Force Expiratory Volume in the first one second (FEV1), and Peak Expiratory Flow Rate (PEFR)} and on the 1st postoperative day when compared to the pre-operative day in laparoscopic cholecystectomy surgery patients.

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