*International Journal of Biomedical And Advance Research*

ISSN: 2229-3809 (Online)
Journal DOI:10.7439/ijbar
CODEN:IJBABN

**Research Article**

# Chest physiotherapy during immediate postoperative period among patients undergoing laparoscopic surgery- A Randomized Controlled Pilot Trail

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## Abstract

**Objective:**To evaluate the effects of diaphragmatic breathing exercise on pulmonary function and diaphragm excursion in patients who underwent laparoscopic surgery

**Materials and Methods**: Twenty sample sizes with twelve men and eight women who underwent laparoscopic surgery were randomly divided as follows: 10 subjects performed diaphragmatic breathing exercise, (other therapies like bronchial hygiene therapy, Thoracic mobility exercise and mobilization) and 10 participated as a control group. All of them underwent evaluations of pulmonary function test with measurement of forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF) and diaphragm excursion by ultra songraphybefore the operation and first, second postoperative day(POD)

**Results:** pulmonary function and diaphragm excursion values between preoperative and postoperative (first, second) days were found to be higher in the exercise group when compared to control group.

**Conclusions:** chest physiotherapy contributed towards early recovery of pulmonary function and diaphragm excursion among patients who had undergone laparoscopic surgery

**Keywords:** chest physiotherapy, laparoscopic abdominal surgery, diaphragmatic breathing exercise, postoperative period

## 1. Introduction

Chest physiotherapy is a common practice in patients who require major open thoracic or abdominal surgery. Nowadays many abdominal surgeries are performed by the laparoscopic technique.[1]In studies comparing the postoperative course in open versus laparoscopic operations, the laparoscopic technique has been found to be superior to the open one, producing approximately 20% to 40% reduction of lung function , fast recovery and a short hospital stay.[2]

Studies have reported that pulmonary function alters following abdominal surgery, both in conventional surgeries and laparoscopic.[3-6] These functional alterations are characterized by reduction of the vital capacity (VC) as well as the forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1)[3-6]

In abdominal surgery, general anesthesia with controlled ventilation has a negative effect on the respiratory function of the most patients. Postoperative pain, drugs, immobilization and preexisting lung diseases all play an important role in the development of the postoperative pulmonary complication. The most prominent complication following upper abdominal surgery is atelectasis, pneumonia and hypoxaemia.[7]

The basic mechanism of postoperative complication is a lack of lung inflation that occurs because of a change in breathing to a shallow, monotonous breathing pattern without periodic sighs, prolonged recumbent positioning and temporary diaphragmatic dysfunction.[8]A related form of atelectasis occurs in patients after surgery, lung secretions tend to be retained in the lung because of mucociliary stasis and suppression of coughing and deep breathing. Retained secretions can obstruct multiple distal airways, leading to under ventilation and atelectasis of the affected region.[9]

Chest physical therapy plays an important role in the prevention of these post-operative complications. Post-operative chest physiotherapy started being implemented in the beginning of the 20$^{th}$ century; itincludes breathing exercise, postural drainage, percussion and vibration or shaking which were developed to improve bronchial drainage.[10]

Diaphragmatic breathing exercise is inspiring to total lung capacity with particular emphasis on the use of the diaphragm; this has been shown to inflate alveoli and reverse postoperative atelectasis and it also improves the efficiency of ventilation, decreases work of breathing, to increase the excursion of the diaphragm, and improves gas exchange and oxygenation.[11]

Study also shows that diaphragmatic breathing exercise encourages more diaphragmatic movement.[12]. Gastaldi AC et al concluded that chest physical therapy contributed towards early recovery of pulmonary function and muscle strength among patients who had undergone laparoscopic cholecystectomy.[3]

However, there are no studies showing the effect of diaphragmatic breathing exercise in preventing post-operative pulmonary dysfunction following laparoscopic surgery. The present study aims to compare the effect of diaphragmatic breathing exercise, on pulmonary function following laparoscopic surgery, which has not been investigated previously.

## 2. Method

The study was approved by the Department of Physiotherapy Scientific Committee and the Institutional Ethics Committee of Kasturba Medical College Mangalore. The study included 20 patients aged 20-70 years undergoing laparoscopic abdominal surgery.Exclusion criteria waspatients who were uncooperative, unstable cardiovascular system, Presence of any acute infection, and patients who underwent open abdominal surgery

The purpose of the study was explained to the participant and an informed consent was obtained. Patients were divided in two groups; (1) control group, (2) diaphragmatic breathing exercise group. Each group contained 10 patients. Patients were selected through convenient sampling. Allocation of the group was done by block randomization.

Each subject was allocated a unique study number which corresponded to that on a sealed opaque envelope containing information about subjects' allocated exercise or control group. Once the allocation of the groups was done, the patient in the exercise group was seen one day prior to the surgery and was given preoperative information and diaphragmatic breathing exercises were taught to the patient. Other therapies like bronchial hygiene therapy, Thoracic mobility exercise and mobilization were taught to every patient in exercise group.

Patient in the control group was not provided any information and training before operation. After operation, physical therapy treatment was withheld unless patient is diagnosed with a pulmonary complication. Pulmonary function test procedures were performed ensuring technical acceptability and reproducibility criteria recommended by the American Thoracic Society. The following variables were recorded; Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second ($FEV_1$), $FEV_1$/FVC ratio,) these were taken in the preoperative period and it was measured again first and second day after surgery. The Ultra sonography for diaphragm excursion was taken in the preoperative period in both groups and it was measured again on 1$^{st}$ postoperative day and at the time of the discharge. These measurements were taken

by an experienced radiologist.

**2.1 Method of performing diaphragmatic breathing exercise**

To teach diaphragmatic breathing the patient was in a Semi Fowler's position so that his back and head were fully supported and his abdominal wall relaxed. The therapist placed his hands on the Rectus abdominis just below the anterior costal margin. Patient was instructed to breathe in slowly and deeply through the nose. Further instruction was given to keep the shoulders relaxed and upper chest quiet, allowing the abdomen to rise slightly. Then patient was asked to relax and exhale slowly through the mouth. [11]

Patient had to practice this three or four times and rest. To learn how to self- monitor this sequence, patient had to place his or her own hand below the anterior costal margin and feel the movement. Patient's hand should rise slightly during inspiration and fall during expiration. Patient was instructed to perform it for 5-10 breaths every hour while awake. [11]

Exercise was given by the therapist four times in a day and the patient asked to perform the same maneuver unsupervised thereafter, which was recorded in a log book .Other therapies like bronchial hygiene therapy, thoracic mobility exercise and mobilization was given to exercise groups.[11]

**2.2 Method of performing diaphragm excursion**

The probe was placed between the midclavicular and anterior axillary lines, in the sub-costal area, and directed medially, cranially and dorsally, so that the ultrasound beam reached perpendicularly the posterior third of the right hemi diaphragm. Diaphragm movements were recorded in M-mode. This maneuver begins at the end of normal expiration, and the patients were asked to inhale in as deeply as they possibly could do. [13]

**2.3 Data analysis**

All statistical analysis was performed using the Statistical Package for Social Science (SPSS) version 13.0 software. P-value of >0.05 with confidence interval of 95% was considered statistically not significant. An analysis of variance (ANOVA) was used to compare the results of each group obtained in the pre-operative as well as for first and second post-operative (OP) days. The non-paired students't-test was used for comparing the measures of the exercise and of the control group on each day of the study at a significance level of 5%.

## 3. Result

The characteristics of the 20 patients included in the data analysis were shown in (Table-1). The baseline analysis characteristics demographic data, including age, sex, height, weight,,10 patients took part in the exercise group, in which 5 were females and 5 males, age 44.0 ±17.9 years old, and 10 engaged in the control group, 3 females and 7 males, age 40.4 ±18.3 years old.

**Table 1: Demographic data of the study participants**

| Characteristics | Control group | Exercise group |
|---|---|---|
| N | 10 ( male 7, female 3) | 10 (male ,5 female, 5) |
| Age | 40.4 ±18.3 | 44.0 ±17.9 |
| Height | 160.0± 7.46 | 156.4 ±10.1 |
| Weight | 58.5± 7.82 | 57.5 ±7.12 |
| Laparoscopic cholecystectomy | 4 | 4 |
| Laparoscopic appendectomy | 2 | 1 |
| Laparoscopic hernioplasty | 4 | 3 |
| Laparoscopic Umbilical hernia repair | 0 | 2 |

**Table 2: comparison of pulmonary function in Control group**

| | preop | Postop 1 day | Postop 2 day | Difference (preminuspost1) | P value | Difference (preminuspost2) | P value |
|---|---|---|---|---|---|---|---|
| FVC | 2.79±1.11 | 1.93±.62 | 2.40±1.01 | .85±.80 | .009 | 0.39±.44 | .022 |
| FEV1 | 2.20±.67 | 1.56±.54 | 1.69±.53 | .63±.42 | .005 | .50±.44 | .011 |
| FEV1/FVC | 84.3±6.0 | 76.4±8.0 | 75.8±1.4 | 7.9±1.1 | .052 | 8.0±1.4 | .159 |
| PEF | 4.62±1.17 | 2.79±.69 | 3.64±1.06 | 1.82±1.09 | .007 | .97±1.06 | .009 |

**Table 3: comparison of pulmonary function in Diaphragmatic breathing exercise group**

| | preop | Postop 1 day | Postop 2 day | Difference (preminuspost1) | P value | Difference (preminuspost2) | P value |
|---|---|---|---|---|---|---|---|
| FVC | 2.46±.59 | 1.96±.62 | 2.14±.46 | 0.5±.57 | .005 | 0.32±.46 | .041 |
| FEV1 | 2.00±.51 | 1.53±.61 | 1.68±.46 | 0.47±.59 | .012 | 0.32±0.4 | .059 |
| FEV1/FVC | 81.9±5.0 | 76.9±1.3 | 78.0±1.1 | 5.0±1.3 | .474 | 3.0±1.1 | .523 |
| PEF | 4.64±1.56 | 2.98±1.37 | 3.76±1.46 | 1.65±1.69 | .017 | .87±1.48 | .093 |

**Table 4: Comparison of diaphragm excursion in Control group**

| | preop | Postop 1 day | Postop 2 day | Difference (preminuspost1) | P value | Difference (preminus discharge) | P value |
|---|---|---|---|---|---|---|---|
| Diaphragm excursion | 4.08±.85 | 3.06±1.25 | 3.67±1.03 | 1.02±.69 | .007 | .40±.51 | .034 |

**Table 5: comparison of diaphragm excursion Diaphragmatic breathing exercise group**

| | preop | Postop 1 day | Postop 2 day | Difference (preminuspost1) | P value | Difference (preminus discharge) | P value |
|---|---|---|---|---|---|---|---|
| Diaphragm excursion | 3.83±.88 | 3.03±.79 | 3.69±.88 | .80±.84 | .014 | .14±.55 | .482 |

The mean values for pulmonary function (FVC, FEV1, FEV1/FVC, PEF) and diaphragm excursion in the preoperative period and on the first and second day after the surgery in both groups are shown in (Table-2, 3, 4, 5) one can observe a meaningful reduction in the first postoperative in relation to the preoperative phase for all variables analyzed ($p<0.05$) for both groups, except in the relation FEV1/FVC, which did not show any significant differences. By comparing preoperative and second postoperative in both groups, the value found in the exercise group were greater than those in the control group.

## 4. Discussion

This study evaluated the effects of diaphragmatic breathing exercise on pulmonary function and diaphragm excursion of patients who underwent laparoscopic surgery. It is necessary to point out that in the literature no such references were found for any works that linked the chest physiotherapy or laparoscopic surgery, which attests to the importance and pioneering nature of this pilot study.[3]

The result of present study shows that pulmonary function (FVC, FEV1, FEV1/FVC, and PEF) and diaphragm excursion between preoperative,first and second postoperative day werelesser in the control group compared to exercise group. General anesthesia and surgical procedures affect the respiratory system negatively such as decreased diaphragm activity and ventilatory response which leads to decreased lung volumes, combined with expiratory muscle impairment, caused a reduction of the expiratory flow and damage to the cough mechanism, favoring the retention of pulmonary secretions.[3, 14]

The presence of the diaphragm reflex inhibition is defined in conventional surgeries; there is an emphasis on the occurrence of this dysfunction also in the laparoscopicsurgery, which promotes minor alterations in pulmonary functions resulting from the lesser manipulation of the abdominal structures. The patients of this study may have presented diaphragmatic reflex paresia by the reduction of the diaphragm excursion found in postoperative.[6, 15]

The use of diaphragmatic breathing exercise carried out by a specialized physical therapist speed up the patients' pulmonary condition recovery back to the preoperative patterns. Although the incidence of pulmonary complications has not been covered in this study, the early normalization of the pulmonary functions suggest a lower risk of further development of the most common pulmonary complications, namely atelectasis and hypoxemia.[3,16]

It is known that the impairment of the pulmonary functions after laparoscopic surgeries is lower than after conventional surgeries, which suggests that these patients are less likely to develop complications.[15] Nonetheless, it has been shown that laparoscopy produces minor alterations, but which have an impact on pulmonary functions, particularly in those patients who have had previous pulmonary impairments.[3,17]

In many hospitals throughout the world, surgery that was previously performed via a large incision is now more commonly performed laparoscopically. The efficacy of physiotherapy in laparoscopic surgery has not been investigated. A recent survey found that 58% of physiotherapists in Australian hospitals where laparoscopic surgery is performed routinely assess and treat these patients postoperatively.[18] One of the limitations of study is small sample size. Further research is needed studies with large sample size andcomparing the different breathing exercise devices in laparoscopic surgery. In conclusion, chest physiotherapy contributed to the early recovery of both the pulmonary function and diaphragm excursion of the patients who underwent laparoscopic surgery, as was indicated by the treatment or prevention of postoperative pulmonary complications.

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