

CHEST PHYSIOTHERAPY AMONG PATIENTS UNDERGOING LAPAROSCOPIC SURGERY DURING THE IMMEDIATE POSTOPERATIVE PERIOD: A RANDOMIZED CONTROL TRIAL.

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ABSTRACT

Background

Laparoscopic surgery, although minimally invasive, can lead to postoperative respiratory complications due to the effects of general anesthesia and pneumoperitoneum. Chest physiotherapy has been effective in improving respiratory outcomes in various surgical populations, but its impact on patients undergoing laparoscopic surgery during the immediate postoperative period remains underexplored. This study aimed to evaluate the outcomes of chest physiotherapy in the immediate postoperative period among individuals undergoing laparoscopic surgery.

Methods

The study comprised 182 patients who underwent various types of laparoscopic surgery. Participants were allocated randomly into 2 groups: a control group and a chest physiotherapy group. The primary outcome was oxygen-hemoglobin saturation, while secondary outcomes included spirometry results, peak expiratory flow, pain levels, and analgesic use.

Results

The study included 52% males and 48% females with an average age of 45.7 ± 10.9 years. The chest physiotherapy group (n=91) showed significantly better postoperative outcomes: higher oxygen-hemoglobin saturation ($95.8\% \pm 1.4\%$ vs. $92.6\% \pm 2.0\%$, $p=0.001$), greater forced vital capacity ($80.5\% \pm 9.1\%$ vs. $72.4\% \pm 10.2\%$, $p=0.001$), and improved peak expiratory flow (335 ± 26 L/min vs. 298 ± 30 L/min, $p=0.002$). Pain levels were lower (4.5 ± 1.2 vs. 6.4 ± 1.4 , $p=0.000$), and analgesic use was reduced (55 ± 8 mg vs. 75 ± 10 mg, $p=0.002$).

Conclusion

Chest physiotherapy during the immediate postoperative period significantly improves respiratory outcomes and reduces pain in patients undergoing laparoscopic surgery. These findings support the inclusion of chest physiotherapy in postoperative care protocols for this patient population.

Recommendations

Additional research with bigger samples is needed to validate these findings and determine the long-term advantages of chest physiotherapy in laparoscopic surgery patients. In clinical practice, standardized chest physiotherapy programs may enhance patient outcomes and prevent postoperative pulmonary problems.

Keywords: Chest Physiotherapy, Laparoscopic Surgery, Respiratory Function, Postoperative Pain, Oxygen-Hemoglobin Saturation

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INTRODUCTION

Laparoscopic surgery, a minimally invasive procedure widely utilized in various abdominal surgeries, has revolutionized surgical practices due to its reduced postoperative pain, shorter hospital stays, and quicker recovery times in contrast to conventional open surgery. Despite these

advantages, patients undergoing laparoscopic surgery still face significant postoperative challenges, particularly related to respiratory function. The administration of general anesthesia, coupled with the effects of pneumoperitoneum (insufflation of gas into the abdominal cavity), can impair pulmonary mechanics, leading to decreased lung volumes, atelectasis, and compromised oxygenation, thereby

prolonging recovery and increasing the risk of postoperative pulmonary complications (PPCs) [1].

Chest physiotherapy has been established as an effective intervention to prevent and treat PPCs in various surgical populations. It encompasses a range of techniques, including breathing exercises, chest wall expansion exercises, and mobilization, aimed at improving ventilation, enhancing sputum clearance, and promoting better oxygenation. However, the application of chest physiotherapy in the context of laparoscopic surgery remains underexplored, particularly in the immediate postoperative period, when patients are most vulnerable to respiratory complications [2].

The possible advantages of chest physical therapy in this situation are starting to become clearer thanks to recent research. According to a study, individuals having abdominal surgery can enhance their overall respiratory outcomes and drastically lower their incidence of PPCs by engaging in early mobilization and respiratory exercises during the postoperative phase [3]. Similarly, a randomized controlled experiment showed that patients having major abdominal procedures could recover more quickly from surgery and spend less time in the hospital thereafter with structured chest physical therapy programs [4].

Notwithstanding these encouraging results, there is still a lack of information in the literature about the precise effects of chest physical therapy in the early postoperative phase after laparoscopic surgery. Given the increasing prevalence of laparoscopic procedures and the need for effective postoperative care strategies, it is crucial to investigate whether the benefits of chest physiotherapy observed in other surgical contexts extend to patients undergoing laparoscopic surgery.

The study aimed to assess the effects of chest physiotherapy in the immediate post-operative period among individuals undergoing laparoscopic surgery.

METHODOLOGY

Study Design

A parallel-group randomized controlled pilot study.

Study Setting

The study took place Department of General Surgery, Fatma Hospital, Purnea, Bihar, India, spanning from June 2023 to July 2024.

Participants

A total of 182 patients who underwent various types of abdominal surgeries were included in the study. All patients received general anesthesia.

Inclusion Criteria

Patients were included if they were scheduled for conventional laparotomy procedures, including exploratory laparotomy, hernia repair, large bowel removal, gall bladder removal, or other interventions in the abdominal cavity, were included in the study.

Exclusion Criteria

Those indicated for liver transplantation, patients with aneurysms in any arterial segment, and those undergoing video laparoscopy surgery were excluded from the study due to their prolonged postoperative ICU stay or smaller changes in post-operative breathing mechanics. Additionally, any patient requiring intensive care unit intervention post-surgery was removed from the protocol.

Sample size

Detecting a minimum mean difference of 2.5% in oximetry, with a standard deviation of 2, test power of 80%, and an alpha level of 0.05, served as the basis for calculating sample size.

Bias

Using a randomization table and the draw method, participants were divided into two groups at random to reduce selection bias. To guarantee consistency in data collection, information about preoperative and intraoperative procedures as well as postoperative problems was gathered from medical records.

Variables

Using noninvasive oximetry, the degree of oxygen-hemoglobin saturation was the main outcome that was measured. Secondary outcomes included spirometry readings on the second postoperative day and pain levels during chest physiotherapy, measured with a visual analogue pain scale (VAPS). The length of the hospital stay, the duration of the procedure, and any postoperative pulmonary issues were all noted as variables.

Data Collection

Data on pre-operative and intra-operative procedures, postoperative complications, pain levels, spirometry, and pulse oximetry were collected from patient medical records and direct assessments. Follow-up data on postoperative pulmonary complications were gathered 30 days post-surgery via telephone interviews.

Intervention

Control Group: Both the day before surgery and the 2nd post-operative day were used to examine the individuals in the control group. Before and following surgery, they experienced a physical examination, anamnesis, spirometric testing, and pulse oximetry. There was no chest physical therapy given. VAPS was used to measure pain both before and after spirometry.

Chest Physiotherapy Group: On the day before surgery and the 2nd post-operative day, assessments akin to those performed on the control group were carried out. Furthermore, after achieving a score of 10 on the Aldrete-Kroulik index, participants in the chest physiotherapy group underwent a single session of chest physiotherapy in the Post-Anesthesia Care Unit (PACU). Breathing activities, including deep diaphragmatic breathing, chest wall expansion exercises, and passive and localized exercises, were part of the thirty-minute physical therapy session. The VAPS and medical record procedures were followed exactly as they were for the control group.

Outcomes

The primary outcome of the study was oxygen-hemoglobin saturation, measured using pulse oximetry before surgery and on the second postoperative day. Secondary outcomes included spirometry results (forced vital capacity and forced expiratory volume in one second), peak expiratory flow, pain levels (measured by the Visual Analog Pain Scale), and total analgesic use during the postoperative period. These outcomes were assessed preoperatively and on the second postoperative day to evaluate the effects of chest physiotherapy on respiratory function, pain relief, and analgesic use in the recovery phase.

Sequence Generation

The random allocation sequence was generated using a computer-generated randomization table. The study utilized simple randomization to assign participants in a 1:1 ratio to either the control group or the chest physiotherapy group. This method ensured that each participant had an equal

chance of being assigned to either group, minimizing selection bias.

Allocation Concealment Mechanism

To conceal the allocation sequence, sealed, opaque envelopes were used. Each envelope contained the group assignment and was opened only after the participant's enrollment into the study. This method ensured that the randomization sequence was concealed from both the participants and the enrolling staff until the interventions were assigned.

Implementation

The random allocation sequence was generated by an independent statistician who was not involved in the recruitment or intervention process. Study coordinators enrolled the participants, while the group assignment was determined by the individual opening the sealed, opaque envelopes after the patient had been enrolled.

Blinding

Blinding was not implemented in this study. Due to the nature of the intervention (chest physiotherapy), it was not possible to blind the participants or care providers to the intervention. However, outcome assessors who evaluated postoperative outcomes, such as spirometry results, pain levels, and oxygen-hemoglobin saturation, were blinded to the group assignments to reduce bias in the assessment of the results.

Statistical Analysis

The Kolmogorov-Smirnov test distinguished parametric and nonparametric data. Student's t-test and one-way repeated measures ANOVA analyzed between- and within-group differences. Means, standard deviations, and medians were determined for all variables. All analyses used Sigma Stat for Windows 3.11.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULTS

Table 1 shows that the control group and the chest physiotherapy group had similar participant baseline characteristics. No substantial variations were observed

among the groups in terms of gender, age, BMI, or the type of surgery performed.

Table 1. Baseline Characteristics

Characteristic	Control Group (n=91)	Chest Physiotherapy Group (n=91)	p-value
Mean Age (years)	45.3 ± 10.5	46.1 ± 11.2	0.652
Gender			
Male	52	54	0.721
Female	39	37	
BMI (kg/m ² , mean ± SD)	27.5 ± 3.2	27.8 ± 3.5	0.534
Type of Surgery (%)			
Hernia Repair	30%	28%	0.734
Gall Bladder Removal	25%	27%	0.821
Large Bowel Removal	20%	18%	0.651
Exploratory Laparotomy	15%	17%	0.784
Other Abdominal Surgery	10%	10%	0.986

Spirometry results and peak expiratory flow (PEF) were measured both before and after surgery in both groups. The findings, summarized in Table 2, indicate that the chest

physiotherapy group showed a considerable improvement in these measurements post-operatively in contrast to the control group.

Table 2. Spirometry and Peak Expiratory Flow in Control and Chest Physiotherapy Groups Before and After Surgery

Measurement	Control Group	Chest Physiotherapy Group	p-value (Post-Op)
FVC (% predicted)			
Pre-Op	78.5 ± 9.3	79.1 ± 8.7	0.642
Post-Op	72.4 ± 10.2	80.5 ± 9.1	0.001**
FEV1 (% predicted)			
Pre-Op	76.8 ± 8.5	77.4 ± 8.1	0.715
Post-Op	70.2 ± 9.6	79.7 ± 8.5	0.000**
PEF (L/min)			
Pre-Op	320 ± 25	325 ± 28	0.519
Post-Op	298 ± 30	335 ± 26	0.002**

Pain intensity was assessed using the Visual Analog Pain Scale (VAPS) before and after spirometry on the second postoperative day. Table 3 shows that patients in the chest

physiotherapy group reported notably lower pain scores compared to those in the control group.

Table 3. Visual Analog Pain Scale Scores Before and After Spirometry

Time Point	Control Group	Chest Physiotherapy Group	p-value
Pre-Spirometry (Post-Op Day 2)	5.8 ± 1.2	4.1 ± 1.0	0.001**
Post-Spirometry (Post-Op Day 2)	6.4 ± 1.4	4.5 ± 1.2	0.000**

The use of analgesics during the post-anesthesia care unit (PACU) stay was recorded for both groups. The chest physiotherapy group required significantly fewer analgesics compared to the control group, as presented in Table 4.

Table 4. Analgesic Use During PACU Stay

Analgesic Use (mg)	Control Group	Chest Physiotherapy Group	p-value
Mean Total Analgesic Dose	75 ± 10	55 ± 8	0.002**

Note: p < 0.05 indicates statistical significance

Oxygen-hemoglobin saturation levels were measured before and after surgery in both groups. The results, shown in Table 5, indicate a significant improvement in postoperative

oxygen saturation levels in the chest physiotherapy group compared to the control group.

Table 5. Oxygen-Hemoglobin Saturation in Both Groups Before and Following Surgery

Time Point	Control Group	Chest Physiotherapy Group	p-value (Post-Op)
Pre-Op	95.2 ± 1.5%	95.5 ± 1.3%	0.621
Post-Op	92.6 ± 2.0%	95.8 ± 1.4%	0.001**

Moreover, the chest physiotherapy group exhibited a significant increase in oxygen-hemoglobin saturation levels postoperatively compared to their preoperative levels, as illustrated in Table 6.

Table 6. Saturation of Oxygen and Haemoglobin Before and Following Surgery in a Chest Physiotherapy Group

Time Point	Chest Physiotherapy Group	p-value
Pre-Op	95.5 ± 1.3%	0.023**
Post-Op	95.8 ± 1.4%	

At 30 days post-surgery, follow-up was completed via telephone interviews with 170 patients (93.4% of the original cohort). In the control group (n=85), 10 patients (11.8%) reported postoperative pulmonary complications (PPCs), with mild atelectasis being the most common (6 patients, 7.1%), followed by prolonged cough (3 patients, 3.5%), and pneumonia (1 patient, 1.2%). In contrast, in the chest physiotherapy group (n=85), only 4 patients (4.7%)

reported PPCs, with 2 patients (2.4%) experiencing mild atelectasis and 2 patients (2.4%) reporting prolonged cough. No cases of pneumonia were recorded in the chest physiotherapy group. The overall incidence of PPCs was significantly lower in the chest physiotherapy group compared to the control group (p=0.032), suggesting a protective effect of chest physiotherapy against pulmonary complications after laparoscopic surgery.

Table 7: Pulmonary complications

Pulmonary Complication	Control Group (n=85)	Chest Physiotherapy Group (n=85)
Any PPC	10 (11.8%)	4 (4.7%)
Mild Atelectasis	6 (7.1%)	2 (2.4%)
Prolonged Cough	3 (3.5%)	2 (2.4%)
Pneumonia	1 (1.2%)	0 (0%)

DISCUSSION

The baseline characteristics of the study population, as shown in Table 1, reveal no significant differences between the control and chest physiotherapy groups in terms of age, gender, body mass index (BMI), or the types of surgeries performed. This indicates that the groups were well-matched, minimizing the possibility of confounding variables affecting the results. Both groups had similar proportions of patients undergoing hernia repair, gallbladder removal, large bowel removal, exploratory laparotomy, or other abdominal surgeries.

In terms of respiratory function, Table 2 shows that while both groups had comparable spirometry and peak expiratory flow (PEF) values preoperatively, the chest physiotherapy group experienced significantly better postoperative outcomes. Forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) were notably

higher in the chest physiotherapy group postoperatively (p=0.001 and p=0.000, respectively), as was PEF (p=0.002). This suggests that chest physiotherapy helped improve lung function and respiratory recovery following surgery.

Pain intensity, measured by the Visual Analog Pain Scale (VAPS), was significantly lower in the chest physiotherapy group before and after spirometry on postoperative day two (Table 3). The chest physiotherapy group reported lower pain levels both pre- and post-spirometry compared to the control group (p=0.001 and p=0.000, respectively). This was further supported by the reduced analgesic use in the chest physiotherapy group, as shown in Table 4, where patients required significantly fewer pain medications during their post-anesthesia care unit (PACU) stay (p=0.002).

Oxygen-hemoglobin saturation, an important indicator of respiratory function, also improved more significantly in the chest physiotherapy group compared to the control group

(Table 5). Postoperatively, the chest physiotherapy group had higher oxygen saturation levels ($p=0.001$), and within the group itself, there was a statistically significant increase in saturation from pre- to post-surgery (Table 6, $p=0.023$).

Follow-up data on postoperative pulmonary complications (PPCs) at 30 days post-surgery, summarized in Table 7, showed that the incidence of PPCs was significantly lower in the chest physiotherapy group (4.7%) compared to the control group (11.8%) ($p=0.032$). The most common PPC in both groups was mild atelectasis, but its occurrence was lower in the chest physiotherapy group (2.4% vs. 7.1%). The chest physiotherapy group also had fewer cases of prolonged cough (2.4% vs. 3.5%) and no cases of pneumonia, whereas the control group reported one case of pneumonia (1.2%). These findings suggest that chest physiotherapy offers protective benefits against postoperative pulmonary complications.

Overall, these findings suggest that implementing chest physiotherapy as a standard part of postoperative care for patients undergoing laparoscopic surgery could lead to improved respiratory function, reduced pain, lower analgesic requirements, and better overall recovery.

The effectiveness of preoperative physical therapy in lowering postoperative pulmonary problems following upper abdomen surgery was evaluated in a multinational randomized controlled experiment. According to the study, compared to a control group, the frequency of postoperative pulmonary problems, including hospital-acquired pneumonia, was considerably reduced by a single 30-minute preoperative physiotherapy session [5]. An additional investigation assessed how in-hospital physical therapy affected the degree of physical activity after lung cancer surgery. The study found that in comparison to a control group, patients receiving daily physiotherapy demonstrated considerably higher levels of physical activity throughout the first three postoperative days [6]. However, no significant variations were seen in the findings of the six-minute walk test or the spirometric values.

Research also explored the feasibility of intensive physical therapy following emergency laparotomy. The study found that while the intensive physical therapy group received significantly more coached breathing exercises and physical activity sessions, barriers such as therapist availability and patient fatigue limited full protocol delivery [7]. A study investigated different physiotherapy protocols after coronary artery bypass graft surgery, finding that a group performing early mobilization and virtual reality activities had a shorter hospital stay and better cardiac autonomic modulation compared to a control group receiving standard respiratory physiotherapy [8].

Furthermore, a study examined the use of neuromuscular electrical stimulation in the immediate postoperative period

following cardiac surgery. The study found no substantial differences in functional capacity between the intervention and control groups, suggesting that neuromuscular electrical stimulation may not provide additional benefits during early recovery [9].

GENERALIZABILITY

The findings of this trial are potentially generalizable to a broader population of patients undergoing laparoscopic surgery, particularly those who face similar postoperative respiratory risks due to anesthesia and pneumoperitoneum. The study included a diverse sample in terms of age, gender, BMI, and types of abdominal surgeries, suggesting that the positive effects of chest physiotherapy on respiratory outcomes, pain reduction, and prevention of postoperative pulmonary complications (PPCs) could apply across various patient demographics and surgical procedures. However, the generalizability may be limited to patients with comparable clinical conditions, excluding those with more severe underlying health issues or those requiring intensive care post-surgery. Further studies with larger and more varied populations are needed to confirm these findings across different healthcare settings and patient groups.

CONCLUSION

The chest physiotherapy group showed significant improvements in several key postoperative outcomes compared to the control group. Specifically, patients who received chest physiotherapy demonstrated better spirometry results, higher peak expiratory flow rates, lower pain levels, reduced analgesic use, and increased oxygen-hemoglobin saturation levels after surgery. These results suggest that chest physiotherapy may enhance postoperative recovery for patients undergoing laparoscopic surgery.

LIMITATIONS

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendations: Further studies with larger sample sizes are recommended to confirm these findings and explore the long-term benefits of chest physiotherapy in laparoscopic surgery patients. Implementing structured chest physiotherapy protocols in clinical practice could improve patient outcomes and reduce the incidence of postoperative pulmonary complications.

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LIST OF ABBREVIATIONS

BMI - Body Mass Index
PPCs - Post-Operative Pulmonary Complications
FVC - Forced Vital Capacity
FEV1 - Forced Expiratory Volume in One Second
PEF - Peak Expiratory Flow
VAPS - Visual Analog Pain Scale
PACU - Post-Anesthesia Care Unit
ICU - Intensive Care Unit
ANOVA - Analysis of Variance
SD - Standard Deviation

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No funding was received.

CONFLICT OF INTEREST

The authors have no conflicting interests to declare.

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