Section: General Medicine

Original Research Article

EFFECT OF INTRAOPERATIVE PEEP ON POST-OPERATIVE PULMONARY COMPLICATION ON SMOKING PATIENTS UNDERGOING LAPAROSCOPIC ABDOMINAL SURGERY

K. Sureshkumar[1], K. Sivasankar[2], N. Jayakumar[3], P. Sudha[4]

[1]Assistant Professor, Department of Anaesthesiology, Government Rajaji Hospital and Madurai Medical College, Tamilnadu, India.
[2]Assistant Professor, Department of Emergency Medicine, Government Rajaji Hospital and Madurai Medical College, Tamilnadu, India.
[3]Assistant Professor, Department of TB and Respiratory Medicine, Government Medical College and ESI Hospital, Coimbatore, Tamilnadu, India.
[4]Assistant Professor, Department of General Medicine, Government Rajaji Hospital & Madurai Medical College, Tamilnadu, India.

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Corresponding Author:
Dr. P.Sudha
Email: drsusisudha@gmail.com

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Abstract

Background: Post-operative pulmonary complications (PPCs) are a common complication of laparoscopic abdominal surgery, with rates ranging from 12-58%. **Aim:** This study is to compare the recruitment efficacy of tidal volumes combined with standard PEEP (6– 8 cm H2O) with those of low PEEP (≤2 cmH2O) in smoking patients undergoing laparoscopic surgery during general anaesthesia. **Materials and Methods:** A Double-blinded randomised controlled study was conducted at Govt Rajaji hospital, Madurai medical college. All 60 patients fulfilled the inclusion criteria, and informed consent was obtained. Randomization was done in two groups, group L-Low PEEP group and group H-High PEEP group. **Result:** Out of 60 patients, 26 patients were in the age group between 18 to 40 years, and 34 patients were more than 40 years age group. Among 60 smokers, 45% were moderate smokers, 38% were Heavy smokers, and the remaining 17% were in the mild group. Intraoperative vitals after co2 gas insufflation in both groups were comparatively the same. The incidence of post-operative pulmonary complications in the High PEEP group is significantly lesser when compared with the Low PEEP group. However, the incidence of mCPIS in group L is significantly higher when compared with group H. **Conclusion:** Our study concludes that for smoking patients undergoing laparoscopic abdominal surgeries under General anaesthesia, an intraoperative strategy with a higher level of PEEP can decrease post-operative pulmonary complications compared with a lower level of PEEP.

INTRODUCTION

Cigarette smoking is a type of aerosol produced by incompletely burning tobacco leaves. It can be classified into mainstream smoke and side stream smoke. Post-operative pulmonary complications (PPCs) are a common complication of laparoscopic abdominal surgery, with rates ranging from 12-58%.[1] Recent research suggests that using a lung-protective ventilation strategy can reduce the risk of PPCs. Still, the specific role of positive end-expiratory pressure (PEEP) in preventing PPCs during laparoscopic surgery is not yet clear.[2] Surgeries on organs in the abdominal area, such as the gallbladder, colon, small intestine, stomach, liver, and pancreas, are increasingly being performed laparoscopically instead of through a large incision. However, upper abdominal procedures performed this way have a high risk of post-operative pulmonary complications (PPCs). These are any pulmonary abnormalities that occur after surgery and harm the patient's recovery. The reported risk of PPCs for upper abdominal surgery ranges from 17% to 88%.[3] Pulmonary complications after abdominal surgery include atelectasis, pneumonia, respiratory failure, and tracheobronchial infection. The most common of these complications is atelectasis, but pneumonia is considered the main cause of mortality. This can be caused by shallow, monotonous breathing, which can decrease ventilation to certain parts of the lungs and lead to atelectasis. Other contributing factors include incisional pain, lingering effects of anaesthesia, and prolonged bed rest. Although

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atelectasis usually improves on its own, if the collapsed parts of the lungs do not re-inflate, an infection can develop as a secondary complication. Other serious post-operative complications, such as intraperitoneal infection, wound infection, and cardiac and haemodynamic complications, can also worsen patient outcomes.[4] Identifying patients at risk of post-operative pulmonary complications is crucial as they are the most frequent cause of morbidity and mortality in the post-operative period. The presence of risk factors such as age, smoking status, obesity, pre-existing chronic lung disease, co-morbidities, type and duration of anaesthesia, type and duration of surgery and the extent of the surgical incision are important to be considered as these factors are known to be associated with pulmonary complications.[3] During laparoscopic surgery, changes in the lungs can occur due to the upward movement of the diaphragm caused by the inflow of gas used to inflate the abdomen, which decreases the compliance of the lungs. Additionally, carbon dioxide homeostasis changes can occur due to the absorption of CO2 from the peritoneum.[5] General anaesthesia and surgery-related pain can also affect the patient's breathing pattern and lead to shallow breathing, making it difficult to clear mucus from the chest. Research has shown that changes in pulmonary function can occur after both traditional and laparoscopic abdominal surgeries.[6] After laparoscopic surgery, the rate of post-operative pulmonary dysfunction is around 20-25% depending on the type of surgery. This dysfunction can lead to pulmonary complications such as atelectasis, pneumonia, tracheobronchial infection, and respiratory failure, which can lengthen the patient's hospital stay.[7] Also, studies have shown a reduction in pulmonary function measured by Forced Vital Capacity (FVC) and Forced Expiratory Vital Capacity (FEV1) after surgery. The cause of post-operative pulmonary dysfunction is thought to be impairment in the function of the diaphragm.

Aim

This study is to compare the recruitment efficacy of tidal volumes combined with standard PEEP (6– 8 cm H2O) with those of low PEEP (≤2 cmH2O) in smoking patients undergoing laparoscopic surgery during general anaesthesia.

MATERIALS AND METHODS

A Double-blinded randomised controlled study was conducted at Govt Rajaji hospital, Madurai medical college from 2020 to 2021. All 60 patients fulfilled the inclusion criteria, and informed consent was obtained. Randomization was done in two groups, group L-Low PEEP group and group H-High PEEP group. Inclusion criteria: Older than 18 years, smoking patients, ASA 2 OR 3, body mass index (BMI) between 18 kg/m2 and 35 kg/m2, general anaesthesia expected to last more than 1 hour, and an intermediate or high preoperative index for PPC risk by the Assess Respiratory Risk in Surgical Patients in Catalonia Study (ARISCAT Score ≥26). Patients who are not eligible for this study include those who have recently undergone emergency surgery, have a history of previous lung surgery, have been on mechanical ventilation within the past 2 weeks, are currently experiencing acute respiratory failure (such as pneumonia or acute lung injury/ARDS), have persistent instability in their cardiovascular system or severe cardiac disease (as classified by the New York Heart Association), are experiencing sepsis or septic shock, requiring renal replacement therapy, have a progressive neuro-muscular illness, are pregnant, or have already participated in another study or have refused to participate. Both groups received the same fraction of inspired oxygen concentration of 0.50 and a tidal volume of 7ml/kg ideal body weight. In addition, standard fluid and pain management protocols were applied to both groups during the perioperative period. Parameters observed are post-operative pulmonary complications (PPC), modified clinical pulmonary infection score (mCPIS), and extrapulmonary complications. The observations in both groups will be compared using an unpaired t-test. The values will be represented as mean ± SD. In addition, discrete (categorical) groups will be compared by Chi-square ($\chi 2$) test.

RESULTS

Table 1: Demographic data of the study

		No of patients
Age group	18-40 years	26 (43%)
	>40 years	34 (57%)
BMI	18-25	38 (63%)
	25-35	22 (37%)
Smoking index	1	10 (17%)
	2	27 (45%)
	3	23 (38%)

Out of 60 patients, 26 patients were in the age group between 18 to 40 years, and 34 patients were more than 40 years age group. Thirty-eight patients were in the BMI range of 18-25 and 22 in the 25-35 range. Among 60 smokers, 45% were moderate smokers, 38% were Heavy smokers, and the remaining 17% were in the mild group. Intraoperative vitals after co2 gas insufflation in both groups were comparatively the same [Table 1].

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Table 2: Comparison of grades and scores between groups

		Group L	Group H	P-value
Post-operative pulmonary complication (PPC) (Grades)	1	12	7	0.038
	2	6	3	
	3	0	0	
	4	0	0	
Modified clinical pulmonary infection (Scores)	0	17	23	0.032
	1	13	7	
	2	0	0	

The incidence of post-operative pulmonary complications in the High PEEP group is significantly lesser when compared with the Low PEEP group. Even though there was no significant difference in the number of patients when categorized grade-wise, the overall incidence of PPC in the high PEEP group was significantly lesser than in the low PEEP group. On the other hand, the incidence of mCPIS in group L is significantly higher when compared with group H. Among the 60 smokers, 33% of patients had an infection in the post-operative period (Table 2). Among 60 smoking patients who underwent laparoscopic abdominal surgery, extrapulmonary complications were encountered in none among them.

DISCUSSION

In our study, out of 60 patients, 10 patients were mild smokers, 27 with moderate smoking and 23 with severe smoking index. Among these 23 patients with severe smoking index, 10 patients were given high PEEP, 15 patients were in a moderate group, 5 from the mild smoking index were given high PEEP randomly, and 30 patients were put in the low PEEP group. On post-operative follow-up, the incidence of PPC in low PEEP was 18, 12 in Grade 1 and 6 in Grade 2. In high PEEP, it was 10 patients, including 7 from Grade 1 and 3 from Grade 2. mCPIS incidence in the low PEEP group was 13, and high PEEP was in 7 patients in both groups under Grade 1. None was above Grade 2 in PPC and Grade 1 in mCPIS. This study had a surgical duration of a shorter period, not exceeding 3 hours which may be one of the reasons why none of the patients had high-graded complications in the post-operative period. None of the Extrapulmonary complications had other organ involvement in this study, so the relation of PEEP with Extrapulmonary complications remains insignificant. Previous research has shown that both undergoing abdominal surgery and having longer anaesthesia duration can increase the risk of post-operative pulmonary complications (PPCs). Among the factors contributing to PPCs, mechanical ventilation is a significant contributor. Additionally, pre-existing lung conditions, PnP can also increase the risk of PPCs. According to a study by Park et al.[8] patients with PPC (post-operative pulmonary complications) have a higher 90-day mortality risk (5.8%) compared to those without PPC (1.3%). However, this risk can be reduced by effectively managing low tidal volume ventilation, restricted fluid infusion, and sugammadex-induced reversal during abdominal surgery. These factors have been linked to decreased post-operative mortality. In a study by Bluth et al.[9] 21.3% of patients in the high-level PEEP group, compared to 23.6% in the low-level PEEP group, experienced an outcome. Out of the 9 secondary outcomes specified in the study, 6 were not significantly different between the two PEEP groups, while 3 were significant. One of these significant differences was that fewer patients with hypoxemia in the high-level PEEP group (5.0%) compared to the low-level PEEP group (13.6%). During laparoscopic surgery, the pressure inside the abdomen (intra-abdominal pressure) is often higher than the pressure in the airways, which can lead to a displacement of the diaphragm and collapse of adjacent lung tissue, resulting in decreased compliance and oxygenation of the lung. This condition, known as Pneumoperitoneum (PnP), can lead to atelectasis. PEEP is believed to prevent atelectasis by keeping airways open and maintaining adequate gas exchange at the end of expiration during PnP. The level of PEEP should be adjusted according to the patient's surgical characteristics and positioning. Choi et al.[10] reported that the incidence of intraoperative desaturation or post-operative atelectasis was significantly higher in the control group (43.3%) compared to the recruitment manoeuvre group (17.8%), with a p=0.034. In a study by Pi et al.[11] the group that received low volume with high PEEP and recruitment had significantly higher FEV1 (1.52±0.37) on the first post-operative day compared to the other two groups: 0.95±0.38 (P<0.001) and 0.95±0.34 (P<0.001) respectively. Spadaro et al.[12] studies found that patients with expiratory flow limitation had a higher likelihood of developing post-operative pneumonia, acute respiratory failure, and a longer hospital stay. In addition, it was identified that expiratory flow limitation increased the risk of post-operative pulmonary complications by more than 50% (risk ratio, 2.7; 95% confidence interval, 1.7-4.2). Previous studies have suggested that using very low levels of PEEP during surgery could lead to atelectasis by promoting the repeated opening and closing of small airways. However, using higher levels of PEEP could also increase the mean airway pressure of the respiratory system and potentially affect the patient's haemodynamics. However, this study did not find any significant differences in

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haemodynamics when comparing the groups. Therefore, the importance of this trial is that it will provide insight into the effects of using different levels of PEEP on post-operative pulmonary complications in smoking patients undergoing laparoscopic surgery. In this study, we observed that the incidence of post-operative pulmonary complication does not entirely depend on the intraoperative PEEP settings, suggesting that it also depends on the patient's preoperative respiratory status. This study concludes that even with high PEEP, smokers with a heavy smoking index may develop post-operative pulmonary complications, and mild smokers, even with low PEEP, may or may not develop any post-operative pulmonary complications depending on their preoperative respiratory status.

CONCLUSION

Our study concludes that for smoking patients undergoing laparoscopic abdominal surgeries under General anaesthesia, an intraoperative strategy with a higher level of PEEP can decrease post-operative pulmonary complications compared with a lower level of PEEP. Still, it depends mainly on the patient's smoking index and preoperative respiratory status.

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