Original Article: Effects of laparoscopic abdominal surgery on pulmonary function and arterial blood gas parameters of smoking patients

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ABSTRACT

Introduction: Smoking increases the risk of postoperative pulmonary complications in patients receiving general anesthesia. During laparoscopic surgeries, the effects of pneumoperitoneum and carbon dioxide (CO2) insufflation may amplify these. Our goal was to compare the metabolic and blood gas analysis of patients who underwent laparoscopic surgeries while under general anesthesia compared to those who did not smoke. **Material and Methods:** After receiving approval from the institutional review board, the 60 patients undergoing laparoscopic cholecystectomy were split into two groups of 30 each: smokers and non-smokers. A arterial blood gas sampling was performed along with baseline hemodynamic parameters to evaluate and compare PCO2, pH, and bicarbonate (HCO3) values at different time intervals with respect to pneumo-peritoneum creation, between smokers and non-smokers. **Results:** Systolic blood pressure was higher at baseline in the smoker group, and oxygen saturation was noticeably lower. Smokers had significantly higher PCO2 and end-tidal CO2 at all times **Conclusion:** Between smokers and non-smokers, there is a clear distinction in baseline arterial blood gas characteristics. Smokers appear to be more susceptible to the metabolic effects of CO2 insufflation and elevated intraabdominal pressure.

Introduction

Due to the recent development of minimally invasive abdominal surgery, some complications are rarely discussed in the current surgical literature. Laparoscopic surgery complications for the abdomen can be fatal, especially if they are not promptly identified and addressed. The majority of complications that arise during laparoscopic surgery have the side effects of delayed diagnosis, reoperation, longer operation times, and longer hospital stays.

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Unintentional enterotomy (IE) is one of the abdominal surgery complications that go unreported. According to Krabben et al.1, patients who underwent repeat laparotomies had an IE incidence of 19%. In a group of patients who underwent repeat surgery, the prevalence of and risk factors for IE during enterolysis were reported. In patients who have had three or more previous laparotomies, Krabben et al found that the risk of unintentional enterotomy during open surgery is more than ten times higher.

At the time of the second laparotomy, Van Goor reviewed the effects of previous laparotomies on intestinal perforation. He discovered a 20% chance of bowel perforation brought on by adhesions. All issues brought on by laparoscopic trocar insertions were examined by Bhoyrul et al3 in their study. According to the type of trocar and operation, he described and analyzed the main categories of trocar injuries. The undiagnosed bowel injury had a mortality rate of 21%.

In a particular subset of surgeries, laparoscopic procedures have nearly completely replaced open procedures. One of them entails cholecystectomy done laparoscopically. It has many benefits, including fewer complications, shorter hospital stays, smaller incisions, and less blood loss. Although this kind of surgery is minimally invasive, the development of pneumo-peritoneum and the postural adjustments associated with it lead to a number of physiological alterations that may have an impact on the management of anesthesia and call for particular caution.

Respiratory acidosis and hypercapnia can result from the absorption of carbon dioxide (CO_2) used in insufflation. This increases sympathetic nervous system activity and catacholamine sensitivity in the myocardium. A severe reduction in cardiac output might result from this, along with a decline in preload and venous return brought on by elevated intraabdominal pressure.

An acknowledged health risk across the globe is tobacco use. Its use is thought to result in the annual death of close to six million people worldwide. Around 100 million premature deaths worldwide are attributed to tobacco use in the 20th century, according to estimates from the World Health Organization. In the twenty-first century, it is anticipated that this number will reach one billion. Male smokers have a 70 percent higher overall death rate than male non-smokers.

Chronic smoking (more than 20 packs per year for at least 10 years) leads to a variety of pathological changes in the respiratory system, such as inflammation in the lung parenchyma, an imbalance between protease and anti-protease, oxidative stress, ciliary dysfunction, mucosal hypersecretion, airflow restriction, and pulmonary hypertension. Chronic smokers already have compromised lung function, which is made worse by the creation of pneumoperitoneum during laparoscopic procedures. This changes the body's acid-base balance.

By examining blood gas parameters, this study aimed to compare the changes in metabolic and gas exchange status between chronic smokers and non-smokers in patients scheduled for laparoscopic cholecystectomy. The goal was to assess and compare the impact of insufflated carbon dioxide on arterial blood gas (ABG) parameters like PH, PCO_2, and bicarbonate (HCO_3) during the pre-operative, intra-operative, and post-operative periods in smokers and non-smokers. A comparison between smokers and non-smokers' changes in the blood gas parameters mentioned above as a result of pneumoperitoneum was the secondary outcome.

Material and Methods

The trachea was intubated with an appropriate size endotracheal tube after a 3-minute pre-oxygenation with 100% oxygen, which was verified by bilateral equal air entry, an adequate chest rise, and capnography. Vecuronium bromide (0.01 mg/kg), sevoflurane, oxygen, and air were used to maintain anesthesia. After the development of pneumoperitoneum (in both groups), ventilation was initially maintained with a tidal volume (TV) of 6 mL/kg with a respiratory rate of 16/min.

Throughout surgery, patients were positioned in a 15-20° reverse Trendelenburg position. Intraabdominal pressure (IAP) was kept at 12 mmHg throughout laparoscopy. For the purpose of the study, permissive hypercapnia was permitted up until the point of any hemodynamic disturbance or extension of the pneumoperitoneum (more than 40 min). After the operation, the CO2 was fully expelled. Neostigmine and glycopyrrolate were used to reverse the neuromuscular blockade following surgery. After surgery, all patients received 12 hours of observation.

To check the patency of collateral vessels prior to drawing the ABG sample, a modified Allen's test was conducted. Samples were taken from the patient under strict aseptic conditions after the area had been numbed with 1-2 mL of 2 percent lignocaine with adrenaline (while awake). A 2 mL heparinized syringe was used to draw the sample in 3 different locations. The first sample was taken 10 minutes prior to induction, the second sample was taken 10 minutes following the application of the pneumoperitoneum and the head-down position, and the third and final samples were taken 30 minutes following extubation.

Baseline haemodynamic parameters and demographic data were recorded. Before, during, and following the development of the pneumo-peritoneum, as well as following its deflation, the end-tidal carbon dioxide (ETCO2) levels were measured. From the three ABG samples taken, pH, PCO2, and HCO3 values were recorded.

Sample size: In a pilot study we conducted, the response (PCO2) within each subject group was normally distributed with a standard deviation of 7.5 mmHg. With a power of 0 point 9 and a type I error of 0 point 05, the null hypothesis that the population means of the experimental and control groups are equal needed to be rejected in order to detect a difference between the smoker and non-smoker groups of 6 point 53 mmHg (pilot study).

In order to account for 10% attrition, 62 participants in total were needed. Software used for the Statistical Analysis: SPSS for Windows version 16.0 was used to conduct the statistical analysis. We used the Chi-square test to analyze categorical data. The unpaired student 't' test was used to compare two independent study groups. The Kolmogorov-Smirnov test was used to determine whether the data was normal. The critical value of "P," which represents the likelihood of a significant difference, was chosen to be.

Results

Data on demographics: Of the 30 participants in the smoking group, 25 were men (83%) and 5 were women (16%). Females (60%) outnumbered males (40%) in the group of non-smokers. There was no significant difference between the two groups in terms of mean heart rate, diastolic blood pressure, or mean arterial pressure. Mean duration of pneumo-peritoneum was comparable in both groups. However, the correlation between oxygen saturation and systolic blood pressure was not negligible(Fig 1).

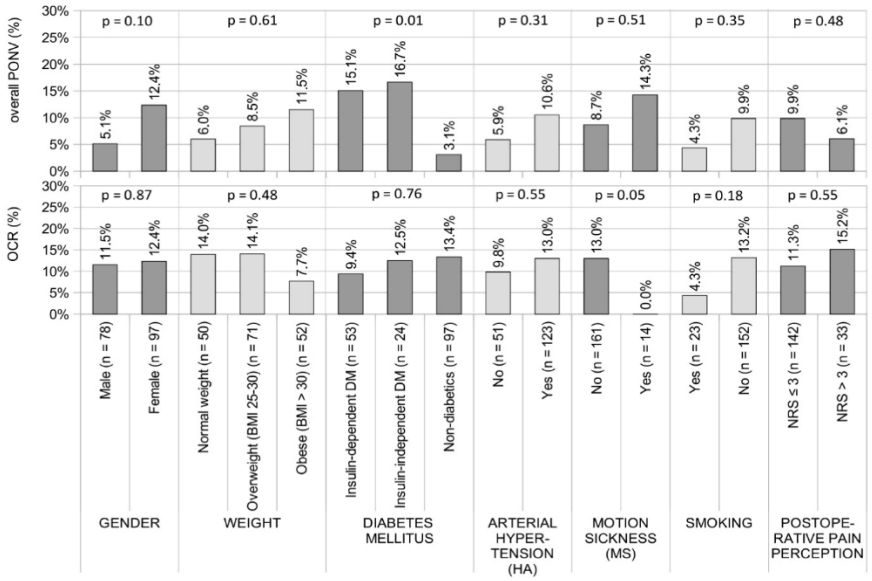

Figure 1. Demographic characters Competition between tow groups

Smokers had significantly higher PCO2 and ETCO2 values throughout the entire sampling and measurement process(Fig 2). The mean baseline pH values did not differ significantly between the groups, but were significantly lower in smokers after pneumoperitoneum and extubation(Fig 3).

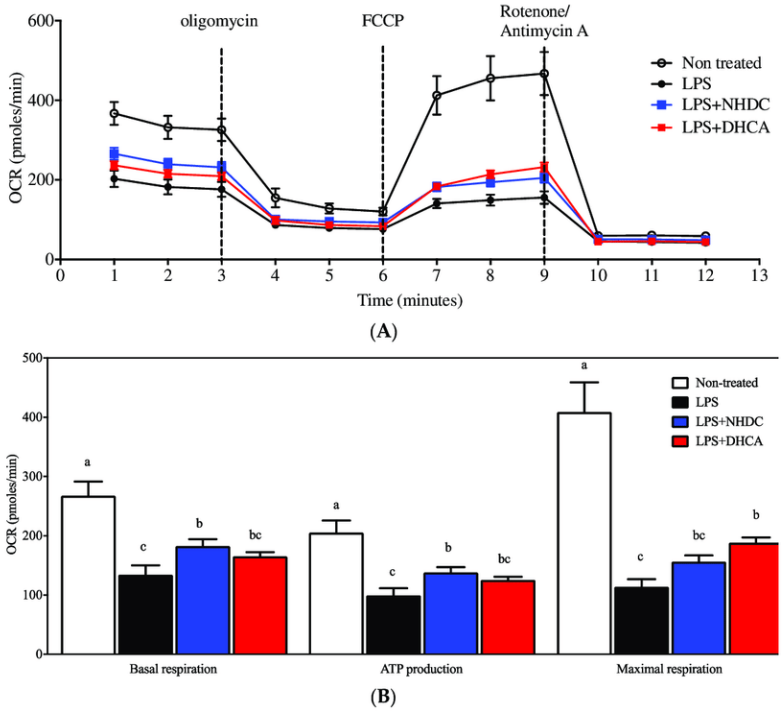

Figure 2. OCR results between tow groups

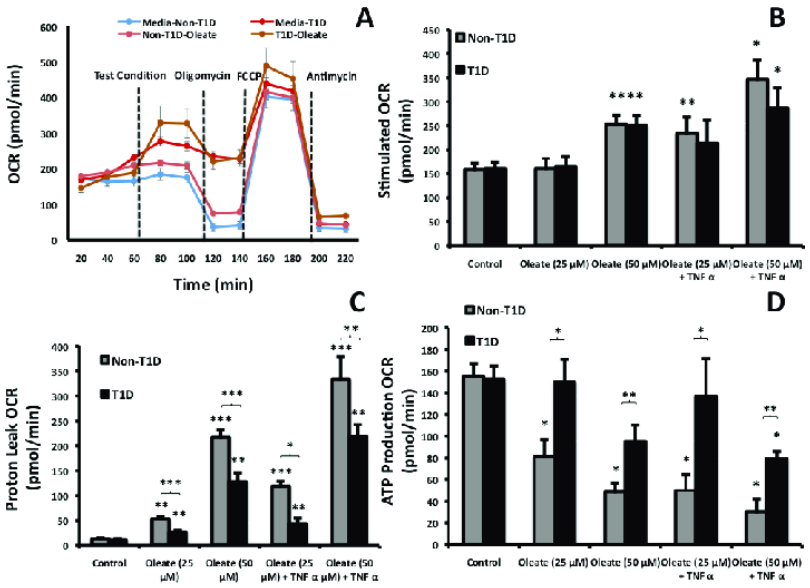

Figure 3. OCR results between tow groups in difference time

At all time intervals, the smoker group's bicarbonate values were noticeably higher. Although not statistically significant, the increase in PCO2 caused by the formation of pneumoperitoneum was higher in the group of smokers. Both smokers and non-smokers experienced the same rise in HCO3 and fall in pH brought on by pneumo-peritoneum(Fig 4).

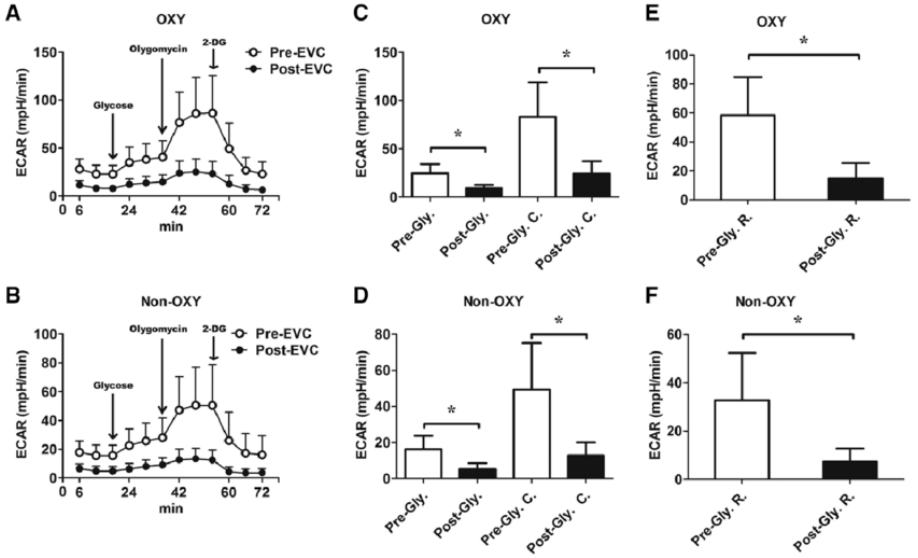

Figure 4. ABG Results between toe groups

Discussion

Pneumoperitoneum's impact on clinical and biochemical parameters has been the subject of numerous studies. As far as we are aware, very few studies have examined the impact of chronic smoking on procedures like these as well as the changes brought on by CO2 and pneumo-peritoneum, focusing more on biochemical changes. Smoking is known to lower lung function and to cause physical abnormalities of the chest wall [17].

A vulnerability to CO_2 retention could result from a reduction in chest expansion brought on by decreased flexibility. The risks of

postoperative pulmonary complications, particularly in smokers, can be further increased by robot-assisted pelvic laparoscopic surgeries that may last longer. With the exception of systolic blood pressure and oxygen saturation, no differences in baseline hemodynamic parameters were found in the current study.

The smoker group had significantly higher systolic blood pressure, possibly as a result of their patients' sympathetic nervous system being stimulated. The smokers' oxygen saturation was lower, which is also consistent with the majority of the literature, including a study by Tait et al on smokers undergoing general anesthesia. It is well known that during laparoscopic procedures, ETCO2 and PCO2 are related. At all time points, including the baseline, the smoker group's ETCO2 and PCO2 values in the current study were significantly higher.

"Kelman et al." In a study on the arterial blood gas tension during laparoscopy, it was discovered that there was a significant increase in ETCO2 from the baseline at intervals of 30 and 40 minutes, and that, respectively, after insufflations and after exsufflations, the ETCO2 became comparable with the baseline. These findings support the current study even though they were not seen in smokers. In the present study, bicarbonate levels were significantly higher and pH values were significantly lower in the smoker group than in the non-smoker group during the pneumoperitoneum period. This is consistent with the increased risk of metabolic acidosis that these surgeries carry, which may be brought on by the effects of CO2 insufflation and hypoventilation. A research project by Zulfikaroglu et al. also, though not specifically in smokers, revealed comparable metabolic changes in patients undergoing laparoscopic surgery.

Smokers experienced a greater change in PCO2 value due to the pneumoperitoneum effect than non-smokers in the current study. Although this difference was not statistically significant, it does suggest that smokers who undergo laparoscopic procedures may experience CO2 retention more frequently. Similar to the pH change, there was no discernible difference between smokers and non-smokers in the bicarbonate and pH changes brought on by the pneumo-peritoneum. The shorter duration of these surgeries and the head-up position, which might not be enough to bring out any significant or substantial metabolic difference between smokers and non-smokers, could be the cause of this.

The results of a study comparing the peri-operative outcomes of gynecological laparoscopic procedures between smokers and non-smokers found no significant differences. Landin et al found a significant correlation between smoking and postoperative pulmonary complications and identified smoking as a modifiable risk factor in laparoscopic inguinal hernia surgeries. The majority of IEs in our study happened during laparoscopic cholecystectomy. According to a study by Bhoyrul et al., laparoscopic cholecystectomy was the procedure most frequently linked to fatal trocar injuries. 182 of the 629 trocar injuries involved bowel damage. During the initial procedure, 28 enterotomies went unnoticed. Bowel injuries were reported to occur 0 point 87 percent of the time in Shamiyeh et al's review of complications associated with laparoscopic cholecystectomy.

In our study, there was a 0.39 percent incidence of IE during laparoscopic cholecystectomy. Except for one, every patient had undergone a laparotomy previously. Each person had, on average, 2.6 prior operations.

Only 4 patients, all of whom had an IE, underwent lysis of adhesions for small bowel obstruction or persistent pelvic pain. In patients with bowel obstruction, there is still debate about the effectiveness and safety of laparoscopic surgery. Laparoscopic adhesiolysis is safe and efficient for treating chronic abdominal pain and recurrent bowel

obstruction, claim Shayani et al though enterotomies were required for every patient in their study who underwent adhesiolysis following hospitalization for an acute bowel obstruction. Swank et al investigated laparoscopic adhesiolysis in 157 patients with chronic pain. One patient died on the second postoperative day, and four of the 11 accidental bowel enterotomies that were performed during the procedure went undetected.

In a study by Wullstein et al., laparoscopic treatment of acute small bowel obstruction was only feasible in half of the patients. He came to the conclusion that while postoperative recovery was improved with laparoscopic treatment of acute adhesive small bowel obstruction compared to conventional laparotomy, the risk of intraoperative complications increased. Additionally, he pointed out that patients who had undergone multiple open abdominal operations previously were more likely to experience intraoperative bowel perforations.

At our facility, four patients with an undiagnosed IE presented with fever, tachycardia, increasing abdominal pain, peritonitis, and other signs of sepsis. During the postoperative period, sepsis signs should be watched out for more carefully. This will help to identify problems sooner and prevent dangerous treatment delays. We no longer provide laparoscopic surgery to patients with acute bowel obstruction in light of the available literature and a review of our complications.

The most frequent fatal complication of laparoscopic ventral hernia repair is unintentional enterotomy, which can cause sepsis and cause death if it is not promptly diagnosed. It should be emphasized that unlike in open surgery, where intestinal injury is more readily visible and can be repaired, an IE may not be recognized in laparoscopic abdominal surgery due to the intestine retracting out of the field of vision.

Conclusion

Between smokers and non-smokers, there is a clear distinction in baseline arterial blood gas characteristics. Smokers appear to be more susceptible to the metabolic effects of CO2 insufflation and elevated intraabdominal pressure.

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