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A PROSPECTIVE COMPARATIVE STUDY OF ARTERIAL BLOOD GAS PARAMETERS IN SMOKER VS NONSMOKER PATIENTS UNDERGOING LAPAROSCOPIC ABDOMINAL SURGERY

Anaesthesiology

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ABSTRACT

Background And Aims: Smoking is a risk factor for postoperative pulmonary complications in patients undergoing general anaesthesia. These may get amplified with effects of pneumo-peritoneum and carbon dioxide (CO_2) insufflation during laparoscopic surgeries. Our aim was to compare metabolic and blood gas analysis of smokers versus non-smoker patients during laparoscopic surgeries under general anaesthesia. **Methods:** After permission from institutional review board, 100 patients undergoing laparoscopic surgeries were divided into two groups, smokers and non-smokers (50 each). Along with baseline haemo-dynamic parameters, arterial blood gas sampling was done to assess and compare PCO_2, pH and bicarbonate (HCO_3) values at various time intervals with respect to pneumo-peritoneum creation, between smokers and non smokers. **Results:** Systolic blood pressure and mean arterial pressure were significantly higher in the smoker group compared to non-smoker group at all intervals. Mean heart rate and diastolic blood pressure were significantly higher in the smoker group compared to non-smoker group after creation of pneumo-peritoneum. Oxygen saturation significantly decreases in the smoker group compared to non-smoker group after the pneumo-peritoneum. The mean value of $ETCO_2$, PCO_2 and HCO_3 were significantly higher in the smokers group compared to the non-smokers at all stages of ABG analysis. pH was significantly lower in the smoker group during and after pneumoperitoneum. **Conclusion:** There is a significant difference in baseline arterial blood gas characteristics between smokers and non-smokers. Metabolic effects of CO_2 insufflation and increased intraabdominal pressure appears to be more enhanced in smokers.

KEYWORDS

Blood gas analysis, laparoscopic surgery, pneumoperitoneum, smoking

INTRODUCTION

Laparoscopic procedures have almost completely replaced open procedures in a certain subset of surgeries. It offers numerous advantages such as smaller incisions, reduced blood loss, postoperative pain and other complications leading to a reduced overall hospital stay.[1] Although this type of surgery is minimally invasive, creation of pneumo-peritoneum and postural changes associated with it causes a number of physiological alterations which may have an effect on the anaesthesia management and warrant specific caution. Absorption of carbon dioxide (CO_2) used in insufflation can cause hypercapnia and respiratory acidosis. This further activates the sympathetic nervous and also sensitises the myocardium to catecholamines. This along with a decrease in preload and venous return due to increased intraabdominal pressure may cause a gross decrease in cardiac output [2-4].

Tobacco smoking is an internationally accepted health hazard. Its use is estimated to kill nearly 8 million people worldwide every year. According to the World Health Organization estimates, globally, around 100million premature deaths occurred due to tobacco in the 20th century. This number is expected to rise to 1 billion during the 21st century. The overall death rate for male smokers is 70% greater than that for male non-smokers [5]. Chronic smoking (more than 20 pack-year at least for 10 years) causes a number of pathological changes in the respiratory system which includes inflammatory changes in the lung parenchyma, the imbalance between protease and anti-protease, oxidative stress, ciliary dysfunction, mucosal hypersecretion, airflow limitation, and pulmonary hypertension [6,7]. As the lung function is already in a compromised state in chronic smokers, creation of pneumoperitoneum for laparoscopic surgeries in such patients further aggravates and causes an alteration in the acid-base status of the body.
The aim of this study is to compare the changes in metabolic and gas exchange status between chronic smokers versus non-smokers in patients posted for laparoscopic abdominal surgery by analysing blood gas parameters.

METHODOLOGY

A prospective experimental study was carried out in our tertiary care centre over a period of 8 months, after getting permission from the institutional Ethics committee, B.J. medical college and civil hospital and clinical trial registry – India (CTRI) with registered number CTRI/2022/10/046491. 100 participants were finally analyzed after the final exclusion of eligible patients at different stages of the study. Patients who were posted for laparoscopic abdominal surgery were selected for the study. Informed consent was obtained from all the patients and they were allocated into following two groups; Group I: patients with a history of smoking more than 20 pack-year for more than 10 years and Group II: patients with no history of smoking. Inclusion Criteria was participants aged 20 to 60 years of both sexes planned for laparoscopic abdominal surgery. Exclusion criteria were a patient refusal, ASA 3 and 4, other lung and cardiac pathologies, hypertension, uncontrolled diabetes mellitus, systemic infection, emergency operation, history of malignancy, history of alcohol or drug abuse. Participants were recruited at the time of pre-anaesthetic evaluation. Along with that general physical examination, systemic examination and airway examination was also performed. Basic laboratory investigations like haemoglobin, total leukocyte count, differential count and platelet count, liver function test, renal function test, chest x-ray, electrocardiogram (ECG) and coagulation profile were done. Smokers were advised to abstain from smoking for at least two weeks prior to surgery and were advised incentive spirometry and nebulisation with broncho-dilators. History of any bleeding diathesis or consumption of any anticoagulants was also ruled out at that time. They were explained about benefits of smoking cessation, and compliance to advice was assessed at the time of admission (generally 1 to 2 days prior) by history and clinically as for any other routine surgery under general anaesthesia.

On the day of surgery patient after confirming fasting status, signed consent and going through the safety checklist, patients were premedicated with glycopyrrolate 4 microgram/kg, fentanyl 2 microgram/kg and ondansetron 0.15mg/kg iv 20min prior to induction. The patients were taken to the operation theatre. All the standard monitors were attached which includes ECG monitor, pulse oximeter, non-invasive blood pressure and capnography monitor. Baseline haemodynamic parameters were recorded. After monitoring the haemodynamics for 10minutes, the anaesthetic procedure was started, Surgery was carried out under general anaesthesia with

propofol (1–2.5 mg/kg) for induction and succinylcholine (2 mg/kg) to facilitate tracheal intubation. After pre-oxygenation with 100% oxygen for 3 min, the trachea was intubated with appropriate size endotracheal tube, which was confirmed by bilateral equal air entry, adequate chest-rise and capnography. Anaesthesia was maintained with oxygen, air and sevoflurane along with intermittent doses of atracurium besylate (0.1 mg/kg).

Ventilation was initially maintained with a tidal volume (TV) of 8 ml/kg with a respiratory rate of 12/min followed by TV of 6 mL/kg with the rate of 16/min after the creation of pneumoperitoneum (in both groups). During laparoscopy, intraabdominal pressure (IAP) was maintained at 12 mmHg. For the purpose of the study, we allowed permissive hypercapnia till the point of any haemodynamic derangement or prolongation of pneumo-peritoneum (more than 40 min). The CO_2 was completely evacuated at the end of surgery. After completion of surgery neuro-muscular blockade was reversed with neostigmine and glycopyrrolate. All patients were monitored for 12 h postoperatively.

Before drawing the ABG sample modified Allen's test was performed to check the patency of collateral vessels. Under all aseptic precautions, samples were drawn from the patient after infiltrating the area with 1–2 mL 2% lignocaine with adrenaline (when awake). The sample was drawn in 3 different settings with the help of 2 mL heparinized syringe. The first sample was drawn 10 min before induction, the next sample drawn 10 min after pneumo-peritoneum and head down position and third and last sample was drawn 30 min after extubation. Demographic parameters, baseline hemodynamic parameters were noted. End-tidal carbon dioxide (ETCO2) levels were noted before the creation of pneumo-peritoneum, after pneumo-peritoneum and after deflation of pneumo-peritoneum. pH, PCO_2 and HCO_3 were recorded from the three ABG samples drawn.

Statistical Analysis: The statistical analysis was done using SPSS for Windows version 16.0 software. For categorical data, the Chi-square test was used. For comparing two independent study groups unpaired student 't' test was used. The critical value of 'P' indicating the probability of significant difference was taken as <0.05 for comparison.

RESULTS

Table-1: Comparison Of Demographic And Baseline Clinical Parameters Between Smokers And Non-smokers:

Parameter	Smoker	Non-smoker	p-value
Age (years)	45.5 ± 8.57	41.58 ± 11.18	0.052
M:F	45:5	20:30	
Heart rate	78.02 ± 6.71	76.12 ± 5.73	0.13
SBP (mmHg)	132.16 ± 8.18	123.04 ± 8.07	0.0001
DBP (mmHg)	78.02 ± 4.85	76.2 ± 4.97	0.07
MAP (mmHg)	96.07 ± 5.67	92 ± 5.77	0.001
SpO2 (%)	98.06 ± 0.91	98.38 ± 0.69	0.052

Demographic Data:

The mean age of the smoker group was 45.5 ± 8.57 and of non-smoker group was 41.58 ± 11.18 years. In the smoker group male: female ratio was 45:5 while in the non-smoker group females were more with male: female ratio 20:30. Mean duration of pneumo-peritoneum was similar in both groups (70.02 ± 2.66 min in smokers versus 69.72 ± 2.45 min in non-smokers, P value = 0.56). There was no significant difference in mean heart rate, diastolic blood pressure and oxygen saturation between two groups. But the difference between systolic blood pressure (P = 0.0001) and mean arterial pressure were significant (P = 0.001).

Values of PCO_2 and $ETCO_2$ were significantly higher in the smoker group at all stages of sampling and measurement (P < 0.001). There was no significant difference in mean baseline pH values but was significantly lower in smokers after pneumo-peritoneum and after extubation. Bicarbonate values were significantly higher in the smoker group at all time intervals.

Table No 2

Parameter	Smoker	Non-smoker	p value
$ETCO_2$ (mmhg)			
Pre pneumo-peritoneum	40.5 ± 4.52	34.62 ± 2.06	<0.001
During pneumo-peritoneum	45.76 ± 4.77	36.88 ± 2.19	<0.001
After pneumo-peritoneum	42.98 ± 5.06	34.78 ± 2.11	<0.001
PH			
Pre pneumo-peritoneum	7.38 ± 0.04	7.39 ± 0.023	0.13
During pneumo-peritoneum	7.34 ± 0.04	7.37 ± 0.02	0.002
After pneumo-peritoneum	7.35 ± 0.039	7.39 ± 0.022	<0.001
HCO_3(mmol/L)			
Pre pneumo-peritoneum	24.98 ± 2.22	22.88 ± 1.92	<0.001
During pneumo-peritoneum	25.92 ± 2.63	24.08 ± 2.01	0.002
After pneumo-peritoneum	24.64 ± 2.41	22.76 ± 2.02	<0.001
PCO_2 (mmHg)			
Pre pneumo-peritoneum	42.72 ± 5.28	36.18 ± 2.74	<0.001
During pneumo-peritoneum	45.98 ± 5.68	37.12 ± 3.05	<0.001
After pneumo-peritoneum	44.36 ± 5.87	36.02 ± 3.03	<0.001

Table-3: Comparison Of Change In Blood Gas Parameters:

Parameter	Smoker	Non-smoker	p value
Increase in PCO_2 (mmHg)	3.26 ± 1.23	0.94 ± 0.7	<0.001
Increase in HCO_3 (mmol/L)	0.94 ± 0.9	1.2 ± 0.63	0.09
Decrease in PH	0.0308 ± 0.007	0.0268 ± 0.014	0.07

Increase in PCO_2 due to creation of pneumoperitoneum was significantly higher in smoker group (3.26 ± 1.23) compared to non-smoker group (0.94 ± 0.7, p value <0.001). Increase in HCO_3 and decrease in pH was similar in both smoker and non-smoker group.

DISCUSSION

Laparoscopic procedures have almost completely replaced open procedures in a certain subset of surgeries. Absorption of carbon dioxide (CO_2) used in insufflation can cause hypercapnia and respiratory acidosis. Tobacco smoking is an internationally accepted health hazard. Smoking is known to decrease pulmonary function and is associated with physical abnormalities of the chest wall. Reduction in chest expansion arising from reduced flexibility could lead to a vulnerability to CO_2 retention.[8] Robot-assisted pelvic laparoscopic surgeries, which may extend for longer durations can further increase chances of postoperative pulmonary complications, especially in smokers.[9] As the lung function is already in a compromised state in chronic smokers, creation of pneumoperitoneum for laparoscopic surgeries in such patients further aggravates and causes an alteration in the acid-base status of the body.

In the current study, no differences were observed in baseline hemodynamic parameters except systolic blood pressure and mean arterial pressure. Systolic blood pressure was significantly higher in the smoker group possibly due to the effect of stimulation of the sympathetic system in such patients. In a study by **Amiya K barik et al** [10] There was no significant difference between mean heart rate, diastolic blood pressure and mean arterial pressure between two groups. But the difference between systolic blood pressure (P = 0.002) and oxygen saturation were significant (P = 0.001).

In the present study, $ETCO_2$ and PCO_2 values were significantly higher in the smoker group at all time intervals including the baseline. Similar findings were observed in **B. Zulfikaroglu et al. study**[11] in laparoscopic cholecystectomy group.

In our current study, pH values were significantly lower and bicarbonate was significantly higher during the period of pneumo-peritoneum in the smoker group compared to non-smokers. This is in keeping with the higher chances of metabolic acidosis which may occur due to the effects of CO_2 insufflation and hypoventilation during such surgeries. A study by Zulfikaroglu et al. also brought out similar metabolic changes in patients undergoing laparoscopic surgery, although not specifically in smokers.

In our study, mean heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure was significantly increased after the development of pneumo-peritoneum. These findings are similar to the G Chopra et al[12] study in laparoscopic cholecystectomy group.

CONCLUSION

Metabolic effects of CO_2 insufflation appear to be more enhanced in smokers. Hemodynamic parameters remain raised during and after pneumoperitoneum in smokers, which may be due to pathological changes in their body systems because of chronic smoking. Intra-operative mean heart rate, mean systolic blood pressure, mean diastolic blood pressure and mean arterial pressure were significantly

higher in smoker group compared to non-smoker group during entire operative period (P<0.05).

Values of PCO_2, $ETCO_2$ and Bicarbonate were significantly higher in the smoker group at all stages of ABG sampling and measurement (P<0.05). Mean pH values were significantly lower in the smoker group during and after pneumoperitoneum (P<0.05). Increase in PCO_2 due to creation of pneumoperitoneum was significantly higher in smoker group while increase in HCO_3 and decrease in pH was similar in both smoker and non-smoker group.

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