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Effects of Hyperventilation on Haemodynamics, Partial Pressure of Carbon Dioxide and Acid Base Status in Laparoscopic Surgeries-Randomized Control Study

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Abstract
The aim of the study was to compare the effects of hyperventilation on haemodynamics and partial pressure of carbon dioxide and acid base status with three different respiratory rates and tidal volume of 10 ml /kg .
Methods: *90 patients undergoing laparoscopic surgeries under General Anaesthesia were randomized into three groups, with tidal volume of 10 ml/kg and respiratory rate of 12,14,16 per minute. Hemodynamic variables (heart rate and mean arterial pressure) were recorded and End tidal C02, PaC02, pH and Bicarbonate estimation done before, during and after C02 pneumoperitoneum.*
Results: *The three groups were similar in demographic profile.There were no significant difference in mean arterial pressure before creation of pneumoperitoneum in all three groups. (p value 0.067). Arterial blood gas analysis demonstrated higher PaCO2 and lower pH in control group than in study group. PaCO2 values measured before pneumoperitoneum showed a higher value in group 1 whereas it was lower in normal range in groups 2 and 3 .The values were 34.92 mm of Hg and 33.13 mm of Hg respectively and statistically significant (p value is 0.0000). Heart rate was significantly higher in the control group than the study groups during pneumoperitoneum Peak inspiratory pressure did not suffer significantly between the groups and the p value was 0.976. During the pneumoperitoneum the groups 2 and 3 showed a significantly higher values than the group 1 (p 0.000.)*
Conclusions: *During laparoscopic surgeries and increasing the minute ventilation by increasing the respiratory rate from 12 per minute to 14 per minute produces a significant decrease in partial pressure of carbon dioxide ,end tidal carbon dioxide and pH .*
Keywords: *respiratory rate, laparoscopic surgeries, hyperventilation.*

Introduction

In recent years, laparoscopic surgery has gained popularity in clinical practice. The key element in laparoscopic surgery is creation of pneumoperitoneum and carbon dioxide is commonly used for insufflation. This pneumoperitoneum perils the normal cardiopulmonary system to a considerable extent[(1)] and the patient positions required for

laparoscopy induce pathophysiologic changes that complicate anaesthetic management.

Pneumoperitoneum decreases thoracic compliance by 30 – 50 % in healthy obese, but the shape of pressure volume loop does not change. after the pneumoperitoneum Reduction in functional residual capacity due to elevation of diaphragm and changes in the distribution of pulmonary ventilation and perfusion from increased airway pressure can be expected .However ,increasing IAP to 14mmHg with the patient in a 10 -20 degrees head up or down position does not significantly modify physiologic deadspace or shunt in patients without cardiovascular problems.[2][3]

The physiologic effects of pneumoperitoneum include systemic absorption of CO2 and hemodynamic and physiologic alteration in a variety of organs due to the increased intraabdominal pressure. CO2 absorption across the peritoneal surface and into the systemic circulation can result in hypercarbia and eventual systemic acidosis Hypercapnia can cause cardiac arrhythmias, vasoconstriction of the pulmonary vessels, and a mixed response in cardiac function. Acidosis associated with hypercapnia has a depressive effect on myocardial contractility, whereas hypercapnia can stimulate the autonomic nervous system leading to tachycardia and increased myocardial contractility. [4][5]

During uneventful CO2 pneumoperitoneum, the increase in partial pressure of arterial carondioxide progressively increases to reach a plateau 15 to 30 minutes after beginning of CO2 insufflation in patients under controlled mechanical ventilation during laparoscopic surgeries.

Materials and Methods

It was a prospective double blinded randomized study .The study was approved by Institutional ethical committee and written informed consent was obtained from ninety patients.

Ninety patients of ASA physical status 1 and 2, age group of 18 – 60 years of both sexes undergoing elective laparoscopic general surgical procedures lasting a minimum of 45 minutes. were randomized into three groups using computer generated random number.

Group 1 – ventilated with rate of 12 /min and tidal volume of 10 ml/kg

Group 2- ventilated with rate of 14 /min and tidal volume of 10 ml/kg.

Group 3 – ventilated with rate of 16/min and tidal volume of 10ml/kg.

Inclusion criteria

Patients of ASA physical status I. and II undergoing laparoscopic general anaesthesia like cholecystectomy, appendicectomy procedures lasting more than 45 minutes.

Exclusion criteria

Patients suffering from any respiratory diseases (bronchial asthma, chronic bronchitis, emphysema and respiratory failure), Congestive cardiac failure Renal failure. and patients with positive Allen's test were excluded.

Patients were advised overnight fasting and Allen's test was performed the previous day to check for the adequacy of collateral circulation in palm.

Patients were pre medicated with given T.Ranitidine 150 mg and T.Emeset on the previous night of surgery and on the morning of surgery.

After attaching the monitors for electro cardiogram, oxygen saturation and non invasive blood pressure basal paramerters were recorded.

Patients were given Inj .Fentanyl 2 mic/kg for analgesia and induced with Inj Propofol 2 mg /kg and paralysed with Inj.Succinyl choline 1.5mg/kg.

After adequate relaxation intubated with appropriate size endotracheal tubes and connected to Drager-Fabius ventilator with the tidal volume of 10 ml/kg and ventilator rates as assigned to the patient. Maintained with N2O and O2 at 1 and1 litres per minute. and Isoflurane titrated to 0.5 to 1%.

Patients left radial artery was cannulated with 20 G IV cannula and connected to a three way adaptor and flushed with heparin saline to

maintain the patency. An arterial sample was collected and sent for analysis .Arterial Blood Gas analysis was sent 30 min after pneumoperitoneum and after exsufflation of CO2.

Mean arterial pressure, Peak Inspiratory pressure, Heart rate, Et CO2 measured baseline and every 15 minutes thereafter .

Sample Size

As per Open Epi version 3.0, considering two sided significance level as 95%, power of the study as 80% and ratio of sample size unexposed/exposed as 1, and referring the percent of unexposed with outcome as 11% and that of exposed with outcome as 62% as per the master article taken as reference*,[6] the primary outcome PCO2 and a sample of ninety patients were recruited for the study.

Methods of statistical analysis to be used

Data Analysis was done by SPSS version 19.0. Continuous variables were expressed as mean+/- SD or median with IQR as wherever required. Normally distributed data compared using t test as a test of significance for the difference of mean and categorical variables analysed using chi-square test for difference in proportion. Analysis was done with two-tailed at $p<0.05$ as statistically significant.

Observation and Results

The patient in each group was statistically comparable in distribution of age, weight and sex distribution.

Table 1 Demographic profile

S.N0	Total	Group 1	Group 2	Group 3	P value
Age	30	43±12	41±14	44±9	0.84
Weight	30	53±11.5	51±12.3	53±13.5	0.61
Height	30	158±12	161±14	160±11	0.72

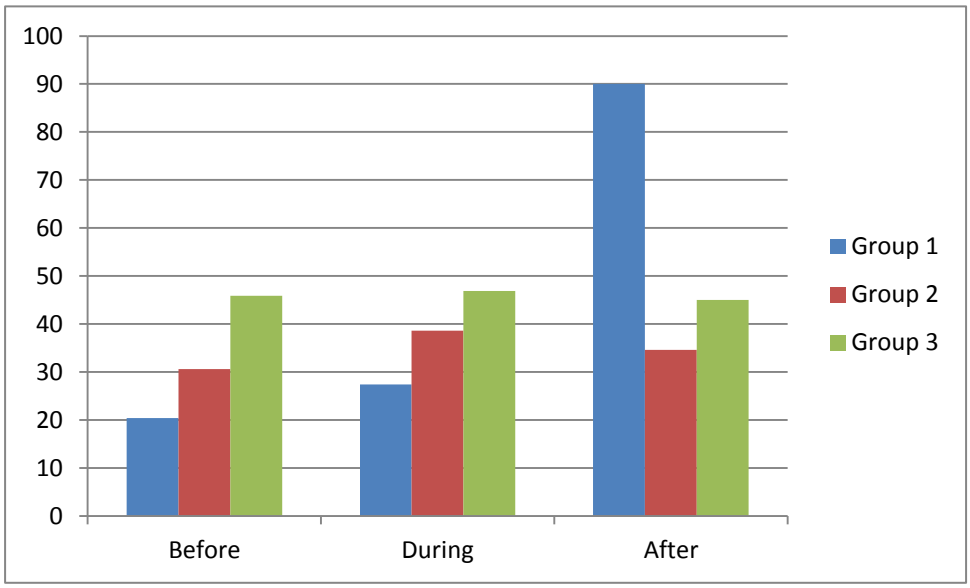
Table 2 Monitored Parameters

		MAP			HeartRate		ETCO2		
	Before	During	After	Before	During	After	Before	During	After
Group 1	81.3±6.77	88.2±8.19	83.3±7.4	83.4	78.93	88.73	33.03±2.69	37.5±3.52	35.21±2.45
Group 2	86.7±8.85	94.2±8.04	88.97±6.81	88.37	81.53	92.03	29.93±3.26	31.34±3.85	29.37±3.35
Group 3	86.8±8.12	94.63±9.43	94.43±8.6	93.6	85.57	89.63	23.14±2.47	29.67±3.82	29.81±1.82
Pvalue	0.04	0.05	<.001	<0.001	0.013	0.01	<0.001	<0.001	<0.001

Table 3 Acid base values between groups

	PH			HCO3			PCO2		
	Before	During	After	Before	During	After	Before	During	after
Group 1	7.36±.02	7.36±.02	7.36±.02	22.6±0.7	22.65±0.71	22.65±0.17	39.03±2.69	42.55±3.52	39.55±3.52
Group 2	7.45±.03	7.44±.05	7.36±.03	22.6±0.7	22.65±0.73	24.72±0.71	34.93±3.26	37.34±3.85	33.34±3.85
Group 3	7.36±.05	7.36±.04	7.36±.04	22.6±0.7	22.65±0.71	23.63±0.72	33.14±2.47	34.67±3.82	30.67±3.82
Pvalue	0.04	0.05	<.001	<.001	<.001	<.005	<0.001	<0.001	<0.001

Figure 1: Comparison of Peak Inspiratory Pressure between groups



Discussion

During laparoscopic surgeries carbondioxide pneumoperitoneum is created and the effects of hypercarbia on the circulatory system are complex. This usually includes an increase in cardiac output, heart rate, force of myocardial contraction, blood pressure, central venous pressure, vasoconstriction in pulmonary vessels and decreased peripheral resistance. Healthy ASA I patients are less likely than ASAIII patients to undergo extreme changes.

General anaesthesia with intubation and mechanical ventilation results in decrease in functional residual capacity which is caused by loss of muscle tone, diaphragmatic displacement and loss of thoracic volume .Lung compliance drops, airway pressure increase and V/Q abnormalities occur. These changes are exaggerated by Trendelenburg position especially in elderly patients, obese and those with preexisting cardiopulmonary disease.

Various studies as mentioned in the review of literature have studied the effects of laparoscopy on hemodynamics and respiratory function.

This study correlates with the study done by Maharjan. K.Shreshtha [(6)] et al ,which concludes that increasing the minute ventilation by 10 -15% has beneficial effects during pneumoperitoneum to prevent hypercarbia and acidosis .

There was no significant difference in mean arterial pressure before creation of pneumoperitoneum in all three groups. (p value 0.067). During pneumoperitoneum there was an increase in mean arterial pressure in all the 3 groups[(7)]

pH did not show any significant difference between the study and control groups before creation of pneumoperitoneum. (p value 0.073). During pneumoperitoneum the pH varied significantly from control to study groups but no significant difference was observed between the study groups. After deflation also the control group differed significantly from study groups(p value 0.000).But no significant difference was observed between the study groups.(p value 0.127). [(8)]

PaCO2 values measured before pneumoperitoneum showed a higher value in group 1 whereas it was lower in normal range in groups 2 and 3 .The values are 34.92 mm of Hg and 33.13 mm of Hg respectively. It was statistically significant (p value 0.0000.)

During pneumoperitoneum also the Pa CO2 was significantly higher in group1 than the other 2 groups. p value is 0.000. Even groups 2 and 3 varied significantly among themselves ie: group 2 showed a higher value than group3.p value is 0.004.

After deflation also the PaCO2 remained at higher level in group 1 than groups 2 and 3 (.p value is 0.000.)

Measurements showed a significantly higher value of 33.5 mm of Hg in group 1(.p value 0.000). Group 2 had a significantly higher value than the group 3

(p value 0.001).

During the pneumoperitoneum also the values were significantly higher in group 1 than the groups 2 and 3 .p value is 0.000. Group 2 showed a significantly higher value of 31.03 mm of Hg than group 3 and the p value is 0.030.

After deflation also group 1 had a higher value of 35.43 mm of Hg and 29.166 mm of Hg respectively . (p value is 0.000).Groups 2 and 3 did not show significant difference and the p value was 0.789.

Bicarbonate levels measured before pneumoperitoneum did not show any significant difference among three groups[(1)]

Pre pneumoperitoneum values showed no significant difference among the groups and the p value is 0.143. During pneumoperitoneum there was no significant change in pulse rate in all the 3 groups .After deflation the values showed significant increase in the study groups than the control group and the p value was 0.000.But this was not statistically significant.[(9)] Pneumoperitoneum values did not suffer significantly between the groups and the p value was 0.976.[(10)]

During the pneumoperitoneum the groups 2 and 3 showed a significantly higher values than the group 1 and the p value was 0.000.

There was a statistically significant increase in pH in study groups when compared to control group. But this increase was not clinically significant. Because the study groups showed high normal values of pH whereas control group showed the lower normal pH.

There was a significant decrease in partial pressure of carbon dioxide and end tidal carbon dioxide in study groups when compared to the control groups during and after pneumoperitoneum. There was no significant difference in the bicarbonate values.

Conclusion

Carbon dioxide output increases during laparoscopic surgeries and increasing the minute ventilation by increasing the respiratory rate from 12 per minute to 14 and 16 per minute produces a significant decrease in partial pressure of carbon dioxide ,End tidal carbon dioxide and pH towards the high normal range levels. When the rate was increased to 16 per minute the same changes were observed but this was not statistically significant from patients ventilated with a rate of 14 per minute

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