

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Study On Effects Of Hyper Ventilation In Laparoscopic Surgeries On Haemodynamics, Partial Pressure Of Carbon dioxide And Acid Base Status.

Gomathi Karmegam¹, and S Mahalakshmi^{2*}.

¹Associate Professor In Anesthesiology, Department Of Emergency Medicine, Madras Medical College, Rajiv Gandhi Government General Hospital, Chennai, Tamil Nadu, India.

²Associate Professor In Anesthesiology, Department Of Emergency Medicine, Government Medical College, Omandurar Estate, Chennai, Tamil Nadu, India.

ABSTRACT

Surgical procedures have been improved to reduce trauma to the patient morbidity, mortality and hospital stay with consequent reductions in health care costs. Nowadays laparoscopy is used in colonic, gastric, splenic, hepatic and urologic surgeries. Although laparoscopic surgeries are minimally invasive, uptake of CO₂ from the pressurized pneumoperitoneum can cause clinically relevant hypercarbia and respiratory acidosis with physiological consequences. Hypercarbia and acidosis occurs due to absorption via huge peritoneal cavity, decreased lung compliance and insufficient ventilation. CO₂ is 20 times more soluble/diffusible than oxygen which is insufflated in pressurized form (10-15 mmHg). If duration of surgery is prolonged, systemic absorption of CO₂ will be more and it requires aggressive hyperventilation. The pneumoperitoneum and the patient positions required for laparoscopy induce pathophysiologic changes that complicate anaesthetic management. The aim of the study is to compare the effects of hyperventilation with three different respiratory rates and tidal volume of 10 ml/kg on haemodynamics like mean arterial pressure, pulse rate and partial pressure of carbon dioxide and acid base status in laparoscopic cholecystectomy. It was a prospective, study conducted in the Department of Anaesthesiology, Madras Medical College in the year 2019-2020 Ninety patients of ASA physical status 1 undergoing elective laparoscopic cholecystectomy lasting a minimum of 45 minutes. Patients belonging to the age group of 20 – 60 years of both sexes It is a prospective randomized study. Ninety patients of both sexes undergoing laparoscopic cholecystectomy were randomly allocated into three groups. 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. There was no significant difference in mean arterial pressure before creation of pneumoperitoneum in all the three groups. (p value 0.067). pH did not show any significant difference between the study and control groups before creation of pneumoperitoneum. (p value 0.073). PaCO₂ values measured before pneumoperitoneum showed a higher value in group 1 whereas it was in lower 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 and the 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 and the p value is 0.001. Bicarbonate levels measured before pneumoperitoneum did not show any significant difference among the three groups and the p value was 0.372. 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 the 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 clinically significant. Pre pneumoperitoneum values did not differ significantly between the groups and the p value was 0.976. During pneumoperitoneum the groups 2 and 3 showed a significantly higher values than the group 1 and the p value was 0.000. Carbon dioxide output increases during laparoscopic surgeries and increasing the minute ventilation by increasing the respiratory rate from 12 per minute to 14 per minute in laparoscopic surgeries 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. There was no significant difference in the bicarbonate values. There was no significant difference in between the groups in the mean arterial blood pressure. But the heart rate was significantly higher in the control group than the study groups during pneumoperitoneum.

Keywords: hyper ventilation, Laparoscopic Surgeries, Haemodynamics , partial pressure, Carbondioxide, Acid base status.

<https://doi.org/10.33887/rjpbcs/2023.14.4.18>

**Corresponding author*

INTRODUCTION

Surgical procedures have been improved to reduce trauma to the patient morbidity, mortality and hospital stay with consequent reductions in health care costs. Laparoscopy for clinical purposes was first performed by Jacobaeus in 1910, and, following advances in optical and lighting systems and the work of Steptoe (1965, 1969) [1] The provision of better equipment and facilities along with increased knowledge and understanding of anatomy and pathology, has allowed the development of endoscopy for diagnostic and operative procedures. [2] In early 1970s, various pathologic gynecologic conditions were diagnosed and treated using laparoscopy. This endoscopic approach was extended to cholecystectomy in late 1980s. Nowadays laparoscopy is used in colonic, gastric, splenic, hepatic and urologic surgeries. [3] Although laparoscopic surgeries are minimally invasive, uptake of CO₂ from the pressurized pneumo peritoneum can cause clinically relevant hypercarbia and respiratory acidosis with physiological consequences. Hypercarbia and acidosis occurs due to absorption via huge peritoneal cavity, decreased lung compliance and insufficient ventilation CO₂ is 20 times more soluble/diffusible than oxygen which is insufflated in pressurized form (10-15 mmHg). [4] If duration of surgery is prolonged, systemic absorption of CO₂ will be more and it requires aggressive hyperventilation. The pneumoperitoneum and the patient positions required for laparoscopy induce pathophysiological changes that complicate anaesthetic management. [5] In this study I am studying the effects of hyperventilation on haemodynamics, partial pressure of carbon dioxide and acid base status in laparoscopic cholecystectomy. [6]

MATERIALS AND METHODS

It was a prospective, study conducted in the Department of Anaesthesiology, Madras Medical College in the year 2019-2020 Ninety patients of ASA physical status 1 undergoing elective laparoscopic cholecystectomy lasting a minimum of 45 minutes. Patients belonging to the age group of 20 – 60 years of both sexes It is a prospective randomized study. Ninety patients of both sexes undergoing laparoscopic cholecystectomy were randomly allocated into three groups . 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: ASA physical status I. Patients undergoing laparoscopic cholecystectomy 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. Ninety patients of both sexes undergoing laparoscopic cholecystectomy were randomly allocated into three groups . 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. Patients were advised overnight fasting. All patients were given T. Ranitidine 150 mg , T. Diazepam 5mg on the previous night of surgery and on the morning of surgery . All the patients were pre medicated with Inj. Glycopyrrolate 10mcg/ kg IM 45 minutes before surgery. After shifting to the theatre right cephalic vein was cannulated with 18 G IV cannula and Ringer Lactate was started. After attaching the monitors for electro cardiogram , oxygen saturation and non invasive blood pressure basal parameters were recorded. Patients were given Inj. Fentanyl 2 micg /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 3 and 1.5 litres per minute. And Isoflurane of 0.4 to 0.6%. Patient's 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. Throughout surgery intra abdominal pressure was maintained at 12 cm H₂O. Mean arterial pressure, Peak Inspiratory pressure, Heart rate, EtCO₂ were measured baseline and every 15 minutes thereafter. Increase in Mean arterial pressure of more than 20% controlled with Isoflurane. After the surgery is over and adequate respiratory attempts the patient was reversed with Inj. Neostigmine 50 micg /kg and Inj. Glycopyrrolate 10 micg/Kg dose . After the return of adequate muscle power and return of reflexes the patient was extubated after adequate oral suction.

Statistical Analysis

The sample of 90 patients was taken for the study .Data was expressed as mean +_SD or absolute values .Qualitative analysis was compared with **ANOVA Test**. The level of statistical significance was set at p <0.05% .The patient in each group was statistically comparable in distribution of age, weight and sex distribution.

RESULTS

Table 1: Comparison Of Age Group

GROUP	N	MEAN (yrs)	SD
1	30	38.6	14.58
2	30	35.6	12.70
3	30	39.3	12.67
TOTAL	90	37.8	13.29
P VALUE 0.527 NOT SIGNIFICANT			

Table 2: Comparison Of Anesthesia Duration

Group	N	Mean (min)	SD
1	30	88.86	18.04
2	30	80.6	12.05
3	30	86.56	14.13
Total	90	85.34	15.19

Table 3: Comparison Of Surgery Duration

Group	N	Mean (min)	SD
1	30	65.96	11.19
2	30	62.83	7.17
3	30	65.9	9.14
Total	90	64.9	9.32

Table 4: Comparison Of Mean Arterial Pressure Pre Pneumo Peritoneum

Group	N	Mean(mm Hg)	SD
1	30	84.6	9.74
2	30	86.7	8.85
3	30	83.63	8.92
Total	90	84.3	8.82

Table 5: Comparison Of Mean Arterial Pressure During Pneumo Peritoneum

Group	N	Mean(mm Hg)	SD
1	30	114.13	16.57
2	30	110.2	8.03
3	30	112.63	9.42
Total	90	102.6	10.68

Table 6: Comparison Of Mean Arterial Pressure During Post Pneumoperitoneum

Group	N	Mean (mm Hg)	SD
1	30	90.05	11.34
2	30	88.96	6.81
3	30	89.23	7.8
Total	90	89.3	8.76

Table 7: Comparison Of Ph Pre Pnemoperitoneum

Group	N	Mean	SD
1	30	7.4415	0.043
2	30	7.4516	0.0305
3	30	7.4505	0.051
Total	90	7.4393	0.045

Table 8: Comparison Of Ph During Pneumoperitoneum

Group	N	Mean	SD
1	30	7.3505	0.0183
2	30	7.4416	0.0351
3	30	7.4405	0.0466
Total	90	7.4109	0.0553

Table 9: Comparison Of Ph Post Pneumoperitoneum

Group	N	Mean	SD
1	30	7.3511	0.0221
2	30	7.4413	0.0325
3	30	7.4283	0.0408
Total	90	7.4069	0.0515

Table 10: Comparison Of PCO₂ Pre Pneumoperitoneum

Group	N	Mean(mm Hg)	SD
1	30	39.0303	2.6863
2	30	34.9267	3.2585
3	30	33.1363	2.4725
Total	90	35.6978	3.7361

Table 11: Comparison Of PCO₂ During Pneumoperitoneum

Group	N	Mean(mmHg)	SD
1	30	42.5547	2.9579
2	30	37.3367	3.5174
3	30	34.6687	3.8512
Total	90	38.1867	4.7499

Table 12: Comparison Of PCO₂ Post Pneumoperitoneum

Group	N	Mean (mmHg)	SD
1	30	41.209	2.451
2	30	36.366	3.348
3	30	34.81	1.822
Total	90	37.4619	3.768

Table 13: Comparison Of ETCO₂ Pre Pneumoperitoneum

Group	N	Mean (mm Hg)	SD
1	30	33.5	2.529
2	30	29	2.243
3	30	26.73	2.664
Total	90	29.74	3.746

Table 14: Comparison Of ETCO₂ During Pneumoperitoneum

Group	N	Mean (mmHg)	SD
1	30	37.1	2.656
2	30	31.03	2.846
3	30	29.43	2.92
Total	90	32.52	4.329

Table 15: Comparison Of ETCO₂ During Post Pneumoperitoneum

Group	N	Mean (mmHg)	SD
1	30	35.43	2.83
2	30	29.36	2.83
3	30	29.16	2.98
Total	90	31.32	4.08

Table 16: Comparison Of Bicarbonate Pre Pneumoperitoneum

Group	N	Mean (mmol/l)	SD
1	30	22.6	0.695
2	30	24.44	1.848
3	30	23.81	1.877
Total	90	23.61	1.734

Table 17: Comparison Of Bicarbonate During Pneumoperitoneum

Group	N	Mean (mmol/l)	SD
1	30	22.65	0.806
2	30	24.71	1.665
3	30	23.62	1.989
Total	90	23.66	1.767

Table 18: Comparison Of Bicarbonate Post Pneumoperitoneum

Group	N	Mean (mmol/l)	SD
1	30	23.31	1.15
2	30	24.64	1.7
3	30	23.92	1.718
Total	90	23.95	1.62

Table 19: Comparison Of Pulse Rate Pre Pneumoperitoneum

Group	N	Mean	SD
1	30	80.93	6.52
2	30	81.53	8.2
3	30	83.56	10.5
Total	90	82.47	8.9

Table 20: Comparison Of Pulse Rate During Pneumoperitoneum

Group	N	Mean	SD
1	30	92.03	8.49
2	30	88.73	8.23
3	30	89.63	8.61
Total	90	90.13	8.46

Table 20: Comparison Of Pulse Rate Post Pneumoperitoneum

Group	N	Mean	SD
1	30	93.6	8.04
2	30	88.36	6.19
3	30	83.4	6.51
Total	90	88.45	8.05

Table 21: Comparison Of Peak Inspiratory Pressure Pre Pneumo Peritoneum

Group	N	Mean (cm of H2O)	SD
1	30	20.7	1.89
2	30	20.6	1.92
3	30	20.63	1.56
Total	90	20.64	1.78

Table 22: Comparison Of Peak Inspiratory During Pneumo Peritoneum

Group	N	Mean (cm of H2O)	SD
1	30	23.63	1.9
2	30	25.06	1.99
3	30	26.46	1.71
Total	90	25.05	2.18

Table 23: Post Pneumoperitoneum

Group	N	Mean (cm of H2O)	SD
1	30	21.06	1.59
2	30	20.7	1.84
3	30	21.06	1.46
Total	90	20.94	1.63

DISCUSSION

During laparoscopic surgeries carbon dioxide 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 the pulmonary vessels and decreased peripheral resistance. Healthy ASA I patients are less likely than ASA III patients to undergo extreme changes [7]. General anaesthesia with intubation and mechanical ventilation results in a decrease in functional residual capacity which is caused by loss of muscle tone, diaphragmatic displacement and loss of thoracic volume. Lung compliance drops, airway pressures increase and V/Q abnormalities occur. These changes are exaggerated by Trendelenburg position especially in elderly patients, obese and those with preexisting cardiopulmonary disease [8]. Various studies as mentioned in the review of literature have studied the effects of laparoscopy on haemodynamics and respiratory function. There was no significant difference in mean arterial pressure before creation of pneumoperitoneum in all the three groups (p value 0.067) [9]. During pneumoperitoneum there was an increase in mean arterial pressure in all the 3 groups but there was no significant difference in between the groups (p value 0.157) and the mean arterial pressure decreased after deflation of pneumoperitoneum but there was no significant difference in between the groups (p value 0.142). pH did not show any significant difference between the study and control groups before creation of pneumoperitoneum (p value 0.073) [10]. 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). PaCO₂ values measured before pneumoperitoneum showed a high value in group 1 whereas it was in lower normal range in groups 2 and 3 [11]. The values are 34.92 mm of Hg and 33.13 mm of Hg respectively. It was statistically significant and the p value is 0.000. In between groups 2 and 3 there was further significant difference and the value was higher in group 2 than the group 3. P value was 0.016. During pneumoperitoneum also the PaCO₂ was significantly higher in group 1 than the

other 2 groups. p value is 0.000 [12]. Even groups 2 and 3 varied significantly among themselves ie; group 2 showed a higher value than group 3. 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 and the p value is 0.001. During 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 35.43mm of Hg than the groups 2 and 3 which had values of 29.36 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 [13]. Bicarbonate levels measured before pneumoperitoneum did not show any significant difference among the three groups and the p value was 0.372. During pneumoperitoneum also bicarbonate values did not show any statistically significant difference and the p value was 0.590. Values measured after deflation also showed no significant difference among the groups and the p value was 0.970. 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 the 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 clinically significant [14]. Pre pneumoperitoneum values did not differ significantly between the groups and the p value was 0.976. During pneumoperitoneum the groups 2 and 3 showed a significantly higher values than the group 1 and the p value was 0.000. But after deflation the values were not significantly different and the p value was 0.608. Our study shows that increasing the minute ventilation by 15 % in group 2 and 30 % in group 3 keeps the partial pressure of carbon dioxide and End tidal Carbon dioxide and pH within normal limits but it did not have significant changes in mean arterial pressure and heart rate [15].

CONCLUSION

Carbon dioxide output increases during laparoscopic surgeries and increasing the minute ventilation by increasing the respiratory rate from 12 per minute to 14 per minute in laparoscopic surgeries 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. There was no significant difference in the bicarbonate values. There was no significant difference in between the groups in the mean arterial blood pressure. But the heart rate was significantly higher in the control group than the study groups during pneumoperitoneum.

REFERENCES

- [1] Baraka A, Jabbour S, Hammoud R et al. End tidal carbon dioxide tension during laparoscopic cholecystectomy. Correlation with baseline value prior to CO₂ insufflation *Anaesthesia* 49:775,1994.
- [2] Dexter SP, et al: Haemodynamic consequences of high and low-pressure capno peritoneum during laparoscopic cholecystectomy. *Surg. Endoscopy* 13: 376-1999.
- [3] El-Minawi MF et al Physiological changes during CO₂ and N₂O pneumoperitoneum during diagnostic laparoscopy. *Journal of Reproductive Medicine* 1981 26 338- 346.
- [4] Goodale RL, Beebe DS, Mc Nevin MP et al Haemodynamic, ventilatory and metabolic effects of laparoscopic cholecystectomy *American Journal of Surgery* 1993;166:533-37.
- [5] Hirvonen EA et al: Hemodynamic changes due to trendelenberg position & pneumoperitoneum during laparoscopic hysterectomy. *Acta Anaesthesiology Scandinavia* 39: 949, 1995.
- [6] Hodgson c Mc Clelland RM Newton JR, Some effects of the peritoneal insufflation of carbon dioxide during laparoscopy. *Anaesthesia* 1970;25:382-90
- [7] Joris JL Noriot DP, Legrand MJ et al Haemodynamic changes during laparoscopic cholecystectomy. *Anaesthesia and Analgesia* 1993; 76;1067-71.
- [8] Kashtan J. et al; Haemodynamic effect of increased abdominal pressure. *J Surgery Residency* 30: 249, 1981.
- [9] Liu S-Y Leighton TA Davies I et al, Prospective analysis cardiopulmonary responses in laparoscopic cholecystectomy *J. laparoendoscopic Surgeries* 1991;126:997-1000.
- [10] Muelett CE, Viale JP Sagnard PE et al. *Anaesth Analgesia* 1993;76;622-26.
- [11] Puri GD, Singh H, Ventilatory effects of laparoscopy under general anaesthesia. *British journal of anaesthesia* 1992;68:211-13.
- [12] Putensen Himmer G, Putensen CH, Lammer H et al Functional Residual capacity, Post operative

- lung function and gas exchange following open laparotomy or laparoscopy for cholecystectomy. *Anaesthesiology* 1992 ; 77;A 1253.
- [13] Rademaker. BM, et al. Effects of pneumoperitoneum with Helium on hemodynamics and oxygen transport: A comparison with carbondioxide. *J. Laparoendoscopic Surgery*, 5:15, 1995.
- [14] Rittenmeyer H carbion dioxide toxicity related to a laparoscopicprocedure. *J Post anaesthetic care* 1994;9; 157-61.
- [15] Safron DB, Orlando R III Physiologic effects of pneumoperitoneum, *American Journal of Anaesthesia* 1992: 58;717-21.