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Original Article

Do we have to hyperventilate during laparoscopic surgery?

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Abstract

Purpose: The purpose of this study was to assess the effects of hyperventilation on patients undergoing laparoscopic surgeries on haemodynamics, partial pressure of carbon dioxide and acid base status.

Methods: 60 patients undergoing laparoscopic surgeries under General Anaesthesia were randomized into two groups, "control group" ventilated with tidal volume of 10 ml/kg and respiratory rate of 12/minute and "study group" same tidal volume with respiratory rate of 15/ minute. Hemodynamic variables (heart rate and mean arterial pressure) recorded and End tidal $C0_2$, $PaC0_2$, pH and Bicarbonate estimation done before, during and after C02 pneumoperitoneum and analyzed.

Results: There was no significant difference in hemodynamic variables but there was linear increase in $ETC0_2$ and $PaC0_2$ measurements in higher normal levels in control group ($ETC0_2$ 33.3 ± 3.20, 37.93 ± 3.95 and 43.20 ± 3.40; $PaC0_2$ 30.08 ± 2.35, 34.80 ± 4.01 and 41.94 ± 3.66 mmHg before, during, and after pneumoperitoneum respectively) compared to study group in which these parameters were in lower normal levels ($ETC0_2$ 33.33 ± 4.11, 28.00 ± 4.10 and 36.73 ± 2.49 mmHg and $PaC0_2$ 31.80 ± 2.73, 29.36 ± 3.16 and 35.15 ± 1.32 mmHg before, during, and after pneumoperitoneum respectively). There was highly significant difference in these parameters when intergroup comparison was done during and after pneumoperitoneum period. pH and bicarbonate levels were within normal limits but there was decreasing tendency towards acidosis side in control group.

Conclusion: 10- 15% increment in Minute Volume is beneficial during $C0_2$ pneumoperitoneum to prevent adverse effects of hypercarbia and acidosis.

Key words: Hyperventilation, pneumoperitoneum, end tidal carbon dioxide ($ETC0_{2)}$), partial pressure of carbon dioxide ($PaC02_{)}$), Laparoscopy.

Laparoscopic surgeries are gaining popularities mainly because of less pain, cosmetic scar and less hospital stay but not without unwanted effects. Initially it was used only for cholecystectomy but use is advancing towards other major abdominal, thoracic and gynaecological procedures as well. In this institute, laparoscopic method is being used for cholecystectomy, appendectomy, herniorrhaphy, lap assisted hysterectomy and other abdominal surgeries as well.

Cholecystectomy is being done more frequently and the duration of surgery is getting lesser but other major abdominal surgeries like CBD exploration, colonic surgeries and hysterectomies need quite long duration of pneumoperitoneum. These long surgeries require longer periods of peritoneal insufflations of $C0_2$, which might impede diaphragmatic movement and increase $C0_2$ load for ventilation. Respiratory mechanics and blood gas must be monitored to identify the mechanical and ventilatory effects of $C0_2$ insufflations [1].

Although laparoscopic surgeries are minimally invasive, uptake of $C0_2$ 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 [8]. $C0_2$ 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 $C0_2$ will be more and it requires aggressive hyperventilation[7]. Therefore we have studied whether we have to increase the minute volume during positive pressure ventilation in these patients.

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Materials and methods

60 patients of ASA I&II, undergoing laparoscopic surgery were randomly divided into two groups, control group ventilated with 10 ml/kg of tidal volume and respiratory rate of 12/minute and study group same tidal volume but rate increased to 15/minute. General Anaesthesia was used in all cases (pethidine, sodium thiopentone induction, intubation after succinylcholine, maintained with 50% 0_2 in air, halothane, pancuronium and IPPV, residual effect of pancuronium reversed with neostigmine and atropine).

Standard monitors along with $ETC0_2$ were used and radial artery cannulation done for IBP monitoring and arterial blood gas measurements. Mean arterial pressure, heart rate, peak airway pressure and $ETC0_2$ measurement was done baseline, before intubation, after intubation, before $C0_2$ insufflation and after isufflation in 15 minute intervals and after extubation as well. ABG (pH, $PaC0_2$ and $HC0_3^-$) analysis done before and during $C0_2$ pneumoperitoneum and after $C0_2$ disinflation.

$ETC0_2$ measurement was done with Siemens SC9000XL mainstream analyzer and blood gas analysis done with Nova biomedical blood gas analyzer. Statistical data analysis was done with Pentium 4 version of computer using SPSS 11 for windows. Independent samples T test was used for inter group comparison. Results are reported as mean ±standard deviation. The p value <0.05 was taken as statistically significant difference between the two groups.

Patients suffering from any respiratory diseases (bronchial asthma, chronic bronchitis, emphysema and respiratory failure), congestive cardiac failure and renal failure were excluded from the study.

Results

The demographic parameters (age, sex, and weight), duration of Anaesthesia and duration of surgery were similar between the two groups (Table 1).

$ETC0_2$ and $PaC0_2$ measurement showed linear increase from before pneumoperitoneum levels, increasing during pneumoperitoneum and still increasing to higher normal levels after extubation in control group. But in study group, there was no increase in $ETC0_2$ and $PaC0_2$ levels during pneumoperitoneum and was in normal levels after extubation as well. Statistical analysis showed highly significant differences between the two groups of patients ($p<0.01$), i.e. hyperventilation in study group of patients kept the $C0_2$ output within normal limits (Table 2 and Fig 2).

When hemodynamic variables i.e. MAP and Heart rate of perioperative period compared between the two group, there was no statistical significant differences in any time. There was linear increase in peak inspiratory pressure from basal level to $C0_2$ pneumoperitoneum in both group and again coming back to near normal after extubation. Increases in airway pressure simultaneously decrease the lung compliance and minute volume which may impede $C0_2$ excretion (Fig 1).

When comparisons were made between pH and $HC0_3^-$ levels in different time i.e. before, during and after pneumoperitoneum, there was no statistical significant difference between the two groups i.e. p >0.05(Table 3, 4).

Table 1: Demographic parameters and duration of anaesthesia and surgery in studied patients.

parameters	Control group	Study group	P value
Age (years)	39.27±13.87	45.87±16.03	0.238
Male: female	8:22	7:23	
Weight(kg)	58.46±8.35	57.66±5.08	0.754
Duration of anesthesia (minutes)	65.26±23.60	64.76±26.66	0.939
Duration of surgery(minutes)	53.66±25.06	53.33±25.06	0.957

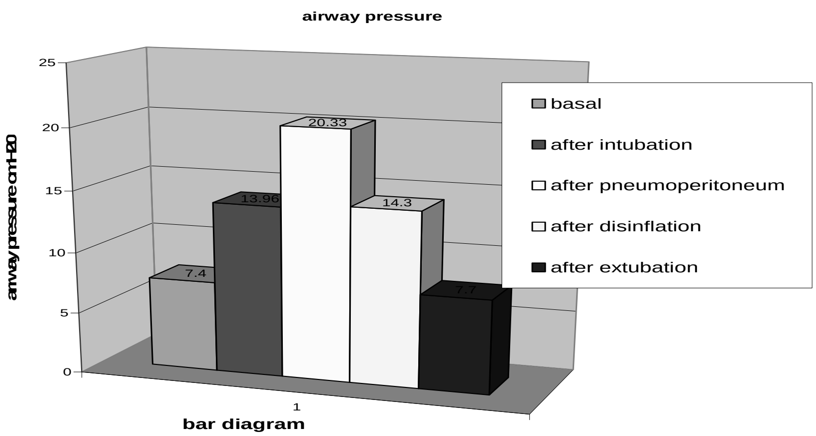

Fig 1: Perioperative airway pressure in studied patients, basal, after intubation, after pneumoperitoneum, after $C0_2$ disinflation and after extubation.

Table 2:.Perioperative $ETC0_2$ and $PaC0_2$ levels (mean ±S.D) in studied patients

$ETC0_2$ mmHg	Before pneumoperitoneum	During pneumoperitoneum	After extubation
Control group	33.60 ±3.48	37.93 ± 3.95	43.20 ± 3.40
Study group	33.33 ± 4.11	28.00 ±2.33	36.73 ± 2.49
P value	0.849	0.000	0.000
$PaC0_2$ mmHg			
Control group	30.08 ± 2.35	34.8 ± 4.01	41.94 ± 3.66
Study group	31.8 ± 2.73	29.36 ± 3.16	35.15 ± 1.32
P value	0.075	0.000	0.000

Table 3: pH values(mean ±S.D) in studied patients with comparison

pH	Before pneumoperitoneum	During pneumoperitoneum	After pneumoperitoneum
Control group	7.479 ±0.038	7.461 ± 0.039	7.383 ± 0.043
Study group	7.480 ± 0.050	7.483 ±0.033	7.406 ± 0.028
P value	0.929	0.107	0.092

Table 4: Comparison of bicarbonate ($HC0^{3-}$) levels (*mean* ±S.D) in two groups of patients

$HC0^{3-}$ mmol/L	Before pneumoperitoneum	During pneumoperitoneum	After pneumoperitoneum
Control group	23.32 ± 1.25	22.96 ± 1.54	24.60 ±1.58
Study group	24.46 ± 1.22	22.79 ±2.06	24.67 ± 2.54
P value	0.180	0.796	0.932

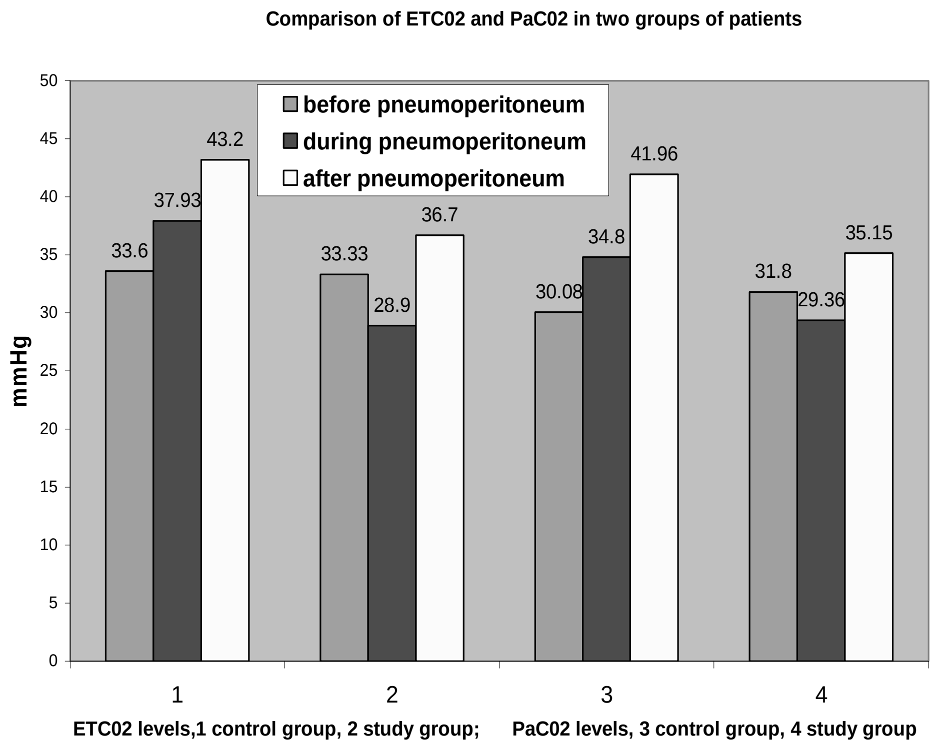

Fig 2: Comparison of $ETC0_2$ and $PaC0_2$ in two groups of patients (mean value)

Discussion

Carbon dioxide is 20 times more soluble/diffusible than oxygen and that is insufflated in high pressure (10-15mmHg) into the huge peritoneal cavity, accelerated absorption into systemic circulation and if ventilatory parameters are not adjusted accordingly, may cause hypercarbia and respiratory acidosis [2].Hypercarbia and acidosis has marked systemic adverse effects, mainly myocardial depression and sympathoadrenal activation and consequences of that. Solubility of gas, duration of surgery and intraabdominal pressure used to create the pneumoperitoneum influence the degree of $C0_2$ absorption [8]. To combat hypercarbia and acidosis and consequences, we have to hyperventilate aggressively in many circumstances[7].

End tidal C02 and PaC02 are recently available techniques for monitoring effectiveness of ventilation and partial pressure of C02 during pneumoperitoneum. But capnography for End tidal C02 monitoring and ABG machine for PaC02 monitoring are not readily available in our contest. And the only option available with us is to hyperventilate to overcome the carbon dioxide load and acidosis.

We included ASA I and II patients of age of 22 – 72 years and weight of 45-70 kg and patients of cardio respiratory and renal failure were excluded. Duration of anaesthesia was 30-125 minutes and duration of surgery of 20- 120 minutes. In our study we increased the minute volume by increasing respiratory rate to 15/minute (25% increment) in study group of patients compared to 12/minute in control group.

There was linear increase in $ETC0_2$ and $PaC0_2$ levels to higher normal range in patients who were not hyperventilated, compared to those who were hyperventilated during and after pneumoperitoneum. But we did not study the $PaC0_2$ level in postoperative period and we can not predict whether hypercarbia was also present in post op period. pH and bicarbonate levels were within normal limits in both group of patients.

Kazama T et al reported that it is necessary to increase expired minute ventilation during $C0_2$ pneumoperitoneum 1.54 times during anaesthesia to maintain $PaC0_2$ values constant[6]. Marked increase in $PaC0_2$ after pneumoperitoneum were reported by Lewis and co workers in young gynaecological patients anesthetized with halothane during spontaneous ventilation[6]. Mullet and colleagues reported 25% increase in PaC02. Wurst, Schulte-Steinberg noted a 30-40% increase in $C0_2$ output during pneumoperitoneum [6].

Hirvonen Eila A et al reported that when $ETC0_2$ was maintained normal or somewhat lower levels during laparoscopy by increasing the ventilation, the $PaC0_2$ can be kept in the normal range and the acidosis is at acceptable levels in healthy patients[5]. Wurst H et al reported that minute volume has to be increased progressively by about 40% to keep $PaC0_2$ constant during pneumoperitoneum[4].

El Minawi MF et al reported that laparoscopic surgery with $C0_2$ pneumoperitoneum, there was significant increase in $PaC0_2$, significant decrease in $Pa0_2$ and pH, which was not present in patients who underwent pneumoperitoneum with N_20[1]. Wittgen CM et al showed in their study that there was significant decrease in pH and increase in $PaC0_2$ in patients with cardio respiratory diseases compared to the patients without cardio respiratory problems[2].

The result of our study showed that $C0_2$ load gradually increase after pneumoperitoneum and remains in higher level after release of $C0_2$ from peritoneum as well. But the level can be checked by simultaneous hyperventilation during $C0_2$ pneumoperitoneum. Airway pressure and hemodynamic variables also increase and adequate adjustment is necessary during laparoscopic surgery.

Conclusion

Carbon dioxide load increases during laparoscopic surgery which is reflected by increase in $ETC0_2$ and $PaC0_2$ levels. To overcome these unwanted effects we have to adjust minute ventilation during intraoperative period. 10-15% increment in minute volume keeps the $PaC0_2$ levels in acceptable range during and after C02 pneumoperitoneum.

References

1. El- Minawi MF et al. Physiological changes during $C0_2$ and N_20 pneumoperitoneum during diagnostic laparoscopy. Journal of reproductive medicine 1981, 26: 338-346
2. Wittgen CM et al. Analysis of hemodynamic and ventilatory effects of laparoscopic cholecystectomy. Archieves of surgery 1991; 126:997-1001.
3. Cunningham et al. anesthesia for laparoscopic general surgery. Anesthesia Analog 1993; 76:1120
4. Wurst H et al. C02 stores in laparoscopic cholecystectomy with C02 pneumoperitoneum. Anesthesia 1995 44(3): 147-530.
5. Hirvonen , Eila et al. Ventilatory effects, blood gas changes and 02 consumption during laparoscopic cholecystectomy. Anesthesia and Analgesia May 1995 vol. 80 no 5.
6. Kazama T et al. C02 output in laparoscopic cholecystectomy. BJA April 1996 vol. 76 no 4.
7. Bhavani Shankar K et al. Arterial to end-tidal carbon dioxide difference during anesthesia for laparoscopic surgery in pregnancy. Anesthesiology 2000; 93(2):370-3.
8. Iwasaka, Hideko et al. respiratory mechanics and arterial blood gases during and after laparoscopic cholecystectomy. Canadian Journal of Anesthesiology, February 1996, vol. 43, no. 2.