Original Research Article

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Effects of Hypercarbia on Spontaneous Ventilation in Short Laparoscopic Procedures

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Abstract

Context: Carbon dioxide is most commonly used to insufflate the abdominal cavity to facilitate short laparoscopic surgeries, where the real challenge lies in management of pathophysiological changes due to hypercarbia. *Aim:* To study the effects of hypercarbia on respiration in short laparoscopic procedures such on diagnostic laparoscopy and laparoscopic sterilization. *Settings and Design:* An observational study on 60 female subjects aged between 25-45 years presenting for diagnostic laparoscopy forinfertility, laparoscopic sterilization of ASA I & II category. *Methods and Material:* Anaesthesia was given by ketofol Intravenous induction and sevoflurane 1% with CO_2/N_2O insufflation of abdomen. The pre, intra, postoperative pulse, BP, O_2 saturation, Respiratory rate, $EtCO_2$ were noted with special reference to preinsufflation, during insufflation & deflation of abdomen. *Statistical analysis used:* Descriptive analysis was carried out by mean and standard deviation and presented in trend line diagram, error bar diagram for quantitative variables, frequency and proportion for categorical variables. *Results:* Pre anesthesia Respiratory rate was 13.13±1.09. A1.75 time rise was noted in Respiratory rate (24.43±3.42) to maintainnormocarbia during insufflation. *Conclusions:* Spontaneous Ventilation is effective in maintaining normocarbia during short laparoscopic procedures. Endotrachal intubation and paralysis to maintain normocarbia could be avoided.

Keywords: Hypercarbia; Spontaneous Ventilation; Laparoscopic; $EtCO_2$.

Introduction

Laparoscopy involves inspecting the abdominal cavity through an endoscope [1-3]. It provides excellent post-operative conditions [4]. Carbon dioxide is commonly used to insufflate the abdominal cavity [5] in laparoscopy, but the challenge remains in management of hypercarbia [6,7]. Insufflation of peritoneum with carbon dioxide and a trendelenberg position could produce respiratory distress [8-10] which may require Endotracheal intubation and paralysis to maintain normocarbia. A thorough understanding of these pathophysiological changes is fundamental. So, we studied the effects of hypercarbia, CO_2 level variations in short laparoscopic procedures with the objective to document the efficacy of spontaneous ventilation in maintaining normocarbia as it has not been explored before.

Subjects and Methods

We did an observational study on 60 female subjects aged between 25-45 years presenting to Dhanalakshmi Srinivasan Medical College and Hospital, Siruvachur, Perambalur between June 2016-2017 for short laparoscopic procedures lasting less than 30 minutes like diagnostic laparoscopy for infertility, laparoscopic sterilization. The subjects belonged to ASA I & II category with mallampatti airway status I & II. We excluded subjects with

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Difficult airway, Co morbidities, Obesity, who needed Prolonged procedures or intubation or IAP of morethan 12mm Hg. Ondansetron 4mg and Ranitidine 50mg IVwere given as Pre medication one hour before the procedure. Anaesthesia was given by ketofol Intravenous induction and tight fitting 3 size Pvc mask with sidestream probefor $EtCO_2$ monitoring with sevoflurane 1% with CO_2/ N_2O insufflation of abdomen. This necessitates reducing the awareness by sedation and monitoring the $EtCO_2$. The safety of spontaneous ventilation was evaluated in short laparoscopic procedures for less than 30 minutes with a constant intra abdominal pressure of 12mmhg. The pre, intra, post operative pulse, BP, O_2 saturation, Respiratory rate, $EtCO_2$ were noted with special reference to pre insufflation, during insufflation & deflation of abdomen.14 out of 60 left the procedure for surgical reasons (n=7) and prolongation of surgery necessitating tracheal intubation(n = 7). Totally 46 subjects were eligible for final statistical analysis. The data was entered in Microsoft excel and IBM SPSS version 22 was used for statistical analysis. P value < 0.05 was considered statistically significant. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data was also represented using appropriate diagrams like trend line diagram, error bar diagram.

Results

A total of 46 participants were included in the final analysis. The pre anaesthesia mean $EtCO_2$ was 26.48 in the study population. The minimum level was 10 mm Hg and maximum level was 38 mm Hg. The pre anaesthesia mean RR was 13.13 in the study population. The minimum level was 10 and maximum level was. The induction mean $EtCO_2$ was 27.67 in the study population. The minimum level was 22 mm Hg and maximum level was 32 mm Hg. The induction mean RR was 13.89 in the study population.

The minimum level was 10 and maximum level was 16. The pre insufflation mean $EtCO_2$ was 28.43 in the study population. The minimum level was 24 mm Hg and maximum level was 32 mm Hg. The pre insufflation mean RR was 14.28 in the study population. The minimum level was 9 and maximum level was 16. The insufflation mean $EtCO_2$ was 36.91 in the study population. The minimum level was 22 mm Hg and maximum level was 42 mm Hg. The insufflation mean RR was 24.43 in the study population. The minimum level was 12 and maximum level was 28. The deflation mean $EtCO_2$ was 30.61 in the study population. The minimum level was 28 mm Hg and maximum level was 34 mm Hg. The deflation mean RR was 19.91 in the study population. The minimum level was 12 and maximum level was 28. The recoverymean $EtCO_2$ was 26.83 in the study population. The minimum level was 14 mm Hg and maximum level was 30 mm Hg. The recovery mean RR was 16.15 in the study population. The minimum level was 12 and maximum level was 30 (Table 1). The study findings also showed the increase in the spontaneous respiratory rate closely corresponding with the raise in $EtCO_2$ levels (Figure 1 to 3).

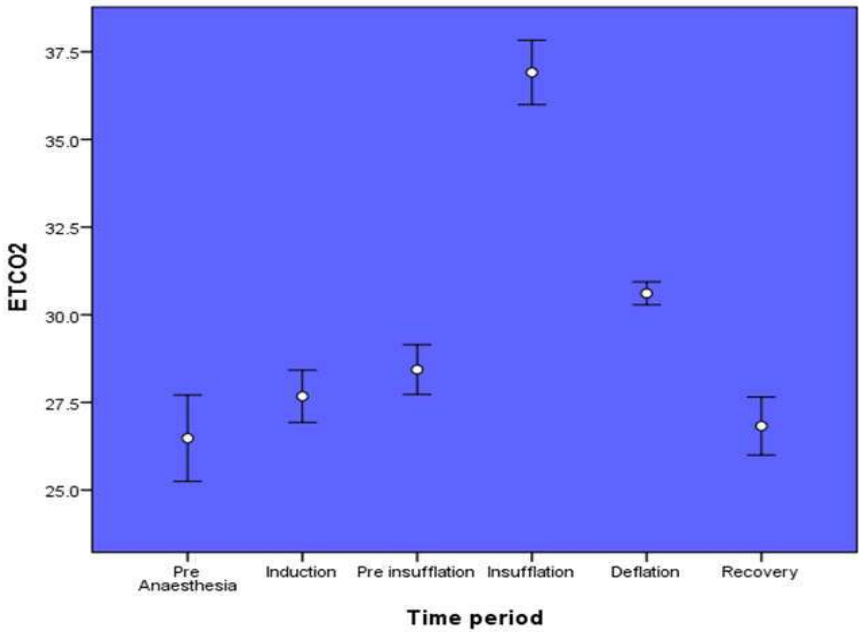

Fig. 1: Error bar chart of comparison of mean different time periods in $EtCO_2$ (N=46)

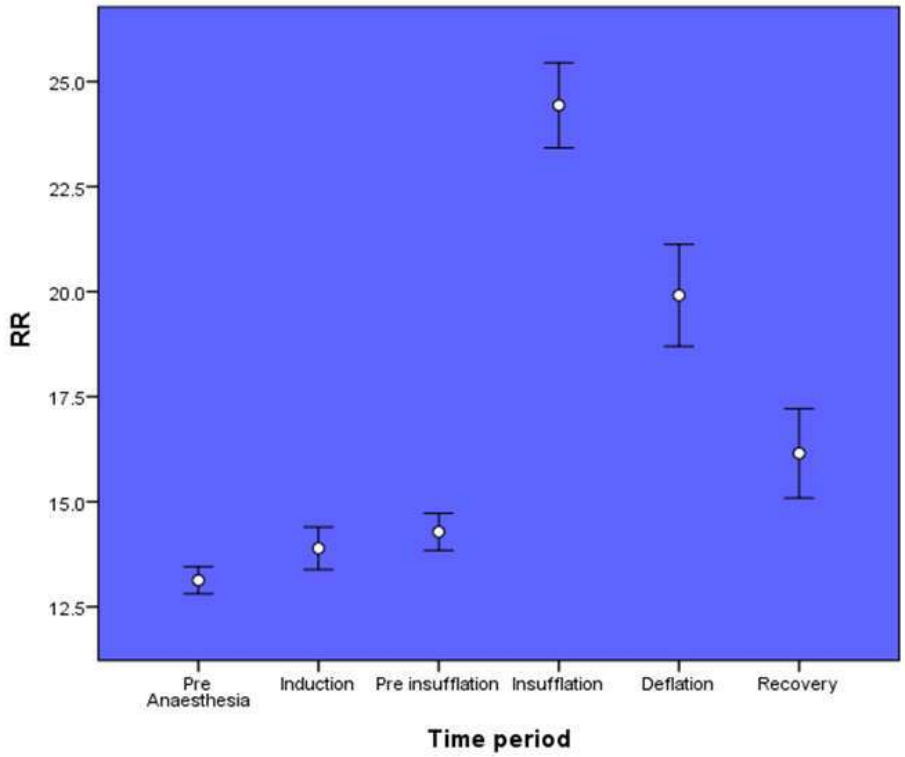

Fig. 2: Error bar chart of comparison of mean different time periods in RR (N=46)

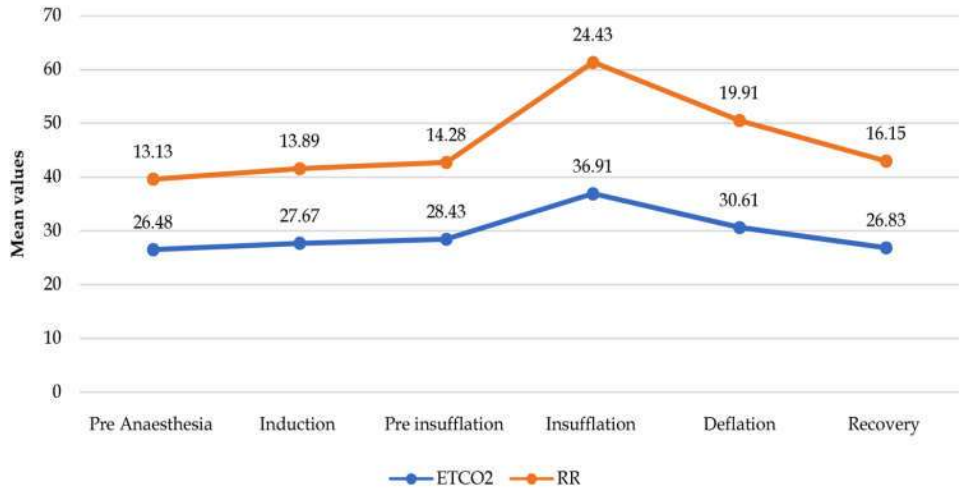

Fig. 3: Trend linefor different time periods in study population (N=46)

Table 1: Descriptive analysis for time periods in study population (N=46)

Time period	Parameter	Mean ±SD	Minimum	Maximum
Pre Anaesthesia	ETCO2 (mm of Hg)	26.48 ± 4.16	10.00	38.00
	RR (per minute)	13.13 ± 1.09	10.00	14.00
Induction	ETCO2	27.67 ± 2.5	22.00	32.00
	RR	13.89 ± 1.7	10.00	16.00
Pre insufflation	ETCO2	28.43 ± 2.39	24.00	32.00
	RR	14.28 ± 1.49	9.00	16.00
Insufflation	ETCO2	36.91 ± 3.1	22.00	42.00
	RR	24.43 ± 3.42	12.00	28.00
Deflation	ETCO2	30.61 ± 1.11	28.00	34.00
	RR	19.91 ± 4.09	12.00	28.00
Recovery	ETCO2	26.83 ± 2.78	14.00	30.00
	RR	16.15 ± 3.58	12.00	30.00

Discussion

Laparoscopic procedures necessitate carbon dioxide insufflation to produce pneumoperitoneum [3,4]. As carbon dioxide is more rapidly soluble in blood than oxygen, hypercarbia is definite and the effects of CO_2 such as peripheral vasoconsiction, hypertension, respiratory compromise in late phases are well known. The factors mainly contributing to the ill effects of hypercarbia are prolonged duration of pneumoperitonum more than 1 ½ to 2 hours and increased intra abdominal pressure of more than 12 mm hg. An increase in end tidal carbon dioxide of more than 20% of pre-insufflations level is associated with increase in respiratory rate of 1.5 to 2 times and is sufficient enough to maintain normocarbia.

$EtCO_2$ is the partial pressure or maximal concentration of carbon dioxide (CO_2) at the end of an exhaled breath, which is expressed as a percentage of CO_2 or mm of Hg [11-13]. In our study, Pre anesthesia Respiratory rate was 13.13±1.09as shown in Table 1. A 1.75 time rise was noted in the Respiratory rate (24.43±3.42) to maintain normocarbia during insufflation as shown in Figure 3.There was also a rise in End Tidal CO_2 pressure from Pre anesthesia levels of 26.48 to insufflation levels of 36.91 mm of Hg as shown in Figure 3. In Gynaecological laparoscopy, Vegfors M et al. (1994) [14] reported that in spontaneous breathing Group, PET CO_2 increased soon after insufflation and remained above 44 mmHg throughout the procedure whereas in controlled ventilation groups all PET CO_2 values were less than 41 mm of Hg. Occasional episodes of arrhythmia were also noticed and hence they concluded that Spontaneous breathing should be avoided in contrast to our study. But our findings suggest that during laparoscopy, ventilation could be well maintained by spontaneous breathing, although there is increase in respiratory work load as indicated by increase in Respiratory rate. We recommend that ventilation and oxygenation should be closely monitored during laparoscopy to avoid hypercapnia and hypoxia.

Nishio I et al (1993) [7] in their study on Forty five women undergoing laparoscopy for gynecological procedure, also observed that ventilation could be well maintained by spontaneous breathing in laparoscopy, although the increase in tidal volume and costal breathing indicate the increase in respiratory work load.

But some authors [15] strongly put forward that End-tidal CO_2 ($PETCO_2$) monitoring may not be a sufficient guide to adjust pulmonary ventilation during laparoscopic surgery, and arterial CO_2 ($PaCO_2$) monitoring is not always indicated. But our study emphasizes the essence of maintaining the hyperventilatiory response to the increase in CO_2 levels in spontaneously breathing patients.

Spontaneous Ventilation is effective in maintaining normocarbia during short laparoscopic procedures. Endotrachal intubation and paralysis to maintain normocarbia could be avoided. There was also no events of Extensive subcutaneous Emphysema in our study as reported by other authors [8,16].

But our study was justified enough only for formulation of Hypothesis and further evidence is required from various RCTs to support and confirm our hypothesis. The smaller sample size and convenient sample used without any comparison is a big limitation of our study. Due to practical and financial reasons, we could not also have a whole picture by including Arterial gas analysis. We mainly demonstrated the effectiveness of spontaneous ventilation in maintaining normocarbia during the short laparoscopic procedures. Our patients were young enough with no comorbidities or airway compromise and the intra-abdominal pressure was kept constant at 12 mm hg and duration of pneumoperitonum never exceeded 30 minutes. Our study also emphasizes the monitoring needs during laparoscopic procedure especially if patients are not given endotracheal general anesthesia. The sedation offered to the patient should be carefully planned and just adequate to maintain the spontaneous breathing drive.

Acknowledgement

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Conflict ofo Interest

None declared

Key Messages

In short laparoscopic surgeries, real challenge lies in management of pathophysiological changes due to hypercarbia. Spontaneous ventilation is effective in maintaining normocarbia during these procedures. Endotracheal intubation and paralysis to maintain normocarbia can be avoided.

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