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# Effects of Co2 Pneumoperitoneum in Patients Undergoing Short Laparoscopic Gynaecology Procedures.

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***Abstract***

***Aims:*** *Laparoscopically performed surgeries have increased manifold as they have provide many advantages when compared to traditional way of performing surgeries. But laparoscopic technique has its own disadvantages, which may be in form of metabolic effects of Co2 pneumoperitoneum. Current observation study was designed for observing metabolic changes in form of Paco2, Etco2, pH and bicarbonate levels in patients undergoing various laparoscopic gynaecological procedures and their effects on patient if any. To ascertain effect of head down, role of lung protective ventilation in managing Paco2 and the need of arterial blood gas monitoring in presence of Etco2 monitoring in laparoscopic gynaecological procedures.*

***Methods:*** *50 ASA 1 and ASA11 patients undergoing short laparoscopic gynaecological procedures lasting upto 60 minutes were selected for this study. Each of them was anaesthetised by standard protocol for general anaesthesia with endotrachial intubation .Surgical technique was uniform in all the cases. Arterial blood gas sampling was done prior to co2 pneumoperitoneum and at intervals of 15minutes and 30 minutes and then in recovery post reversal of pneumoperitoneum and extubation once patient was stable. Variables like Paco2, Etco2, pH and bicarbonate were recorded and analysed statistically for results.*

***Results****: There were significant changes in Paco2, Etco2, pH and bicarbonate at 15 min and 30 min intervals with return to baseline in early post operative period .Changes in variables were in normal range for these variables without any significant effect on patient .Furthermore it was noted that Etco2 varied in accordance to Paco2 thus could be used as surrogate marker of Paco2 in case of arterial blood gas measurement is not available.*

***Conclusion:*** *1.Laparoscopic gynaecological procedures with Co2 pneumoperitoneum results in changes in Paco2, Etco2, pH and bicarbonate, but the changes return to baseline in early post operative period on reversal of Co2 pneumoperitoneum.2. Etco2 monitoring can be used as surrogate marker in short laparoscopic procedures in case arterial blood gas monitoring is not available.3. Lung protective ventilation could be used to manage Paco2 intraoperatively*

***Keywords****: Laparoscopic, pneumoperitoneum, arterial blood gas, end tidal co2, surrogate.*

## I. Introduction

Laparoscopically conducted surgeries have increased manifold in recent years, due to many advantages as compared to surgeries performed by traditional technique .But this technique comes with problems of its own. Complications could be surgical, patient positioning and metabolic due to pneumoperitoneum created during laparoscopic technique[1]

Carbon dioxide (CO2) is the gas that is commonly used to insufflate the abdomen so as to facilitate the surgical view during laparoscopic procedures. Arterial blood gas (ABG ) monitoring to ascertain PaCo2 levels is not routinely done due to non availability of ABG analyzers and the related costs in developing world hospitals. End tidal Co2 measurement may also be not available at times .There is limited data available related to effects of CO2 pneumoperitoneum on Paco2 ,Etco2 ,pH and Hco3, the reliability of EtCO2 monitoring as a surrogate to PaCO2 and effects of head down position during gynaecological laparoscopic procedures if any.

Hence current observational study was carried out to know about these factors.

## II. Material and methods

The present observational study was conducted in Postgraduate Department of Anaesthesiology and Critical Care at SMHS hospital Government Medical College Srinagar after approval by institutional ethical committee.

**Inclusion Criteria**

1. Patients above age of consent (18 years) undergoing elective short laparoscopic gynaecological procedures.
2. ASA I and II patients.

**Exclusion Criteria**
1. Patient's refusal
2. Patients for emergency laparoscopy
3. Obese patients BMI>30
4. Patients who are converted to an open procedure
5. Patients with cardiac disease and COPD
6. Procedures extending more than 60 minutes

In the preoperative assessment, the patients were enquired about any comorbid disease, history of drug allergy, previous operations, loose teeth and artificial dentures or prolonged drug treatment. General physical examination, systemic examinations, and assessment of the airway were done. Preoperative fasting of minimum 8 hours was ensured before operation in all cases. All patients were investigated for CBC, KFT, LFT, ECG and chest X-ray.

On entering in the operative room, standard monitors like ECG, pulse oximeter, non-invasive blood pressure was attached and baseline parameters were recorded. Intravenous access was secured with 18G cannula.Pre-oxygenation was done for three minutes with 100% oxygen. Induction was done by administering propofol (2mg/kg body weight), muscle relaxation was provided by injection atracurium (0.5mg/kg body weight loading dose and maintenance dose of 0.1mg/kg as per the requirement) and then patient was intubated via endotrachial tube of the appropriate size.

Anaesthesia was maintained with 50% nitrous oxide, 50% oxygen and Isoflurane. Injection tramadol 1-2mg/kg along injection paracetamol 1gm/100ml was used for analgesia .Pneumoperitoneum was created with $CO_2$ gas through Veress needle initially at a slow flow (1 L/min) and then faster flow (maximum 20 L/min) to avoid a vasovagal reaction. A target IAP (intra-abdominal pressure) 10-12mmHg once attained with pneumoperitoneum, was maintained with flow of 200ml-400ml/min for all patients throughout the procedure. Surgical technique was uniform in all patients. Patients were ventilated with tidal volume of 8 -10ml/kg and respiratory rate of 14 breaths/minute and $PO_2$, End tidal C02, PaC02, pH, bicarbonate measurement were done before during and after C02 pneumoperitoneum. Most of the procedures in the study group were completed in 30 to 60 min , hence the duration of exposure to co2 was same in most patients.

Ventillatory adjustments were done for end tidal $CO_2$ levels above 55 mmHg or hemodynamic changes attributable to elevated $CO_2$.Arterial blood samples were taken puncturing the left radial artery for arterial blood gas measurements. First sample was taken preoperatively. Second sample at 15min after C02 pneumoperitoneum, third sample after 30 mins and the last/fourth sample was collected in the recovery room fifteen minutes after the patient was extubated and ascertained to be breathing spontaneously and adequately.

## III. Aims and objective

1. To determine the metabolic changes in $EtCO_2$, $PaCO_2$, $HCO_3$, pH in intraoperatively and early post operative period, after Co2 pneumoperitoneum .Pathological effects if any due to such changes in patient undergoing laparoscopic procedures.
2. To observe any influence of high altitude on effects of Co2 pneumopertoneum during laparoscopic gynaecological procedures
3. Role of Etco2 as surrogate marker in place arterial blood gas monitoring is not available
4. Effect of head down position on various metabolic parameteres

## IV. Results and Observations

This observational study was conducted at SMHS hospital of government medical college Srinagar. The study was conducted over a period of one year 50 patients in age group 18-60yrs of ASA (American Society of Anesthesiologists) status 1 and 2 ,scheduled for elective laparoscopic gynaecological procedures were enrolled for the study. The results and observations obtained are depicted in the following tables and graphs.

**Table 1: Age distribution of studied patients**

| Age (years) | No. of Patients | Percentage | Mean±SD |
|---|---|---|---|
| 18-29 | 10 | 20 | 30.4±9.61 |
| 30-39 | 22 | 44 | |
| 40-49 | 14 | 28 | |
| ≥ 50 | 4 | 8 | |
| Total | 50 | 100 | |

Majority of patients belonged to the age group of 30-39 years (44%) with mean and SD30.4±9.61

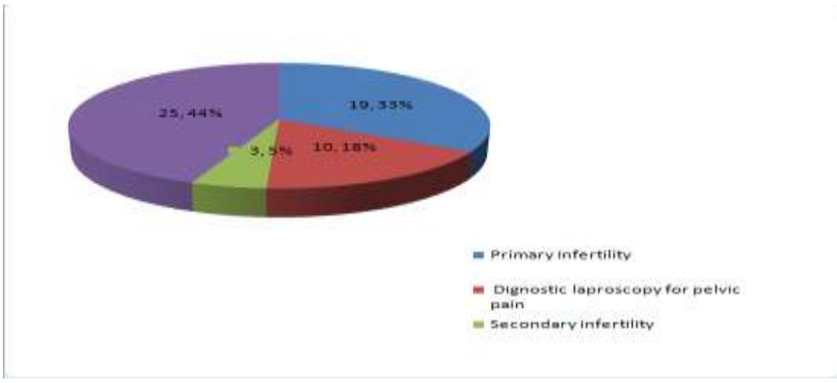


**Figure 1** Chart depicting types of surgeries in patient taken in study

**Table 2:** Showing changes in pH over time

| Time Interval | Mean | SD | Range | P-value |
|---|---|---|---|---|
| Preoperative | 7.41 | 0.024 | 7.35-7.45 | - |
| 15 Min intraoperative | 7.33 | 0.017 | 7.31-7.38 | <0.001* |
| 30 Min intraoperative | 7.27 | 0.018 | 7.24-7.33 | <0.001* |
| Postoperative | 7.40 | 0.017 | 7.34-7.43 | 0.118 |

*Statistically Significant Difference from Baseline (P-value<0.05)

Table 2 shows changes in pH from preoperative to post operative. In pre operative period the pH was within normal range, after 15 mins of CO2 insufflations pH decreased and there was a peak drop in pH at 30 mins, with mean of 7.33 & 7.27 respectively p was statistically significant.

**Table 3:** Showing changes in PCo2 over time

| Time Interval | Mean | SD | Range | P-value |
|---|---|---|---|---|
| Preoperative | 39.54 | 3.065 | 35-45 | - |
| 15 Min intraoperative | 42.82 | 2.775 | 37-47 | <0.001* |
| 30 Min intraoperative | 46.16 | 2.909 | 39-51 | <0.001* |
| Postoperative | 39.82 | 2.716 | 35-45 | 0.093 |

*Statistically Significant Difference from Baseline (P-value<0.05)

Table 3 showing changes in Pco2 after Co2 insufflations which increased at 15 mins & peak at 30 mins with mean & SD 42.82, 2.775 & 46.16, 2.909 respectively was statically significant.

**Table 4:** Showing changes in Etco2 over time

| Time Interval | Mean | SD | Range | P-value |
|---|---|---|---|---|
| After Intubation | 38.66 | 2.818 | 35-45 | - |
| 15 Min intraoperative | 41.56 | 2.287 | 37-46 | <0.001* |
| 30 Min intraoperative | 44.50 | 2.452 | 40-51 | <0.001* |
| After Co2 Desuffalation | 38.90 | 2.468 | 34-44 | 0.103 |

*Statistically Significant Difference from Baseline (P-value<0.05)

Table 4 shows increase in Etco2 which is seen after insufflations of Co2 at 15 mins & peak rise at 30 mins with mean 41.56 & 44.50 respectively value was statically significant.

**Table 5:** Showing changes in HCo3 over time

| Time Interval | Mean | SD | Range | P-value |
|---|---|---|---|---|
| Preoperative | 24.88 | 1.891 | 22-28 | - |
| 15 Min intraoperative | 24.36 | 1.699 | 20-27 | 0.164 |
| 30 Min intraoperative | 23.70 | 1.919 | 19-27 | 0.135 |
| Postoperative | 25.08 | 1.589 | 22-28 | 0.199 |

Table 5 shows changes in Hco3 which decreases over period of time with peak decrease at 30 mins intraoperatively with mean 23.70, SD 1.919 & range 19-27.

## V. Discussion

The mean age of patient was 30 years. Majority of surgeries belonged to laparoscopic ligation followed by diagnostic laparoscopic for infertility. There was no significant hemodynamic changes .Patients with euvolemic status prior to start of surgery have reduced hemodynamic variability due to reduced preload caused by the pneumoperitoneum in laparoscopic abdominal surgeries. Although Hypercarbia has direct and indirect sympathoadrenal stimulating effects on cardiovascular functions also. These effects are not pronounced with mild hypercarbia (PaCO2 45–50 mmHg) whereas moderate to severe hypercarbia affects cardiac function,[2] since it is then a myocardial depressant and has direct vasodilator effect. In the study performed no undue hemodynamic changes directly attributable to hypercarbia or acidosis were recorded and none of the patients required blood transfusion perioperatively. Dexter et al[3] studied two groups of patients, one with pneumoperitoneum with intra abdominal pressure (IAP) of 7 mmHg and the other with IAP of 15 mmHg during laproscopical procedure. It was observed by them that cardiac output and stroke volume were more considerable depressed in the 15 mmHg IAP group. We in our study maintained IAP of 12mmhg which may be the reason there were no significant hemodynamic changes in our study.

In the study performed, metabolic effects of pneumoperitoneum created with Co2 were noted in form of rise in the PaCO2, EtCO2 and a fall in pH signifying hypercarbia and hypercapnia with a resultant respiratory acidosis. PaCO2 (table 3) increased from base line values to 42.86mmhg ±2.775 at 15 min to 46.16mmhg±2.909 at 30, EtCO2 (table 4) from 41.56mmhg at 15min to 44.50mmhg at 30 min respectively and pH (table 2) dropped from 7.33 at 15 minutes to 7.27 at 30 minutes intervals from base line . But the values of Paco2, Etco2 and pH returned to preoperative values in immediate postoperative period. Their appears correlation in change in Paco2 and Etco2 levels ,thus Etco2 may be used as marker of Paco2 change in case arterial blood gas analyser is not available, although ABG may be required for calculating gradient between Paco2 and Etco2 in many patients.

Some researchers suggest that $CO_2$ absorption increases proportionately with the operation time and increase IAP (intraabdominal pressure). However, other reports suggest no proportional relationship between IAP and peritoneal absorption of CO2. [4, 5] In our study most of surgeries were completed in 45 minutes and very few extended to 60 minutes and IAP was targeted around 10 -12mmhg. Several studies have shown the effect of CO2 pneumoperitoneum on the arterial partial pressure of CO2 (PaCO2) and end-tidal CO2 (EtCO2).Octavio Hypolito[6] et al noted statistically significant differences in MAP (mean arterial pressure), pH, HCO3 and base excess using IAP of 20mmhg during creation of pneumoperitoneum, they concluded that high and transient intra-abdominal pressure causes changes in MAP, pH, HCO3 and BE, but without any clinical impact on the patient. Our results were in accordance with their study, although in our study there was fall in pH from normal values which was not the case in the study mentioned above.

Nihat Aksakal et al[7], evaluated either low (8 mmHg) or high (14 mmHg) IAP pneumoperitoneum pressures in laparoscopic cholecystectomy and noted that respiratory acidosis may occur due to decreased compliance and pneumoperitoneum especially during high intraabdominal pressures. Results showed that performing laparoscopy with lower pneumoperitoneum pressures decreases these adverse effects, especially in patients with cardio-pulmonary comorbid disease. Wittgen et al[8] found that patients with normal cardio-respiratory system had increased EtCO2 and PaCO2, with decreased pH values in a study comparing ventillatory effects of laparoscopic cholecystectomy. The maximum rate of increase in this study occurred at 30 minutes of insufflations same was the case in our study.

The rapid rise from the initial carbon dioxide load may be due to the delayed equilibration of the carbon dioxide between the blood and other tissues, considering that the bone which is the biggest buffer has relatively poor blood supply. $CO_2$ elimination occurs directly from lungs by ventilation. Elimination is directly proportional with cardiac output and ventilation rate.[7] insufficient ventilation may cause hypercapnia and acidosis.[9]. Persistent hypercapnia induces renal response including $H^+$ secretion from renal tubule and bicarbonate passage into the extracellular zone. As almost all $CO_2$ is eliminated during laparoscopy, compensatory hyperventilation is required in order to prevent hypercapnia and acidosis.[7]

There was a significant decrease in bicarbonate intraoperatively with peak drop at 30 minute interval (Table 5).Bicarbonate concentrations as low as 19mmol/L was observed.

Some experimental and clinical studies suggest that abdominal pressure formed by $CO_2$ changes ABG towards acidosis and hypercapnia [(, 10, 11, 12.13)]. Although the mechanisms causing these changes are still unclear, predominant opinions suggest acidosis associated with trans-peritoneal $CO_2$ absorption rather than negative effects of increased IAP on ventilation [(14, 15)].

## Conclusion and Recommendations

This study was carried in genetically and geographically different set of population living comparatively higher altitude (5500 ft above sea level). Their response to Co2 pneumoperitoneum was similar to studies performed at other places.

EtCO2 monitoring can be safely used as a surrogate monitoring of PaCO2, if ABGs (arterial blood gas) measurement are not available, however ABG if available should be done to ascertain the PaCO2-EtCO2 gradient during C02 pneumoperitoneum.

This study emphasised that $PaCO_2$ levels could be controlled by increasing respiratory rate rather than increasing tidal volume, due to proven benefits of low volume lung protective ventilation during $CO_2$ pneumoperitoneum within the limits of permissive hypercapnia.

**Limitations**

1. We could not measure the influence of duration of surgery and amount of C02 exposure, as our study was limited to short gynaecological procedures thus, a study including longer duration laproscopical gynaecological procedure would be needed in order to analyse these effect.
2. Measurements of lactate, urea, other electrolytes and albumin and calculation of the anion and osmolar gaps would be recommended to access their influence.
3. Longer term follow up of the patients after the surgery may be needed to review the pulmonary and metabolic consequences of $CO_2$ pneumoperitoneum along with effect of low tidal volume ventilation during laparoscopic procedures**.**

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