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# A PROSPECTIVE, RANDOMIZED STUDY TO ASSESS THE EFFECT OF PNEUMOPERITONEUM ON ARTERIAL AND ENDTIDAL CARBONDIOXIDE PRESSURE GRADIENT DURING LAPAROSCOPIC SURGERY IN ADULTS

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## ABSTACT

**Introduction:** During laparoscopic surgery, Carbondioxide pneumoperitoneum is created resulting in hypercarbia which has complex effects on various systems of our body. Cholecystectomy, appendectomy, colectomy, Roux-en-Y gastric bypass, sleeve gastrectomy, and hysterectomy are some of the most common surgical procedures done using laparoscopic surgery each year in the United States. Laparoscopic surgery has a low overall mortality rate, 0.3% to 1.8%, however it's usual practise to evaluate the risk of perioperative cardiovascular events during preoperative consultation.

**Aims:** To assess the effects of pneumoperitoneum on arterial and end tidal carbondioxide pressure gradient during laparoscopic surgery in adults.

**Materials and Methods**: The present study was an Observational study. This Study was conducted from February 2021- March 2023 at Dept. of anesthesiologist. Total 60 patients were included in this study.

**Results:** Our study demonstrates that the intra-abdominal pressure of 12 mmHg maintained for laparoscopic surgery induces hemodynamic changes characterized by increase in heart rate, mean arterial blood pressure, peripheral vascular resistance.

**Conclusion:** We have shown that abdominal carbon dioxide insufflation during laparoscopic cholecystectomy or appendicectomy generates increases in ETCO2 and PaCO 2 that are considerably larger than preinsufflation values but still within physiological range.

**Keywords:** Pneumoperitoneum, Surgery, laparoscopy. Carbon dioxide and Cardiorespiratory system.

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## INTRODUCTION

Cholecystectomy, appendectomy, colectomy, Roux-en-Y gastric bypass, sleeve gastrectomy and hysterectomy are some of the most common surgical procedures done using laparoscopic surgery each year in the United States.[1] Laparoscopic surgery has a low overall mortality rate, 0.3% to 1.8%, however it's usual practise to evaluate the risk of perioperative cardiovascular events during preoperative consultation. [2,3] Higher risk patient populations, such as the elderly, obese individuals, and those with underlying illnesses, such as cardiovascular and pulmonary disorders, typically have laparoscopic surgery. The Revised Cardiac Risk Index and other commonly used risk assessment instruments have not been validated in patients having laparoscopic surgery.[4]

The American College of Surgeons' National Surgical Quality Improvement Program Myocardial Infarction or Cardiac Arrest score, for example, accounts for differences in surgical procedures based on organ system; analyses limited to risk prediction in laparoscopic patients have not yet been published. Newer scores have been studied in patients undergoing open or laparoscopic surgery.[5]

- Laparoscopy is a minimally invasive surgery allowing endoscopic access to peritoneal cavity after insufflation of gas to create a space between anterior abdominal wall and viscera for safe manipulation of instruments and organ.
- Hans Christian Jacobaeus of Sweden performed the first laparoscopic surgery on humans in 1910.The provision of better equipment and facility with increased knowledge and understanding of anatomy and pathology, has allowed the development of endoscopy for diagnostic and operative procedures.
- Laparoscopy was initially confined to gynaecological surgeries in 1970. In late 1980 it was extended to laparoscopic cholecystectomy, now a days laparoscopy is used in colonic, gastric ,splenic ,hepatic and urologic surgeries.
- Reduction of post-operative pain and ileus, better cosmetic results, less hospital stay less post-operative atelectasis , and wound infection are the advantages of laparoscopy.

## MATERIALS AND METHODS

**Study Design:** Observational study

**Study area:**

**Sample Size:** 60

**Department:** Anesthesiologist

**Study Duration:** February 2022 to February 2023

**INCLUSION CRITERIA**

- ASA physical status 1and 2
- Patients undergoing laparoscopic cholecystectomy or laparoscopic appendectomy.
- SURGERY:elective.

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- Weight : BMI < 25 kg/m2
- Patient who has given valid informed consent.

**EXCLUSION CRITERIA**

- Patient not satisfying inclusion criteria .
- History of haemorrhagic diathesis and clotting disorder.
- Patients suffering from respiratory disease like chronic bronchitis, emphysema, bronchial asthma , respiratory failure.
- Congestive heart failure
- Renal failure
- Known allergy or sensitivity to the drugs
- Patient posted for emergency procedure.

## RESULT AND DISCUSSION

During laparoscopic surgery, carbon dioxide pneumoperitoneum is created resulting in hypercarbia which has complex effects on various system of our body.

**HEMODYNAMIC EFFECTS**

Our study demonstrates that the intra-abdominal pressure of 13 mmHg maintained for laparoscopic surgery induces hemodynamic changes characterized by increase in heart rate, mean arterial blood pressure , peripheral vascular resistance.

These extreme changes are seen in cardiopulmonary insufficiency patient.

Similarly,[6] JORIS et al Both mechanical and humoral variables contribute to the rise in systemic vascular resistance, as was shown during laparoscopic surgery. He said that a decrease in venous return or an increase in systemic vascular resistance are what lead to a drop in cardiac output.

Both mechanical and humoral variables contribute to the rise in systemic vascular resistance, as was shown during laparoscopic surgery. He said that a decrease in venous return or an increase in systemic vascular resistance are what lead to a drop in cardiac output.

When the normal heart is exposed to pneumoperitoneum, it appears that the normal heart, which can tolerate an increase in after load relatively readily, becomes sensitive to changes in afterload like a compensated heart.

These findings point to the need for care in patients planned for laparoscopic surgery who have compromised cardiac function, anemia, or hypovolemia.

These data suggest that it is prudent to reduce the rate of insufflation and limit abdominal inflating pressures to minimum Also [7] V.MURALIDHAR studied physiology of pneumoperitoneum and anaesthesia in laparoscopic surgery. He postulated increased systemic vascular resistance, increased mean arterial pressure, minimal increase in heart rate during pneumoperitoneum.

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**HEART RATE**

**Statistical significance:** The mean heart rate pre insufflation was 78.83, and 20 minutes after insufflation was 82.78 .and p-values is less than 0.05, thus statistically significant.

**Clinical significance;** Caused by CO2 pneumoperitonum, which was in accordance to [6] JORIS et al and [7] MURALIDHAR et al.

**SYSTOLIC BLOOD PRESSURE**

The mean systolic blood pressure before insufflation is 118.63 mmHg, while the mean systolic blood pressure during insufflation is 125.17 mmHg. The statistically insignificant p value is 0.230.

Similarly,[8] GUPTA SHOBHANA et al studied the modifications to critical indicators during laparoscopic surgery. Systolic blood pressure fluctuated between 127.56 and 6.46 mm Hg preoperatively and 129.56 and 8.66 mm Hg after surgery, with a p value of 0.1346 that is not statistically significant. This outcome was consistent with our research.

**DIASTOLIC BLOOD PRESSURE**

The mean diastolic blood pressure is 71.80 mmHg before CO2 pneumperitoneum and 78.13 mmHg during the insufflation. And p value of 0.00, statistically significant.

[8] GUPTA SHOBHANA et al also studied diastolic blood pressure changes, which was 77.48 □ 3.44mmHg preoperatively and 81.08±3.566 mmHg postoperatively, the p value was 0.004 statistically significant, this result was similar to our study have the p value was 0.00 , highly significant. But it was clinically normal range.

**MEAN ARTERIAL BLOOD PRESSURE**

There is statistically significant (p-value 0.00) increase in mean arterial blood pressure during pneumoperitoneum. The mean preinsufflation mean arterial blood pressure was 87 mmHg and 20 minutes after insufflation was 93.790 mmHg, which is in accordance with [6] JORIS et al.

Alterations in cardiac rhythm may also be seen during laparoscopy and are related to increased intra-abdominal pressure, hypercarbia and surgical stimulation. As we maintained the intra-abdominal pressure between 10-13 mmHg, none of the patients developed intra operative arrhythmias.

[10] WITTGEN et al studied that patients with preoperative cardiopulmonary disease showed significant increase in arterial blood pressure and decrease in pH during CO2 pneumoperitoneum compared with patients without underlying disease. So we included patients with stable cardiac status and excluded patients with compromised cardiopulmonary function.

**RESPIRATORY SYSTEM**

[32]TAN and et al, proposed an increase in tidal volume rather than respiratory rate controls hypercarbia efficiently . Also [32] P.L.TAN , T.L.LEE, et al demonstrated an increase in tidal volume is sufficient to eliminate excess CO2 and maintain normal pulmonary oxygenation. Therefore, in our study we maintained tidal volume 10 ml /kg.and respiratory rate 12-15 /min.

**ETCO2 AND PaCO2**

ETCO2 increased from 33.77 to 38.08 mmHg, and PaCO2 increased from 37.52 to 41.36 mmhg respectively during the procedure, and the p value was < 0.05 for both. Thus it is statistically significant, but the ETCO2 and the PaCO2 were under clinically normal range . According to [12] MULLET et al rapid rise in PaCO2 and ETCO2 occurs within 10 minutes of insufflation. So we took data after 20 minute CO2 insufflation.

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Similar to the findings of [12] MULLET et al , In our investigation, during CO2 insufflation, ETCO2 and PaCO2 gradually increased. The rate of rise in CO2 peaked in the first 20 minutes, following which it plateaued and remained constant for the next 15 to 45 minutes.

A correlation between PaCO2 and ETCO2 was observed in our study, this is similar to findings of [13] NYARWAYA et al who also noted a correlation between the PaCO2 and ETCO2.

[27] P.PELOSI et al During laparoscopic surgery, it was discovered that abdominal insufflation significantly reduces the static compliance of the chest wall, lungs, and respiratory system, as well as lung capacity. On the other hand, PETCO2 and PaCO2 closely correspond during laparoscopy. P(a-et)co2 gradient remained unchanged as a result. During abdominal insufflation, oxygen saturation did not change considerably.

**P(a-ET ) GRADIENT**

Prior to insufflation, the mean difference between the PaCO2 and ETCO2 pressure gradients was 3.75 mmHg, whereas the mean difference between the two pressure gradients following pneumoperitoneum was 4.28 mmHg. The pressure gradient in healthy people with a normal ventilation-perfusion ratio is 3-6 mmHg. PaCO2 and ETCO2 gradient's p value was 0.008, which is statistically significant. Despite being statistically significant, the p value is still within the normal physiological range.

**pH AND BICARBONATE**

The mean pH before pneumoperitoneum was 7.50 and the mean pH after pneumoperitoneum was 7.36. pH significantly decreases after 15 minutes, and the p value is 0.00 , less than 0.05. statistically significant.

The mean bicarbonate before and during CO2 insufflation is 26.05 mmHg and 24.52 mmHg .and the p value is 0.30 , statistically insignificant. 31 Se-yuan Liu et al demonstrated that ETCO2 and PaCO2 increased from 31.5 ±0.7 mmhg to 42.2±1.7 mmhg and 33.4 ±0.8 mmhg to 43.8±1.3 mmhg respectively, during the course of the procedure. Arterial p H decreased from 7.44±0.02 mmhg to 7.34±0.01 mmHg, while bicarbonate concentration remain same, similar to our study.

**PEAK AIRWAY PRESSURE**

The mean peak airway pressure before insufflation was 15.47 cmH20 and the mean of peak airway pressure after pneumoperitoneum was 18.32 cmH2O. The p value is 0.00 (<o.05) statistically significant.

## CONCLUSION

We have shown that abdominal carbon dioxide insufflation during laparoscopic cholecystectomy or appendicectomy generates increases in ETCO2 and PaCO 2 that are considerably larger than preinsufflation values but still within physiological range. Throughout the insufflation period, a link between the PaCO2 and ETCO2 was seen.With the caveat that the physician is aware of an elevated P (a-ET) CO2 gradient which represents lower cardiac output, ETCO2 can be utilised as an indicator of PaCO2. Even after CO2 pneumoperitoneum in ASA 1 and 2 patients, the arterial and end tidal carbon dioxide pressure gradients remain below the usual limits. The normal pressure P (a-ET)CO2 gradient denotes appropriate perfusion and ventilation of the alveoli;(blood flow to pulmonary capillaries). According to these findings, laparoscopic surgery performed on ASA1 and ASA2 patients may be monitored for CO2 excretion and arterial oxygenation using endtidal capnography and pulse oximetry as non-invasive procedures.

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**TABLE**

**PaCO2 – ETCO2GRADIENT AFTER CO2 INSUFFLATION**

| | | |
|---|---|---|
| N | Valid | 60 |
| | Missing | 0 |
| Mean | | 4.28 |
| Std. Deviation | | .936 |

**PEAKAIRWAY PRESSURE BEFORE C02 INSUFFLATION**

| | | |
|---|---|---|
| N | Valid | 60 |
| | Missing | 0 |
| Mean | | 15.47 |
| Std. Deviation | | 2.0 |

**PEAKAIRWAY PRESSURE AFTER CO2 INSUFFLATION**

| | | |
|---|---|---|
| N | Valid | 60 |
| | Missing | 0 |
| Mean | | 18.32 |
| Std. Deviation | | 1.936 |