

# Cardiac and Hemodynamic Changes during Carbon Dioxide Pneumoperitoneum for Laparoscopic Gynecologic Surgery in Rajavithi Hospital

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**Objective:** To study the effects of intraperitoneal CO<sub>2</sub> insufflation on cardiopulmonary variables in gynecological laparoscopic patients.

**Material and Method:** A prospective descriptive study of BP, HR, End tidal CO<sub>2</sub>, and Sat O<sub>2</sub> in 30 gynecologic patients who underwent laparoscopic surgery between 1 September 2006 and 30 July 2007.

**Results:** Blood pressure increased in the early state. The End tidal CO<sub>2</sub> significant increased during surgery. Heart rate and Sat O<sub>2</sub> did not change. At completion of the laparoscopic intervention, physiological variables exhibited a trend to baseline values.

**Conclusions:** This prospective descriptive study documents significant changes in systemic hemodynamic variables that seem to be directly associated with the insufflation of CO<sub>2</sub> during gynecologic intraperitoneal laparoscopic surgery. This ongoing evaluation confirms the effect of gynecological laparoscopic surgery and CO<sub>2</sub> insufflation on cardiopulmonary function in patients

**Keywords:** Laparoscopy, Intraperitoneal space, Gynecologic, Hemodynamic processes, Pneumoperitoneum

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Following the revolution of laparoscopy in adults, gynecological laparoscopic techniques have been progressively and successfully introduced into woman practice. The gynecological laparoscopic surgery has various techniques e.g. gasless technique, CO<sub>2</sub> intraperitoneal technique. CO<sub>2</sub> intraperitoneal technique is the most popular. The high intraperitoneal pressure and head down position effect to the increasing risk of hemodynamic and respiratory system. There were some reports of the death of patients from complications of CO<sub>2</sub> embolization and other from operation.

There are many studies of hemodynamic change with the insufflation of CO<sub>2</sub> during laparoscopic surgery. CO<sub>2</sub> pneumoperitoneum has been shown to produce respiratory and hemodynamic changes due to

both CO<sub>2</sub> absorption and the effects of increased intraperitoneal pressure<sup>(1,2)</sup>. It was found that CO<sub>2</sub> insufflation in laparoscopic surgery could affect cardiopulmonary function significantly in end-tidal pressure of CO<sub>2</sub> (ETCO<sub>2</sub>), peak airway pressure and mean arterial pressure (MAP)<sup>(2-4)</sup> but for the heart rate and body temperature could not find the difference<sup>(5)</sup>. The higher level of ETCO<sub>2</sub>, Peak inspiratory pressure, and total exhaled CO<sub>2</sub> per minute, and a lower respiratory compliance was found in laparoscopic gastric bypass procedure compared to open procedure. Arterial blood gas analysis demonstrated higher PaCO<sub>2</sub> and lower pH during laparoscopic procedure than during open procedure<sup>(3)</sup>. There was a rapid rise in PaCO<sub>2</sub> over the first 15-20 min, followed by a second phase of only gradual change<sup>(1)</sup>. The ETCO<sub>2</sub> returned to baseline within 10 minutes after completion of the laparoscopy<sup>(6)</sup>. End-systolic and end-diastolic diameters of the left ventricle, contractility, and performance parameters of

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the heart did not change significantly with trans-esophageal echocardiography in laparoscopic cholecystectomy cases<sup>(7)</sup>.

The present study investigated the physiological impact of such an approach, recognizing that any potential benefit has to be counterbalanced against potential difficulties that may not be present with conventional open surgery for benefit and better management of patients in the future.

### Material and Method

The authors prospectively evaluated a consecutive series of patients enrolled between November 2006 and March 2007. Anesthesia was administered following a standardized protocol. Data collection included heart rate, End tidal CO<sub>2</sub>, O<sub>2</sub> saturation, mean arterial blood pressure. All variables were recorded before, during and after CO<sub>2</sub> insufflation. The authors studied 30 nonpremedicated patients with American Society of Anesthesiologists physical status I and II undergoing elective laparoscopic intervention who successfully completed the surgery with no immediate apparent surgical complications. Specifically, patients with known condition problems were not included in the analysis.

A standard anesthetic regimen was used on all patients. Induction was achieved using NO<sub>2</sub>, isoflurane, and thiopental during which, peripheral intravenous access was obtained. Rocuronium was administered intravenously to facilitate tracheal intubation. Repeat doses of rocuronium were administered as required to maintain neuromuscular blockade. To block the cerebral and systemic response to surgical stimulation, remifentanyl was administered. Intraoperative fluid replacement was provided with lactated Ringer solution.

The subjects were supine for induction and emergence from anesthesia, remaining in a flexed lateral decubitus position during laparoscopic intervention. None of the patients received medications aimed at controlling blood pressure or heart rate (i.e. antihypertensive drugs, Beta-blockers) at any time during the study period.

### Surgical technique

Laparoscopic intraperitoneal access was gained as previously described. Briefly, the patient was placed in a reversed Trendelenburg position. Intraperitoneal access was achieved through open placement of the first trocar at the lower border of the umbilicus. Insufflation CO<sub>2</sub> pressure was maintained constant at

15 mmHg. At the end of the procedure, after ensuring hemostasis, the gas was completely evacuated from the peritoneal cavity from the abdominal cavity before trocar removal. None of the study patients had evidence of gas leak into the subcutaneous layer from an inadvertent opening in the peritoneum, although small undetected tears in the peritoneal membrane could have occurred during laparoscopic dissection. None of the procedures had to be converted to open surgical intervention.

### Data collection

Non invasive blood pressure measurements, heart rate, end tidal CO<sub>2</sub> respiratory rate, and pulse oximetry were recorded at each stage. The standardized anesthesia monitoring protocol parameters have been found to monitor homeostasis reliably during laparoscopic surgery.

### Statistical analysis

Demographics and data with parametric values are presented as mean  $\pm$  SD. It was determined that at least 30 patients would be required for the present study. Within subjects, parametric data were analyzed by ANOVA with repeated measurement and t-test for multiple comparisons with baseline values. The dependent physiological variable was analyzed at four different points in time, namely before insufflation, during the first 10 minutes of pneumoperitoneum (measurements obtained every 2 minutes) for the remaining laparoscopic part of the procedure (measurements obtained every 5 minutes), and after evacuation of the carbon dioxide. A p-value of less than 0.05 was accepted for statistically significant.

### Results

The age of the patients was 24 to 76 years (mean = 37 years). The body mass index was 16.7-32 kg/m<sup>2</sup> (mean = 22 kg/m<sup>2</sup>) (Table 1). The operative time was 15 minutes to 2 hours (mean 65 minutes). Operative time varied depending on the types of operation. The short operative time cases were diagnostic laparoscopy while the long operative time cases were adhesiolysis,

**Table1.** Age groups and body mass index of the patients

| Age groups | n  | Percent | BMI (kg/m <sup>2</sup> ) | n  | Percent |
|------------|----|---------|--------------------------|----|---------|
| < 30       | 6  | 20.0    | < 25                     | 22 | 73.3    |
| 30-50      | 20 | 66.6    | 25-29.9                  | 6  | 20.0    |
| > 50       | 4  | 13.3    | > 30                     | 2  | 6.6     |

**Table 2.** Cardiorespiratory data before, during and after CO<sub>2</sub> insufflation in an extraperitoneal laparoscopy cohort

| Parameter                        | Mean (SD) / p-value             |  |  |                    |
|----------------------------------|---------------------------------|--|--|--------------------|
|                                  | Before insufflation (base line) | First 10 mins insufflation (every 2 min measurement) | Remaining insufflation (every 5 min measurement) | After desufflation |
| Mean arterial pressure (mmHg)    | 91 (10.66)                      | 105 (18.66) /0.005                                   | 108 (4.08) /0.32                                 | 94 (9.66) /0.18    |
| Heart rate (beats/min)           | 87 (16.72)                      | 89 (14.42) /0.22                                     | 89 (13.82) /0.46                                 | 84 (13.45)/0.06    |
| End tidal CO <sub>2</sub> (mmHg) | 29 (5.52)                       | 31 (6.01) /0.00                                      | 38.7 (1.57)/0.03                                 | 31 (6.21) /0.02    |
| Sat O <sub>2</sub> (%)           | 99 (0.55)                       | 99.5 (0.75)/0.59                                     | 100 (0.00) /0.58                                 | 100 (0.55) /0.06   |

ovarian cystectomy, and total laparoscopic hysterectomy, etc. Laparoscopic intervention was completed successfully in all enrolled patients and there was no conversion to exploratory laparotomy. None of the patients was noted to have pneumothorax or significant subcutaneous emphysema.

The end tidal CO<sub>2</sub>, mean BP, heart rate and Sat O<sub>2</sub> before during and after CO<sub>2</sub> insufflation are shown in Table 2 and Fig. 1.

The mean of blood pressure changed mostly in the first 10 minutes. After this stage until evacuation of CO<sub>2</sub> from the abdominal cavity, blood pressure did not have any significant changes.

The heart rate before, during and after CO<sub>2</sub> insufflation had no significant change in the present study. The present study showed that blood pressure in the early stage did not have any correlations with heart rate even when the blood pressure increased significantly in the early stage.

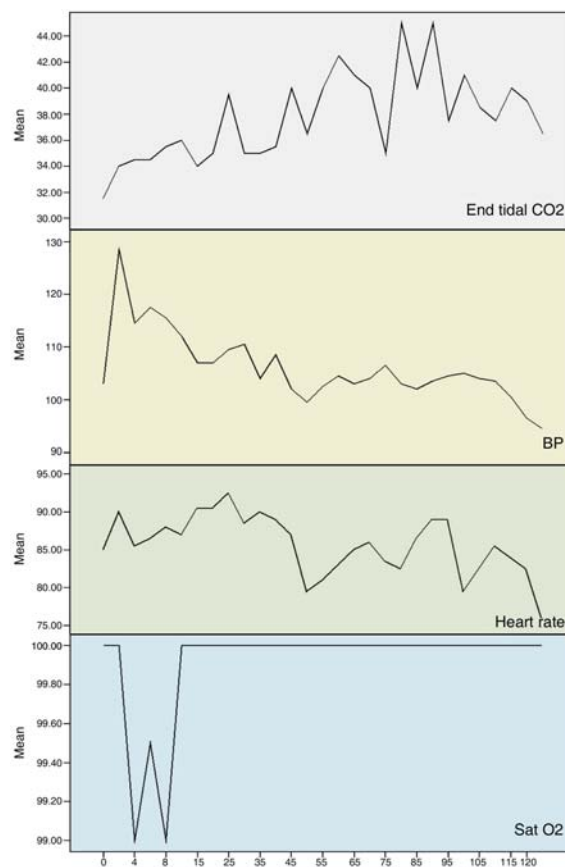
The end tidal CO<sub>2</sub> had significant change during the first 10 minutes of CO<sub>2</sub> insufflation compared to base line and at evacuation of CO<sub>2</sub> from peritoneum.

The Sat O<sub>2</sub> was increased in the early stage of the operation. There was no significant change during and after CO<sub>2</sub> insufflation.

### Discussion

Most problem needed laparoscopic surgery for endometriosis and myoma uteri, showing that most of the age groups were in the reproductive age. The body mass index of this group was mostly within normal limits. Because high body mass index could increase the risk of surgery, it was one of the factors for patient's recruitment. Carbon dioxide pneumoperitoneum has been shown to produce respiratory and hemodynamic changes due to both CO<sub>2</sub> absorption and the effects of increased intraperitoneal pressure<sup>(1)</sup>.

Pneumothorax and subcutaneous emphysema were confounding factors that can affect the rate of CO<sub>2</sub> elimination, which will affect measuring parameters. CO<sub>2</sub> insufflation caused decreasing of cardiac output and affected the cardiovascular system. The end tidal CO<sub>2</sub>



**Fig. 1** The end tidal CO<sub>2</sub>, mean BP, heart rate and Sat O<sub>2</sub> before during and after CO<sub>2</sub> insufflation

had significantly changed just after CO<sub>2</sub> insufflation, similar to a former study<sup>(3,4)</sup>. Blood pressure increased in the early stage of the operation due to increasing of intraperitoneal pressure from CO<sub>2</sub> insufflation. The effect of intraperitoneal pressure increment and reversed Trendelenberg position of the patient affected the decrease of cardiac output due to a decrease in the blood flow back to the heart. After this stage, blood pressure did not have significant changes. The present result was similar to an earlier study<sup>(5)</sup>. It was found that extraperitoneal CO<sub>2</sub> insufflation had lesser effect on mean blood pressure than intraperitoneal CO<sub>2</sub> insufflation, so extraperitoneal or gasless technique may be safer in patients with preexisting cardio respiratory disease<sup>(1,2)</sup>. The present study and other's showed that blood pressure did not have any correlation with heart rate even when the blood pressure increased significantly in the early stage<sup>(5)</sup>.

In summary, this descriptive prospective study documents significant changes in cardio-respiratory parameters during CO<sub>2</sub> insufflation. The end tidal CO<sub>2</sub> was significantly increased during the operation. The blood pressure was significantly increased in the early stage of the operation and had no correlation with the heart rate. The SatO<sub>2</sub> was stable before and during the operation. The present study shows that parameter had no significant effect on the patients.

The authors used the prospective data collection under a standardized anesthesia protocol. However, there was a relatively low number of patients and a strict inclusion criteria of only the low risk population. For future study, expanding the inclusion criteria and gathering more data should give the authors more information for the best patient care in the future.

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**ผลกระทบที่มีต่อระบบหัวใจและหลอดเลือดจากการใส่ก๊าซคาร์บอนไดออกไซด์ในการผ่าตัดผ่านกล้องส่องช่องท้องทางนรีเวชในโรงพยาบาลราชวิถี**

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**วัตถุประสงค์:** เพื่อศึกษาการเปลี่ยนแปลงของระบบหัวใจและหลอดเลือดจากการใส่ก๊าซคาร์บอนไดออกไซด์เข้าช่องท้อง ในการผ่าตัดผ่านกล้องทางนรีเวชในโรงพยาบาลราชวิถี

**วัสดุและวิธีการ:** ศึกษาการเปลี่ยนแปลงของความดันโลหิต อัตราการเต้นหัวใจ ความดันก๊าซคาร์บอนไดออกไซด์ ขณะหายใจออกและค่าออกซิเจนในกระแสเลือด ของผู้ป่วยนรีเวชที่ได้รับการผ่าตัดผ่านกล้องส่องช่องท้องโดยเทคนิคใส่ก๊าซคาร์บอนไดออกไซด์เข้าช่องท้องจำนวน 30 คน แบบ prospective ตั้งแต่วันที่ 1 พฤศจิกายน พ.ศ. 2549-30 เมษายน พ.ศ. 2550

**ผลการศึกษา:** พบว่าความดันโลหิตเพิ่มขึ้นในช่วงแรก ส่วนความดันก๊าซคาร์บอนไดออกไซด์มีการเพิ่มขึ้นตลอดระยะเวลาผ่าตัด ส่วนอัตราการเต้นหัวใจและค่าออกซิเจนในกระแสเลือดพบว่าไม่มีการเปลี่ยนแปลงชัดเจน หลังการผ่าตัดเสร็จสิ้นค่าตัวแปรทั้งหมดมีแนวโน้มที่จะกับสู่ค่าก่อนใส่ก๊าซเข้าช่องท้อง

**สรุป:** การศึกษานี้เป็นการศึกษาเชิงพรรณนา พบมีการเปลี่ยนแปลงอย่างชัดเจนในระบบหัวใจและการหายใจ ซึ่งสัมพันธ์กับการใส่ก๊าซคาร์บอนไดออกไซด์เข้าช่องท้อง ในผู้ป่วยที่ทำการผ่าตัดผ่านกล้องส่องช่องท้องทางนรีเวช

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