Arterial carbon dioxide (PaCO$_2$) is the most important determinant of blood pH, so its changes can cause many disorders for patients. Since the probability of this change was high during anesthesia and it's not possible to monitor PaCO$_2$ directly, during anesthesia, ET-CO$_2$ expiratory CO$_2$ pressure monitoring is used to estimate PaCO$_2$. It is nowadays one of the standard monitoring methods during anesthesia and is often used as a non-invasive procedure for patients during anesthesia as well as in recovery and intensive care units.

According to the ASTM International (formerly known as American Society for Testing and Materials), the measurement of CO$_2$ pressure is now mandatory monitoring and capnography is a standard anesthesia monitoring.$^6$ Continuous measurement of exhaled CO$_2$ is one of the methods that are used in the operating room for evaluation during anesthesia and in patients intubated in the tracheal intubation. But this approach can even be a non-invasive, rapid, and reliable method for predicting PaCO$_2$ in non-intubated patients.$^9$ This measurement enables the estimation of PaCO$_2$ pressure without the need for arterial blood sampling. If there is a consistent relationship between the CO$_2$ pressure and the arterial end, this method is reliable and there will be no need for repeated arterial blood sampling.$^{10, 11}$ So, the aim of this paper is to determine the end-expiratory dioxide pressure in gallbladder laparoscopic surgery and compares it with the PaCO$_2$ pressure.

Methods and Materials
This cross-sectional study was performed on 30 patients undergoing laparoscopic cholecystectomy. They were randomly assigned to Kowsar Hospital of Semnan, Iran in 2018–2019. All stages of the study were approved by the Research
and Ethics Committee of Kowsar Hospital in Semnan. All patients underwent the implementation of the plan before entering the study and a consent form was obtained from all patients. The inclusion and exclusion criteria were evaluated in this study.

- Inclusion criteria: Cholecystitis patients candidate for laparoscopic surgery.
- Exclusion criteria: Patients with lung obstruction diseases such as asthma, emphysema, COPD, and pulmonary embolism.

Demographic data including age, sex, height, weight, and smoking were recorded. After visiting patients at the clinic, pre-op and recording heart rate, respiratory rate, and blood pressure were measured. Patients underwent laparoscopic cholecystectomy under general anesthesia with intravenous induction and maintenance of general anesthesia with inhaled and evaporated anesthetics. At the beginning of surgery before the CO\(_2\) gas is pumped into the abdomen, sampling site was sterilized with 70% alcohol in order to obtain the arterial blood gas (ABG) sample after the Allen test to ensure proper flow of the sample in the hand. It was then prepared using a heparinized G20 syringe from the ABG patient's radial artery. At the same time, CO\(_2\) was measured by a capnography and to facilitate laparoscopic surgical surgery, the intraperitoneal space was filled with CO\(_2\) up to a pressure of up to 20 cm. Exposure to CO\(_2\) was monitored by capnography at all stages of surgery. At the end of surgery, ABG sample was prepared for the second time before CO\(_2\) removal from the abdomen and at the same time, CO\(_2\) was measured and recorded by the CapnoTrue® ASP CO\/_ Spo2 Monitor Capnography. ABG samples were immediately sent to the laboratory and analyzed by a blood gas analyzer (AVL995 Blood Gas Analyzer) and PaCO\(_2\) levels were measured and recorded. After collecting data from ABG samples, arterial PaCO\(_2\) levels were compared with those obtained from capnography results. At the end of the operation, the patient was awakened by neostigmine at the rate of 40 mg/kg after discontinuation of the anesthetic and reversal of the relaxant and transferred to recovery.

**Data Analysis**

Descriptive findings were reported in subgroups using mean and standard deviation. Multivariate regression models were used to investigate the relationship between arterial CO\(_2\) pressure and CO\(_2\) pressure with and without underlying variables and the final analysis was performed on the reduced model. To analyze the difference between the two aforementioned values, One-sample t-test was used and compared with 0. The significance level for all tests was 0.05. SPSS 16 software was used for data analysis.

**Ethical Considerations**

Obtain informed consent to adhere to ethical principles and ensure confidentiality of research information.

**Result**

Twenty-four patients participated in this study which 80% were female and 20% were male. The mean age of the subjects was 41.77 ± 13.89 years. The youngest was 26 years and the oldest was 80 years old. The mean height, weight, and BMI of the patients were 163.5, 70.5 and 26.35, respectively. Also, 28 (93.3%) were non-smokers and 2 (6.7%) were smokers. In this study, systolic blood pressure (SBP) and diastolic blood pressure (DBP) and mean arterial blood pressure (MAP) were reported as 18, 76, and 90, respectively. The mean pre-operative PaCO\(_2\), for laparoscopic surgery was 34.343 PaCO\(_2\), and the mean pre-operative ETCO\(_2\), for laparoscopic surgery was 31.37. These values for post-operative laparoscopy were 34.813 PaCO\(_2\), PaCO\(_2\), and 33.13 for ETCO\(_2\), ETCO\(_2\). The mean and standard deviation of the difference between PaCO\(_2\) and ETCO\(_2\) were 2.9 and 4.11, respectively. These values were 1.6 and 3.72, respectively, for the difference between PaCO\(_2\) and ETCO\(_2\), with a P-value of less than 0.05 for both cases.

According to Table 1, there was a correlation between PaCO\(_2\) and ETCO\(_2\); results as well as between PaCO\(_2\) and ETCO\(_2\);. This correlation was stronger between the values of PaCO\(_2\) and ETCO\(_2\);.

The regression equation based on the final model is as follows:

\[ PaCO_2 – 2 = −34.676 + 0.885 ETCO_2 – 2 + 6.030 Sex – 7.088 Smoker + 0.267PR \]

| Table 1. Correlation between PaCO\(_2\) \(_2\) and ETCO\(_2\) \(_2\) results before laparoscopic surgery |
|-------------------------------------------------------|
| Correlation coefficient | 0.423 |
| P-value | 0.020 |
| Quantity | 30 |

| Table 3. Correlation between PaCO\(_2\) \(_2\) and ETCO\(_2\) \(_2\) results after laparoscopic surgery |
|-------------------------------------------------------|
| Correlation coefficient | 0.720 |
| P-value | 0.000 |
| Quantity | 30 |

| Table 2. Distribution graph and its fitted line based on the regression equation for predicting PaCO\(_2\) \(_2\) using ETCO\(_2\) \(_2\) |
|-------------------------------------------------------|
| Squared R | 0.179 |
| F | 6.095 |
| Degree of Freedom 1 | 1 |
| Degree of Freedom 2 | 28 |
| P | 0.020 |
| Constant number | 19.451 |
| The regression coefficient | 0.475 |

| Table 4. Distribution graph and its fitted line based on the regression equation for predicting PaCO\(_2\) \(_2\) using ETCO\(_2\) \(_2\) |
|-------------------------------------------------------|
| Squared R | 0.519 |
| F | 3.180 |
| Degree of Freedom 1 | 1 |
| Degree of Freedom 2 | 28 |
| P | 0.000 |
| Constant number | 6.430 |
| The regression coefficient | 0.857 |
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