End tidal CO$_2$ level (PETCO$_2$) during laparoscopic surgery: comparison between spinal anaesthesia and general anaesthesia

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ABSTRACT

**Background:** Laparoscopy is a procedure which involves insufflations of the abdomen by a gas, so that endoscope can visualise intra abdominal content without being in direct contact with viscera or tissues. Its advantages are small incisions, less pain, less postoperative ileus, short hospital stay compared to traditional open method. Monitoring of end tidal carbon dioxide (PETCO$_2$) and hemodynamics is very necessary during Laparoscopy surgery. This study is conducted to find out effects of CO$_2$ insufflation on parameters like PETCO$_2$, Mean arterial pulse pressure, SPO$_2$ under spinal anaesthesia and general anaesthesia in ASA I and ASA II patients.

**Methods:** The present study was conducted in the department of anaesthesiology from December 2014 to September 2015. This study was a prospective, randomized controlled, single blind. Each group consisted of 30 patients having Group A and Group B as patient undergoing laparoscopic surgery under Spinal anaesthesia and General anaesthesia respectively. Preoperatively patients in Group A (Spinal anaesthesia) given inj. Midazolam 0.3mg/kg IM 45 before surgery and Group B (General anaesthesia) inj. pentazocin 0.3mg/kg, inj. promethazine 0.5mg/kg, inj. Glycopyrrolate 0.004 mg/kg IM 45 before surgery. In operation theatre, intra operative pulse oximetre, ECG, SPO$_2$, Heart rate (HR), Mean arterial pulse pressure and PETCO$_2$ monitoring done. Amount of CO$_2$ insufflated noted.

**Results:** It was found from present study that in both group there was significant progressive rise in PETCO$_2$ after CO$_2$ insufflation, with peak at 30 min and thereafter plateau till the end of procedure (avg. duration 45-60 min). In group A i.e. laparoscopic surgery under spinal anaesthesia with (spontaneous respiration) the rise in PETCO$_2$ was significant as compared to the group B i.e. laparoscopic surgery under general anaesthesia with controlled ventilation. The heart rate increased after CO$_2$ insufflation in both the group, but it was significant in group A. The increase in SBP, DBP, MAP were less in group A as compared to group B. SPO$_2$ showed no significant changes and it remained above 97% in all patients throughout surgery. All values come to baseline 15 min after insufflation.

**Conclusions:** From the present study it can be concluded that balanced general anaesthesia using IPPV with moderate hyperventilation, as the preferred anaesthetic technique for laparoscopic surgery.

**Keywords:** General anaesthesia, Laparoscopy, PETCO$_2$, Spinal anaesthesia

INTRODUCTION

Laparoscopy is a procedure which involves insufflations of the abdomen by a gas, so that endoscope can visualise intra abdominal content without being in direct contact with viscera or tissues.$^1$ Its advantages are small incisions, less pain, less postoperative ileus, short hospital stay compared to traditional open method.$^{2,3}$

Prime requirement of the laparoscopy is to create pneumoperitonium using a gas which should be colourless, inert, inexplosive and excreted by lungs. CO$_2$ is the preferred insufflation gas because of its ready
availability, nontoxic, highly lipid soluble and non combustible nature. However CO₂ has some demerits like sudden hypertension and tachycardia which enhances myocardial oxygen demand due to high insufflation rate. It may readily absorb from peritoneal cavity into circulation resulting in hypercapnia and respiratory acidosis that may lead to cardiovascular collapse. So measuring PaCO₂ value is mandatory.

PETCO₂ is the most commonly used non-invasive substitute for PaCO₂ in evaluating the adequacy of ventilation. However, PETCO₂ may differ from PaCO₂ because of the ventilation perfusion (V/Q) mismatching and erroneous clinical decision may be reached if the two values are assumed to be equal. Especially patients with preoperative cardiopulmonary diseases demonstrated significant increase in PaCO₂ and decrease in PH and CO₂ insufflation, which were not reflected by comparable increase in PETCO₂. Therefore frequent arterial blood gas analysis required in patients with preoperative cardiopulmonary diseases and in situations where intraoperative hypoxemia and elevated PETCO₂ are encountered. However PaCO₂ estimation from arterial blood is not always feasible and in ASA I and ASA II patient PETCO₂ is found reliable. So monitoring End tidal carbon dioxide (PETCO₂) and hemodynamics is very necessary during Laparoscopy surgery.

We have conducted this prospective and comparative study to find out effects of CO₂ insufflation on parameters like PETCO₂, Heart rate, Mean arterial Pressure, SPO₂ under spinal anaesthesia and general anaesthesia in ASA I and ASA II patients.

**METHODS**

The study was carried out in tertiary care hospital and study protocol was approved by Institutional Ethics Committee. The study was a prospective, randomised, single-blind, controlled, single centre study. The study was conducted in a Tertiary care level institute in department of anaesthesiology between November 2014 and November 2015. Informed written consent was obtained from the patients prior to joining the study. Randomization is used to minimize bias. Randomization was done in the block of 2 as per a computer-generated code. The randomization code was sealed in an envelope. The code number of each individual was also sealed in the envelope.

The study consists of 60 patients in the age group 18-60 years of either gender, weighing 40-70 kg were included in the study. Patients were randomly allocated in 2 groups. Each group consisted of 30 patients having Group A as patient undergoing laparoscopic surgery under Spinal anaesthesia and Group B as patient undergoing laparoscopic surgery under General anaesthesia. Patients with COPD, major cardiovascular diseases like ischemic heart diseases, hypertension and valvular heart disease and those with abnormal liver and renal function test and surgeries which lasted for more than 90 min were excluded from study.

Patients were examined one day prior to surgery and baseline recordings of pulse rate, blood pressure and other vitals were recorded. Preoperatively patients in Group A (Spinal anaesthesia) given inj.Midazolam 0.3mg/kg IM 45 before surgery and Group B (General anaesthesia) inj.pentazocin 0.3mg/kg, inj.promethazine 0.5mg/kg, inj.Glycopyrrolate 0.004 mg/kg IM 45 before surgery. In operation theatre, intra operative pulseoximetre, ECG, SPO₂, Heart rate (HR), Systolic Blood Pressure (SBP), Diastolic blood pressure (DBP), pulse pressure non invasively, and PETCO₂ monitoring done. Amount of CO₂ insufflate noted.

In Group A, the patients were monitored in recovery room till they started moving the toes. In Group B, at the of surgery, when patients had attempts of spontaneous respiration, reversal was done with inj.Neostigmine 0.05mg/kg and inj.Glycopyrrolate 0.008 mg/kg. All vitals monitored. Patients shifted to recovery room for further monitoring.

**Statistics**

All observations were tabulated and analysed statistically using student paired’ t’ test and unpaired t’ test.

**RESULTS**

| Characteristics | Group A (Mean±SD) | Group B (Mean±SD) | "p" Value |
|-----------------|-------------------|-------------------|------------|
| Age (years)     | 41.44±8.39        | 40.72±8.44        | 0.670      |
| Weight (kgs)    | 48.58±7.44        | 47.68±7.61        | 0.552      |
| Gender          |                   |                   |            |
| Males           | 14 (46.66%)       | 13 (43.33%)       | 0.861      |
| Females         | 16 (53.33%)       | 17 (56.67%)       |            |

These two groups were demographically comparable with each other with respect to age, weight and gender.

| Name of the procedure | No. of patients | Percentage |
|-----------------------|-----------------|------------|
| A                     | B               | A          | B          |
| Lap. Appendicectomy   | 24              | 20         | 80%        | 66.67%     |
| Lap. Oophorectomy     | 02              | 02         | 6.67%      | 6.67%      |
| Diagnosis Lap         | 04              | 04         | 13.33%     | 13.33%     |
| Lap. Cholecystectomy  | 00              | 04         | 0          | 13.33%     |

These two groups were comparable with each other with respect to procedure undertaken.
These two groups were comparable with each other with respect to duration of surgery.

Using Student’s unpaired ‘t’ test there is no significant difference in PETCO2 before sufflation (P >0.05). Using Student’s paired ‘t’ test there is significant difference in PETCO2 in both groups at 30 min after insufflation. Using Student’s unpaired ‘t’ test there is significant difference in PETCO2 in group A as compared to Group B at 30 min after insufflation (P <0.05).

Using Student’s unpaired ‘t’ test there is no significant difference in SpO2 before insufflation (P >0.05). Using Student’s paired ‘t’ test there is significant difference in SpO2 at any time in respective group. Using Student’s unpaired ‘t’ test there is less significant fall in SpO2 in group A as compared to Group B after insufflation.

### Table 3: Duration of procedure.

| Time in min | No. of Patients | Percentage |
|-------------|-----------------|------------|
|             | A B             | A B        |
| 45-60       | 10 12           | 33.33% 40% |
| 60-75       | 16 13           | 53.33% 43.33% |
| 75-90       | 06 05           | 13.33% 16.67% |

### Table 4: PETCO2 (mmHg).

| Time                  | Group A | Group B | "p" value |
|-----------------------|---------|---------|-----------|
| Before Spinal Anaesthesia | 30.03   | 30.16   | >0.05     |
| After Spinal Anaesthesia | 30.00   | 30.06   | >0.05     |
| Before insufflation    | 30.10   | 30.70   | >0.05     |
| 5 min. after sufflation| 33.26   | 32.50   | >0.05     |
| 10 min. after sufflation| 38.16   | 33.76   | <0.001    |
| 15 min. after sufflation| 42.66   | 37.76   | <0.001    |
| 30 min. after sufflation| 44.63   | 39.80   | <0.001    |
| 45 min. after sufflation| 43.80   | 38.83   | <0.001    |
| 60 min. after sufflation| 43.40   | 39.15   | <0.001    |
| 75 min. after sufflation| 42.50   | 39.16   | <0.001    |
| 80 min. after sufflation| 43.00   | 38.00   | <0.001    |
| Desufflation           | 42.16   | 35.56   | >0.05     |
| 5 min. after Desufflation| 34.60   | 33.53   | >0.05     |
| At the end of surgery  | 32.60   | 31.56   | >0.05     |

### Table 5: Mean arterial pressure (mmHg).

| Time                  | Group A | Group B | "p" value |
|-----------------------|---------|---------|-----------|
| Before spinal anaesthesia | 88.33   | 88.66   | >0.05     |
| After spinal anaesthesia | 97.06   | 97.43   | >0.05     |
| Before insufflation    | 93.66   | 95.86   | >0.05     |
| 5 min. after sufflation| 96.00   | 97.06   | >0.05     |
| 10 min. after sufflation| 97.36   | 100.06  | <0.05     |
| 15 min. after sufflation| 99.33   | 102.16  | <0.05     |
| 30 min. after sufflation| 101.63  | 105.66  | <0.05     |
| 45 min. after sufflation| 100.00  | 103.30  | <0.05     |
| 60 min. after sufflation| 99.40   | 104.83  | <0.001    |
| 75 min. after sufflation| 98.25   | 105.80  | <0.001    |
| 80 min. after sufflation| 99.50   | 105.50  | <0.001    |
| Desufflation           | 96.23   | 100.60  | <0.001    |
| 5 min. after desufflation| 94.16   | 96.60   | <0.05     |
| At the end of surgery  | 92.83   | 94.40   | >0.05     |

### Table 6: SPO2 (%).

| Time                  | Group A | Group B | "p" value |
|-----------------------|---------|---------|-----------|
| Before spinal anaesthesia | 98.56   | 98.56   | >0.05     |
| After spinal anaesthesia | 98.70   | 98.70   | >0.05     |
| Before insufflation    | 98.60   | 98.80   | >0.05     |
| 5 min. after sufflation| 98.50   | 98.56   | >0.05     |
| 10 min. after sufflation| 98.20   | 98.40   | >0.05     |
| 15 min. after sufflation| 97.63   | 98.36   | >0.05     |
| 30 min. after sufflation| 97.56   | 98.70   | <0.05     |
| 45 min. after sufflation| 97.90   | 98.66   | <0.05     |
| 60 min. after sufflation| 97.78   | 98.66   | <0.05     |
| 75 min. after sufflation| 98.25   | 98.40   | >0.05     |
| 80 min. after sufflation| 98.50   | 99.00   | >0.05     |
| Desufflation           | 98.56   | 98.66   | >0.05     |
| 5 min. after desufflation| 98.76   | 98.63   | >0.05     |
| At the end of surgery  | 98.73   | 98.60   | >0.05     |

### Table 7: Heart rate (per min).

| Time                  | Group A | Group B | "p" value |
|-----------------------|---------|---------|-----------|
| Before spinal anaesthesia | 83.93   | 83.93   | >0.05     |
| After spinal anaesthesia | 98.80   | 91.40   | >0.05     |
| Before insufflation    | 90.16   | 90.40   | >0.05     |
| 5 min. After sufflation| 91.36   | 89.53   | <0.05     |
| 10 min. After sufflation| 94.93   | 90.06   | <0.05     |
| 15 min. After sufflation| 93.73   | 91.73   | <0.01     |
| 30 min. After sufflation| 97.66   | 92.50   | <0.05     |
| 45 min. After sufflation| 96.63   | 92.76   | <0.05     |
| 60 min. After sufflation| 98.57   | 92.23   | <0.001    |
| 75 min. After sufflation| 95.50   | 93.20   | <0.05     |
| 80 min. After sufflation| 96.50   | 92.50   | <0.05     |
| Desufflation           | 93.53   | 91.03   | >0.05     |
| 5 min. After Desufflation| 91.20   | 88.80   | >0.05     |
| At the end of surgery  | 90.23   | 87.03   | >0.05     |
Using Student’s unpaired ‘t’ test there is no significant difference in heart rate before suflation (P >0.05). Using Student’s paired ‘t’ test there is significant difference in Heart rate in both groups at 30 min after insufflation. Using Student’s unpaired ‘t’ test there is there is significant increase in Heart rate in group A as compared to Group B at 30 min after insufflation (P <0.05).

DISCUSSION

Laparoscopy is a procedure very commonly performed for diagnostic and therapeutic purposes. Group A patients received spinal anaesthesia and Group B patients received general anaesthesia. We compared these two techniques in view of PETCO₂, hemodynamic changes and efficacy of technique for the better tolerance, suitability for surgical procedure.

Baraka et al. studied PETCO₂ during laparoscopic cholecystectomy found PETCO₂ value following CO₂ insufflation, increased with time to reach its maximum at 40 min.³ Correlation of this maximum PETCO₂ tension with the corresponding baseline values prior to CO₂ insufflation showed a positive linear relationship (Correlation coefficient 0.86). The correlation showed that PETCO₂ tension of 5.32 Kpa (40 mmHg) could be achieved during laparoscopy when baseline values is adjusted to around 4.0 Kpa (30 mmHg). Plateau after 40 min showed that excess CO₂ absorbed from peritoneal cavity has reached equilibrium with that removed by ventilation. Chandra and Mogra et al, noticed significant rise in PaCO₂ while using Bain’s circuit whereas normocarbia maintained throughout the procedure with circle absorber system.⁹ The hemodynamic changes which are significantly greater in Bain’s circuit group may reflect increase in CO₂ tension. Therefore they recommended use of circle absorber system for maintenance of normocarbia during laparoscopic cholecystectomy. Present study correlate with this study.

Nyarwaya J.E. et al, studied cardio respiratory changes during laparoscopic cholecystectomy and they found no significant change in PaO₂ and SPO₂.¹⁰ In present study no significant change in SPO₂ throughout the procedure and it remain above 97 % and this correlate with above study Miller et al.¹¹ There is increase in blood pressure after CO₂ insufflation which goes to peak level after 15-30 min of insufflations, plateau thereafter. Our study correlates with Miller.

Wylie et al reported in laparoscopic surgeries with CO₂ insufflation increase in blood pressue and heart rate due to absorption of CO₂ which occurs after CO2 insufflation.¹² Present study correlate with this study. Intraoperatively in group A, 8 (26.88%) out of 30 patients complained of severe right shoulder tip pain and postoperatively in group B, 1 (13.33%) out of 30 patients complained of severe right shoulder tip. 5 patients in group B and 1 patient in group A had postoperative nausea and vomiting.

CONCLUSION

There was significant increase in PETCO₂ in patients undergoing laparoscopic surgery under spinal anaesthesia than those under general anaesthesia. However SPO₂ was maintained above 97% in both groups. Though hemodynamic changes in form of HR in patients under spinal anaesthesia and increase in MAP in patients of general anaesthesia were seen, patients under spinal anaesthesia were uncomfortable on the operation table especially in Trendlenberg’s position and 8 patients complained of shoulder tip pain, intra operatively.

It was not possible to establish a correlation between the amount of CO₂ insufflate and PETCO₂ levels because of leak around the laparoscope.

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