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Original Research Article

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 pulseoximetre, 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 CO_2 has some demerits like sudden hypertension and tachycardia which enhances myocardial oxygen demand due to high insufflation rate.[4] It may readily absorb from peritoneal cavity into circulation resulting in hypercarbia and respiratory acidosis that may lead to cardiovascular collapse.[5,6] So measuring $PaCO_2$ value is mandatory.

$PETCO_2$ is the most commonly used non-invasive substitute for $PaCO_2$ in evaluating the adequacy of ventilation. However, $PETCO_2$ may differ from $PaCO_2$ 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 $PaCO_2$ and decrease in PH and CO_2 insufflation, which were not reflected by comparable increase in $PETCO_2$. Therefore frequent arterial blood gas analysis required in patients with preoperative cardiopulmonary diseases and in situations where intraoperative hypoxemia and elevated $PETCO_2$ are encountered. However $PaCO_2$ estimation from arterial blood is not always feasible and in ASA I and ASA II patient $PETCO_2$ is found reliable. So monitoring End tidal carbon dioxide ($PETCO_2$) and hemodynamics is very necessary during Laparoscopy surgery.[7]

We have conducted this prospective and comparative study to find out effects of CO_2 insufflation on parameters like $PETCO_2$, Heart rate, Mean arterial Pressure, SPO_2 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 randomally 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, SPO_2, Heart rate (HR), Systolic Blood Pressure (SBP), Diastolic blood pressure (DBP), pulse pressure non invasively, and $PETCO_2$ monitoring done. Amount of CO_2 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

Table 1: Distribution according to age, weight and gender.

Characteristics		Group A (Mean±SD)	Group B (Mean±SD)	"p" Value
Age (years)		41.44±8.394	40.72±8.447	0.670
Weight (kgs)		48.58±7.445	47.68±7.617	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.

Table 2: Procedure undertaken.

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.

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%

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

Table 4: $PETCO_2$ (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

Using Student's unpaired't' test there is no significant difference in $PETCO_2$ 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 there is significant difference in PETCO2 in group A as compared to Group Bat 30 min after insufflation (P <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

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

Table 6: SPO_2 (%).

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

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 there is less significant fall in SPO_2 in group A as compared to Group B after insufflation.

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 sufflation (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 $PETCO_2$, hemodynamic changes and efficacy of technique for the better tolerance, suitability for surgical procedure.

Baraka et al, studied $PETCO_2$ during laparoscopic cholecystectomy found $PETCO_2$ value following CO_2 insufflation, increased with time to reach its maximum at 40 min.[8] Correlation of this maximum $PETCO_2$ tension with the corresponding baseline values prior to CO_2 insufflation showed a positive linear relationship (Correlation coefficient 0.86). The correlation showed that $PETCO_2$ 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 $PaCO_2$ 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 CO_2 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 PaO_2 and SPO_2.[10] In present study no significant change in SPO_2 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 CO_2 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 CO_2 insufflation increase in blood presure and heart rate due to absorption of CO_2 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 $PETCO_2$ in patients undergoing laparoscopic surgery under spinal anaesthesia than those under general anaesthesia. However SPO_2 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 CO_2 insufflate and $PETCO_2$ levels because of leak around the laparoscope.

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