Haemodynamic, end-tidal carbon dioxide, saturated pressure of oxygen and electrocardiogram changes in laparoscopic and open cholecystectomy: A comparative clinical evaluation

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Citation

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Abstract

In a prospective comparative hemodynamic, end tidal carbon dioxide ($EtCO_2$), saturated pressure of oxygen (SpO_2) and electrocardiogram (ECG) changes in laparoscopic cholecystectomy and open cholecystectomy was conducted in 60 patients of either sex belonging to ASA grade I & II. The patients were randomly divided into two groups of 30 each to undergo laparoscopic cholecystectomy (group I) and open cholecystectomy (group II). Hemodynamic parameters, $EtCO_2$, SpO_2 and ECG parameters were recorded before induction (baseline) and at 10 min interval and thereafter throughout the procedure.
Highly significant increase ($p<.001$) in pulse rate, systolic and diastolic blood pressure and mean arterial pressure between the groups occurred within 30 -40 min. A very highly significant ($p<.001$) increase from the baseline was seen in $EtCO_2$ at 40 and 50 minutes interval in group I. There were no major alterations in electrocardiogram and saturated pressure of oxygen in both the groups.
The authors conclude that laparoscopic cholecystectomy causes notable physiological alteration than open cholecystectomy intraoperatively. There is statistically significant hemodynamic changes along with hypercarbia even in ASA I and II patients during laparoscopic cholecystectomy as compared to open cholecystectomy .Therefore continuous hemodynamic, capnographic , pulse oximeter and ECG monitoring intra operatively are mandatory in patients undergoing laparoscopic cholecystectomy.

INTRODUCTION

Laparoscopic is a Greek word meaning, to look into the flanks achieved through the abdominal wall after creation of pneumoperitoneum.[1] Among laparoscopic surgery cholecystectomy is now one of the most commonly performed operations worldwide. Laparoscopic cholecystectomy requires only small limited incisions, very short hospital stay and has faster recovery times, thereby allowing them to return to routine activities much sooner, in addition less post operative pain and less post operative ileus.[2]

However laparoscopic cholecystectomy has some inherent complications due to increase in intrabdominal pressure, carbon dioxide absorption from peritoneal cavity and frequent changes of patient position. These are associated with severe pulmonary, hemodynamic and acid base changes.[3] This study has tried to compare hemodynamic, $EtCO_2$, SPO_2 and ECG changes during laparoscopic and open cholecystectomy, and to evaluate any additional effects of the insufflated carbon dioxide during laparoscopic cholecystectomy under general anaesthesia.

AIM

1. To compare hemodynamic, end tidal carbon dioxide(EtCO2), saturated pressure of Oxygen (SpO2) and electrocardiogram changes during laparoscopic and open cholecystectomy.
2. To evaluate any additional effects of the insufflated carbon dioxide during laparoscopic cholecystectomy under general anaesthesia.

MATERIAL AND METHOD

After approval from the hospital ethics committee, 60 adult patients of either sex, between 25-60 years of age belonging

to ASA Grade I and II and scheduled for elective cholecystectomy were selected. Patients with any known systemic illness or in whom laparoscopic cholecystectomy had being converted to open cholecystectomy were not included in the study group.

The patients were divided into two groups of 30 each scheduled to undergo laparoscopic cholecystectomy (group I) and open cholecystectomy (group II).

A complete pre anaesthetic check up was carried out and an informed consent was taken from each patient. Following an overnight fast, all the patients were premedicated with oral tab diazepam 0.1-0.2 mg /kg (at bed time) and 5mg was given with a sip of water at 6 AM on the day of surgery. Following preoxygenation with 100% oxygen for 3 minutes, patients were induced with inj thiopentone 5mg/kg i.v. followed by Inj succinylcholine 1.5mg/kg to facilitate endotracheal intubation.

Anaesthesia was maintained with 33% oxygen in nitrous oxide and isoflurane, lungs were mechanically ventilated with tidal volume 8-10ml/kg and set rate was 14-16/min with

I: E ratio 1:2 to maintain normocapnia. Neuromuscular block was achieved with inj vecuronium (at loading dose of 0.08-0.1 mg/kg i.v. and thereafter at 0.02mg/kg i.v. Intraoperative analgesic requirements were met with inj pethidine 0.5mg/kg. Pulse rate, systolic (SBP) and diastolic(DBP) blood pressure, mean arterial pressure(MAP), end tidal carbon dioxide ($EtCO_2$), saturated pressure of arterial oxygen (SpO_2) and electrocardiogram (ECG)were monitored continuously and were recorded at baseline, every 10 min for the first 60 minutes, at time of exsufflation and at the time of completion of surgery. At the end of surgery in all patients neuromuscular block was reversed with inj neostigmine 40µg/kg and inj glycopyrrolate 0.4mg i.v. The data was analyzed using paired‘t' test to find out overall significance between the groups and over period of time.

OBSERVATION AND RESULTS

Patients in both groups were comparable in terms of age, weight and sex (Table I).

Figure 1

Table 1: Demographic Data: Patients particulars Age, Sex, ASA & Duration of surgery

PARTICULAR	GROUP I	GROUP II	REMARKS
AGE (range) Mean±SD	22-60 39.97±10.61	25-58 46.23±10.55	P>0.05
SEX MALE:FEMALE	8:22	6:24	P>0.05
WEIGHT Mean±SD	45-76Kg 59.26±7.65	41-78kg 58.67±8.7	P>0.05
ASA GRADE I:II	26:4	24:6	P>0.05
Duration of surgery Mean±SD	80-100min 100.83±25.12	80-120 107.33±25.64	P>0.05

Figure 2

Table 2: Mean & SD of hemodynamic responses at different intervals of time.

Haemodynamic Responses	BOBASAL)	10min	20min	30min	40min	50min	60min	Exsufflation
HR Group I Group II P value	80.6±12.9 79.2±8.43 0.62	87.3±12.44 86.8±9.2 0.859	89.67±13 87±7.1 0.32	100.77±14.4 86.77±7.1 0.001	101.07±13.6 85.3±8.1 0.001	92.9±15.4 85.3±8.4 0.02	90.2±10.4 83.87±8.6 0.012	85.27±7.6
SBP Group I Group II P value	123.97±7.96 121.50±15.17 0.44	134.87±12.1 126.8±6.88 0.003	138.23±11.1 129.7±8.73 0.01	148.9±11.48 128.53±8.69 0.001	157.6±9.09 125.83±10.44 0.001	146.53±13.08 125.9±9.89 0.01	138.4±7.38 122.37±12.4 0.01	132±7.34
DBP Group I Group II P value	77.2±7.14 77.13±11.12 0.978	85.06±12.06 83.4±5.24 0.498	89.13±11.39 86.1±6.08 0.217	96.07±10.77 85.43±5.48 0.01	95.67±8.97 82.13±7.51 0.001	89.67±12.42 82±6.61 0.005	86.13±7.03 80.57±10.68 0.023	80.63±5.38
MAP Group I Group II P value	92.8±6.46 91.9±12.24 0.727	101.37±10.78 98.23±5.73 0.172	105.8±10.79 100.23±6.68 0.021	113.93±10.7 99.2±7.09 0.001	114.27±8.37 96.73±7.78 0.001	104.8±6.5 96.63±7.05 0.01	104.9±10.34 93.2±8.19 0.01	97.93±4.5
ETCO2 Group I Group II P value	28.03±1.92 29.56±2.71 0.15	29.27±2.73 29.33±2.45 0.556	29.83±2.69 29.43±2.48 0.54	38.5±3.31 29.4±2.58 < .001	39.1±3.56 29.5±2.71 < .001	42.53±1.93 29.43±2.6 < .001	35.7±3.35 29.36±2.49 .001	30.93±2.57

Figure 3

Figure 1: In group I the increase in heart rate was very highly significant at 30 and 40 minutes (100.77 Â± 14.4) and (101.07Â± 13.06) respectively. In contrast, no significant increase in heart rate from baseline was noted throughout the procedure in group II. On comparing the heart rate between the two groups at different time intervals the difference in the heart rate was statistically very highly significant at 30 and 40 minutes intervals (p<0.001) and significant at 50 minutes interval (p<0.05).

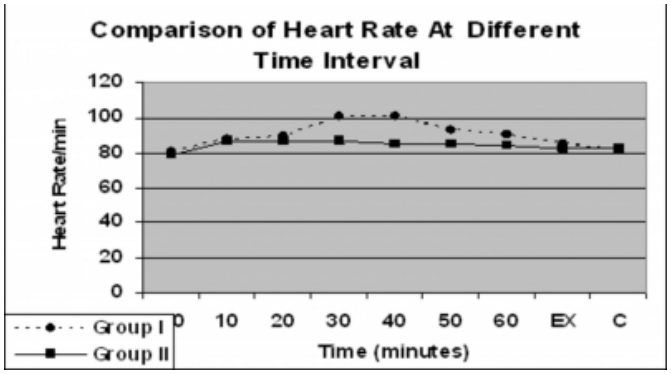
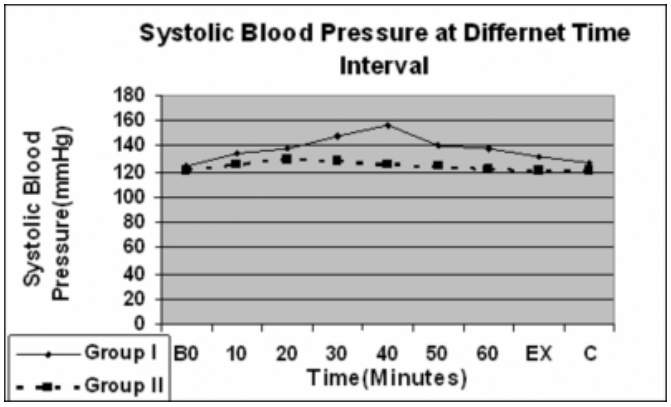


Figure 4

Figure 2: In group I the increase in systolic blood pressure was very highly significant at 30 and 40 minutes (148.93± 11.48) and (157.60± 9.09) respectively. In group II, initial rise in SBP was insignificant.



On comparing the systolic blood pressure between the two groups at different time intervals the difference was statistically very highly significant at 30 and 40 minutes interval (p<0.001) and highly significant at 50 and 60 minutes interval (p<0.01).

Figure 5

Figure 3: There was an increase in DBP after 10 min in both the groups but in group II the increase was not statistically significant. In group I, the increase of DBP was very highly significant at 30 and 40 minutes interval (96.07Â± 10.77 and 95.67 Â± 8.97) respectively. The difference in DBP between the two groups was highly significant (p<0.01) at 30 and 50 minutes interval and very highly significant (p<0.001) at 40minutes. (Table2)

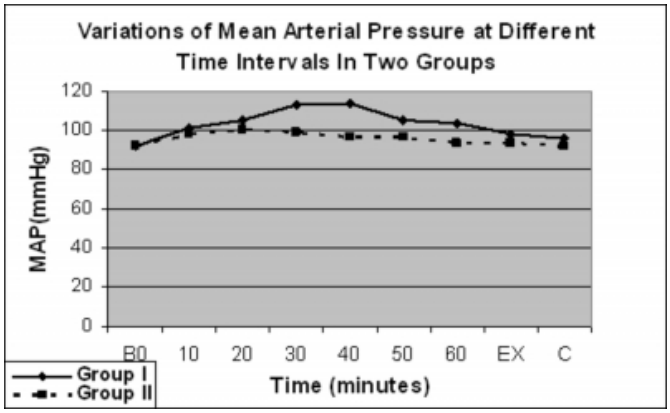


Figure 6

Figure 4: There was an increase in mean arterial pressure in both the groups at 10 minutes after start of surgery. In group I, a significant increase in MAP from baseline (92.80Â±6.46) mm Hg was noted after 30 minutes of insufflations (113.93Â±10.70 mm Hg) and the increase persisted for 60 min (104.90Â±10.35 mm Hg). In group II, a rise in MAP was noted, which was insignificant. On comparing the two groups, the difference in the MAP was very highly significant (p<0.001) at 30 and 40 minutes interval and highly significant at 50 and 60 minutes (p<0.01) . (Table 2)

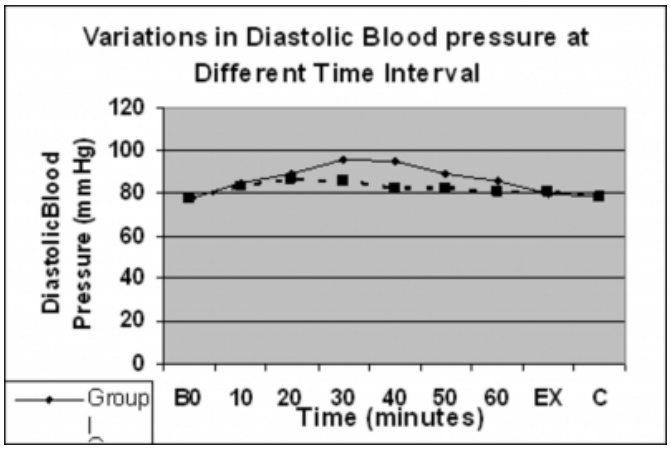
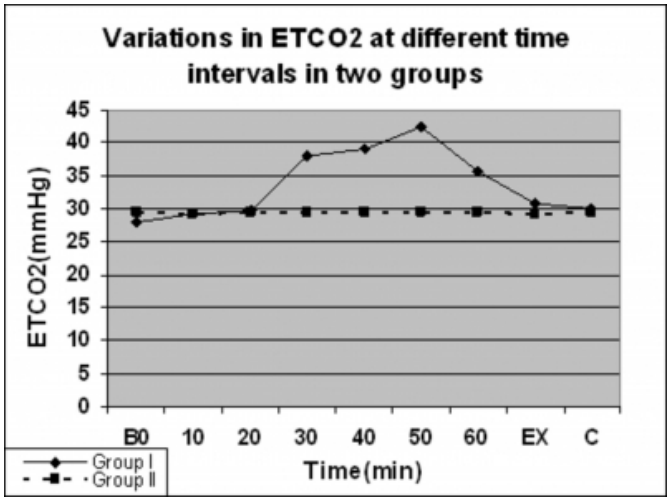


Figure 7

Figure 5: In group I, a significant increase in EtCO values from baseline (28.03 Â± 1.92 mm Hg) was observed after 30 min (38.50 Â±3.31mm Hg) of CO insufflation, which persisted upto 60 minutes (35.70Â±3.35). In group I the increase in EtCO continued further and was very highly significant at 40 and 50 minutes interval (39.10Â± 3.50) and (42.5 Â± 1.93) respectively. In group I it was observed that EtCO kept on increasing from the baseline throughout the surgery .It was very highly significant at 30, 40 and 50 minutes interval, it remained highly significant at the time of exsufflation and completion. Wheareas in group II the EtCOvalues remained comparable with the baseline throughout the surgery (p>0.05)



SpO_2 were normal and comparable in both the groups throughout the period of surgery ECG changes were not seen in any patient in both the groups.

DISCUSSION

The prospective study was carried out on 60 patients posted for elective cholecystectomy. The patients were allocated into two groups of 30 patients each, who underwent laparoscopic cholecystectomy (Group I) and open cholecystectomy (Group II) respectively

It was further observed that there was no significant difference statistically in the mean age, weight, sex, ASA grade of patients and duration of surgery between the groups.

In our study the mean age in laparoscopic cholecystectomy & open cholecystectomy group was 39.97 years & 46.23 years respectively. Slightly higher mean age in other studies was due to the enrolment of patients up to the age of 70 years, whereas in our study the maximum range was up to 60 years.

In the present study, female patients predominated (73.33%) in both the groups .This may be due to the fact that incidence of cholelithiasis is more common in females as compared to males.

In present study, there was an increase in HR, SBP, and DBP in both the groups, after 10 minutes. In Group I the increase in the heart rate, BP continued further and was very highly significant from the baseline at 30 and 40 minutes interval. The rise in heart rate in group I continued up to 1 hour, after which it became comparable with the base line. In group II after the initial rise in the heart rate at 10 minutes, it remained comparable with the base line throughout the surgery.

Various studies have demonstrated an increase in heart rate during laparoscopy. The most common cause is believed to be hypercarbia due to absorption of carbon dioxide from peritoneal cavity. This induces release of catecholamines which causes tachycardia. An increase in intra abdominal pressure (IAP) with decrease in venous return may also cause a compensatory increase in heart rate.[4]

Bradycardia has also been reported which may be due to vagally mediated reflex initiated by stretching of peritoneum or by inadequate ventilation and hypoxia.[5]

The rise in HR, SBP, DBP in group I from the base line was very highly significant ($p<0.001$) at 30 and 40 minutes interval and highly significant ($p<0.01$) at 50 and 60 minutes interval. At the time of exsufflation SBP was highly significant ($p<0.01$).

In group II, after 10 and 20 minutes there was highly significant ($p<0.001$) increase in heart rate, SBP, DBP from the baseline. However after the initial rise the heart rate, SBP, DBP remained comparable throughout with the base line and the difference was not statistically significant.

However when the HR and SBP between the two groups were compared at different time intervals the difference in the heart rate was statistically very highly significant at 30 and 40 minutes interval ($p< 0.001$) and significant at 50 minutes interval. ($p<0.05$). However when the DBP between the two groups were compared at different time intervals, the difference in DBP was statistically highly significant at 30 and 50 minutes interval ($p<0.01$) very highly significant at 40 minutes interval ($p<0.001$).

Harris MNE et al 6 observed that there was a significant

increase in heart rate from the base line (75±2.60) after 30 minutes interval (99±4.23). At the time of exsufflation the heart rate was (81±5.38) which was significant from the base line ($p<0.05$).

In the present study there was an increase in mean arterial pressure in both the groups at 10 minutes interval from the base line. In group 1 the rise in mean arterial pressure continued further and was very highly significant at 30 and 40 minutes interval (113.93 10.70) and (114.2 8.37) respectively ($p<0.001$). In group II there was an increase in MAP at 10 and 20 minutes (98.23 5.73) and 100.23 6.68) respectively. However after the initial rise the mean arterial pressure remained comparable with the base line throughout the surgery in group II.

In group I, the difference from the base line was very highly significant ($p<0.001$) at 20, 30 and 40 minutes interval and highly significant ($p<0.01$) at 50 and 60 minutes interval respectively. The difference from the base line was significant ($p<0.05$) at the time of exsufflation also.

In group II the difference from the base line was statistically highly significant ($p<0.01$) at 10 and 20 minutes interval. However after the initial rise, the mean arterial pressure remained comparable with the base line throughout and the difference was not statistically significant.

When the MAP between the two groups were compared at different time intervals the difference in the MAP was very highly significant at 30 and 40 minutes interval (p value <0.001) and highly significant at 50 and 60 minutes interval ($p<0.01$). Our findings are similar to the findings observed by Kelman G R et al.7

Critchley. LA et al8 observed that on comparing the two groups, the increase in SBP, DBP, and MAP during laparoscopic surgery was significantly high throughout the period of surgery.

The major causes of physiological changes in blood pressure during laproscoipc cholecystectomy are due to rise of intra abdominal pressure and systemic absorption of CO_2 following creation of pneumoperitoneum. [9] Increasing the intra abdominal pressure to 20mm Hg shift the blood out of the abdominal organs and the inferior vena cava to the central reservoir causing increase in venous return to heart. Venous return to heart is further enhanced by Trendelenberg position. Thus there is an increase in afterload to heart. [10]

Increase in IAP also causes mechanical compression of the aorta and an increase in systemic vascular resistance (SVR). The SVR may be further increased by increase in levels of catecholamines rennin, angiotensin and vasopressin. [11]

Sympathetic effects of CO_2 absorbed from peritoneal cavity is a contributing factor for increase in BP. [12] All these factors are probably responsible for the rise in BP seen during laparoscopic cholecystectomy in our patients.

Increase in IAP above 20mm Hg can lead to emptying of abdominal capacitance vessels with a fall in central venous reserve and decrease in the cardiac output and BP. [13]

In the present study the IAP was not allowed to rise above 14mm Hg. This probably explains why hypotension was not observed in any of our patients.

In the present study there was an increase in $EtCO_2$ from the base line after 10 minutes in group 1. In group 1 the increase in $EtCO_2$ continued further and was very highly significant at 40 and 50 minutes interval (39.10 ± 3.50) and (42.5 ± 1.93) respectively. In group I the $ETCO_2$ continued to rise and the difference from the base line was highly significant at 10 and 20 minutes interval ($p<0.01$) and very highly significant at 40 and 50 minutes interval ($p<0.001$). After exsufflation, the $EtCO_2$ value was comparable with base line (39.93 ± 2.57) and the difference from the baseline remained statistically highly significant, till the time of completion ($p<0.01$). In group II, there was no increase in $EtCO_2$ and remained comparable with the baseline throughout the surgery. On comparing the two groups a significant increase in $EtCO_2$ was observed in patients undergoing laparoscopic cholecystectomy than open cholecystectomy same as in the study conducted by Fox et al. [14]

Kelman GR7 in a study on arterial blood gas tension during laparoscopy observed that there was a significant increase in $ETCO_2$ from the base line (34 ± 0) at 30 and 40 minutes interval (39±0.4) and (41± 03) respectively after insufflation. The increase continued but after exsufflation the $ETCO_2$ became comparable with the base line (36 ± 0.8).

The most important factor for the increase in $EtCO_2$ seen during laparoscopic cholecystectomy is absorption of $EtCO_2$ from peritoneum. Apart from this, respiratory changes because of raised IAP and decreased diaphragmatic movements and ventilation perfusion mismatch with increased dead space lead to decreased CO_2 elimination from

the lungs. This increases arterial alveolar CO_2 gradient in circulation. [15,16]

There were no major alterations in electrocardiogram. Electrocardiogram (ECG) showed sinus rhythm in both the groups throughout the procedure.

Saturated pressure of oxygen (SPO_2) was within normal range and comparable in both the groups throughout the surgery.

CONCLUSION

Laparoscopic cholecystectomy causes more severe physiological alterations than open cholecystectomy intra operatively. There is significant hypercarbia with acidosis and significant haemodynamic changes even in ASA grade I and II patients during laparoscopic cholecystectomy. Although these physiological changes generally do not need any intervention but it makes continuous intraoperative monitoring mandatory. Therefore we recommend continuous haemodynamic, capnography, pulse oximetry and E.C.G. monitoring intra operatively in patients undergoing laparoscopic cholecystectomy.

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