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# COMPARATIVE STUDY OF FLUCTUATIONS IN HEMODYNAMIC PARAMETERS USING DIFFERENT INTRA-ABDOMINAL PRESSURES IN LAPAROSCOPIC CHOLECYSTECTOMY

Anaesthesiology

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## ABSTRACT

**INTRODUCTION:** Laparoscopic cholecystectomy decreases postoperative pain, decreases the need for postoperative analgesia, returns the patient to full activity within 1 week (compared with 1 month after open cholecystectomy), discharged the day after surgery. This study was conducted to compare the fluctuations in hemodynamic changes using different intra- abdominal pressures with CO2 in laparoscopic cholecystectomy.

**MATERIALS AND METHODS:** This randomised, prospective, interventional study was conducted in Durgapur Steel Plant Hospital, Durgapur, West Bengal from November 2018 to January 2020. In our study, we attempted to compare the fluctuations in hemodynamic changes using different intra- abdominal pressures. Present study included 90 cases undergoing laparoscopic cholecystectomy who were randomly divided into 3 groups with different intra-abdominal pressures, maintained during surgical intervention by CO2 insufflation.

**RESULT:** Mean VAS score was 2.83 in group A after 6 hours of laparoscopic cholecystectomy which decreased to 2.13 and 0.07 by the end of 12 and 24 hours respectively. The mean VAS scores for group B and C were 5.87; 8.03, 4.33; 7.10 and 2.40; 5.93 at 6, 12 and 24 hours post laparoscopic cholecystectomy respectively. Mean VAS score was significantly lower in group A as compared to group B and lower in group B as compared to group C respectively at all time intervals ($p<0.01$).

**CONCLUSION:** Low intra-abdominal pressures during surgical intervention by CO2 insufflation leads to better hemodynamic control, better pain management and decreased hospital stay. Present study thus recommends use of low pressure pneumoperitoneum in all cases undergoing laparoscopic cholecystectomy.

## KEYWORDS

Laparoscopic cholecystectomy, Hemodynamic, Intra-abdominal pressures, VAS scores

## INTRODUCTION

The use of laparoscopy technique in general surgery has gained increasing popularity in the last few decades, due to small limited incisions, well acceptance by the patients, benefit of faster recovery, short duration of postoperative hospital stay[1,2]. Now a day's biliary diseases, among which cholelithiasis being the fore runner of general ill health and thereby requiring the surgical intervention for total cure. Laparoscopy requires creation of a pneumoperitoneum (PnP) to help visualize the area of interest[3]. The physiological changes observed during laparoscopic surgery are a result of patient position, introduction of exogenous insufflation of CO2 and increased intra-abdominal pressures due to pneumoperitoneum[4]. During laparoscopic cholecystectomy, patient is put in reverse Trendelenburg position, and it results in the decreased venous return and cardiac output. Absorption of CO2 from peritoneal cavity is the potential mechanism causing hypercarbia and rise in end tidal-CO2. Severe hypercarbia exerts negative ionotropic action on the heart and reduces left ventricular function[5]. Increased intraabdominal pressures interferes with infra-diaphragmatic venous and arterial flow and displace the diaphragm into the chest cavity, decreasing the total lung capacity and FRC. Pressures of >15mmhg are associated with significant changes than low intra -abdominal pressure. The study was undertaken to attempt to compare fluctuations in hemodynamic parameters using different intra-abdominal pressures due to CO2 insufflation.

These alterations are derived from 3 factors: the first one is the intra-abdominal pressure created by the pneumoperitoneum; the second one is the existence of an insufflation gas that may be absorbed by the blood depending upon the gas used and; the third one is the positioning of the patients. The insufflated CO2 compresses both the venous capacitance and the arterial resistance vessels. This produces a rise in the systemic vascular resistance (SVR), and the pulmonary vascular resistance (PVR) leading to an increased afterload.

Cardiac index might be significantly reduced, and the magnitude of this effect is proportional to intra-abdominal pressure achieved. Threshold pressure of 12 mm Hg IAP has been found to be optimal to minimize the effect of IAP on haemodynamic changes[6].

Laparoscopic cholecystectomy decreases postoperative pain, decreases the need for postoperative analgesia, returns the patient to full activity within 1 week (compared with 1 month after open cholecystectomy), discharged the day after surgery[7].

There are limited studies on this issue despite the fact that procedures under low-pressure have been as effective as those under high pressure and reportedly have lesser impact on cardiovascular and hemodynamic parameters.

### AIMS AND OBJECTIVES OF STUDY:

**AIM:** To compare the fluctuations in hemodynamic changes using different intra- abdominal pressures with CO2 in laparoscopic cholecystectomy.

### OBJECTIVES:

**PRIMARY OBJECTIVE:** To assess the hemodynamic changes of low pressure pneumoperitoneum by comparing with high pressure pneumoperitoneum with CO2 in people undergoing laparoscopic cholecystectomy.

### SECONDARY OBJECTIVE:

To assess secondary outcomes like length of hospital stay, post pain.

## MATERIALS AND METHODS

### STUDY DESIGN:

Randomised, prospective, interventional study.

### STUDY DURATION:

November 2018 to January 2020.

### STUDY SETTING:

Operation theatre of Durgapur Steel Plant Hospital, Durgapur, West Bengal.

### STUDY POPULATION:

Adult males and females, ASA physical grade 1 and 2 patients scheduled for elective surgeries, under general anaesthesia.

**INCLUSION CRITERIA:**
1. Adult males and females of age group 18-45.
2. ASA grade I and II
3. Patients posted for elective surgery.

**EXCLUSION CRITERIA:**
1. Patients with HYPERTENSION, DM, COPD, ASTHMA and CORONARY ARTERY DISEASE.
2. Patients with PORTAL HYPERTENSION, GALLBLADDER CARCINOMA, CIRRHOSIS, GENERALISED PERITONITIS and UNCORRECTED COAGULOPATHIES.

**RESULT AND DISCUSSION**
Laparoscopic cholecystectomy is a minimally invasive surgical procedure for removal of a diseased gallbladder. This technique essentially has replaced the open technique for routine cholecystectomies since the early 1990s[8]. Laparoscopic cholecystectomy provides a safe and effective treatment for most patients with symptomatic gallstones and has become the treatment of choice for many patients[9].

Pneumoperitoneum is most often created by insufflating carbon dioxide gas into peritoneal cavity. However, absorption of carbon dioxide from peritoneal cavity is the potential mechanism for rise in end tidal carbon dioxide and severe hypercarbia exerts a negative ionotropic effect on the heart and reduces left ventricular function[5].

The physiological changes observed during laparoscopic surgery are a result of patient position, introduction of exogenous insufflation of CO2 and increased intra-abdominal pressures due to pneumoperitoneum[4]. Frequent complications associated with pneumoperitoneum includes subcutaneous or mediastinal emphysema, pneumothorax, hypoxemia, hypotension carbon dioxide embolism cardiovascular collapse, and cardiac arrhythmias. There are studies, which have concluded that these adverse effects can be minimized by use of low pressure for pneumoperitoneum instead of the standard or high- pressure pneumoperitoneum[10,11].

In our study, we attempted to compare the fluctuations in hemodynamic changes using different intra- abdominal pressures. Present study included 90 cases undergoing laparoscopic cholecystectomy who were randomly divided into 3 groups with different intra-abdominal pressures, maintained during surgical intervention by CO2 insufflation. Intra-abdominal pressure was 8-10 mm Hg in group A while it was 11-13 mm Hg in group B and 14 mm Hg and above in group C respectively.

Mean age of the cases undergoing laparoscopic cholecystectomy was 35.52 years with no difference between study groups (p-0.53). All the groups were comparable with respect to gender and ASA grade distribution.

**Hemodynamic parameters**
In present study, immediately after insufflation, mean heart rate was significantly higher in group C as compared to group B and higher in group B as compared to group A ($p<0.01$). The mean heart rate in group A was significantly lower as compared to group B and C, till 10 minutes after exsufflation while the difference between group B and C was significant till 5 mins after insufflation. Mean systolic and diastolic blood pressure was significantly higher in group C after insufflation as compared to group B and is also higher in group B as compared to group A ($p<0.01$). The mean SBP in group A was maintained significantly lower as compared to group B and that of group B than group C, till exsufflation ($p<0.01$).

Singh SP et al. [12] in a similar study observed that difference in mean heart rate of patients of Group A (low pressure) and Group B (normal pressure) were found to be statistically significant at 10 min after induction (89.75±12.04 vs. 84.05±12.99 beats/min), 20 min after induction (90.18±11.60 beats/min vs. 82.95±11.65 beats/min) and at 2 hours after induction (91.25±10.55 vs. 83.60±11.76 beats/min). Before induction systolic and diastolic blood pressure of Group B was found to be higher than that of Group A. At rest of the periods of observation too, systolic and diastolic blood pressure of Group B was found to be higher than that of Group A. Gohil A et al.[13] in their study observed average change in heart rate in low pressure patients was a decrease of 0.8±12.01 beats per minute. Average change in heart rate in patients who underwent normal pressure was an increase of 1.8 ± 5.33 beats per minute. However no difference was observed related to systolic and diastolic blood pressure. Ghosh BC et al.[14] in their study observed that all intra-operative parameters (HR, SBP, DBP, MAP), were found to be significant at 20 minutes intra-operatively and before reversal of GA. In post-operative period, they observed significant differences at 2 hours post-operatively in all parameters except mean arterial pressure. In all the cases, low pressure group showed better hemodynamic control than normal pressure group. Sohar S et al. [15] in their study observed that average heart rate and mean arterial pressure during the procedure were higher in a standard-pressure group compared with a low-pressure group. In a study conducted by Rishimani et al.[16] while MAP was increased 41.15% with 14 mmHg and 24.94% with 6 mmHg, HR remained constant in both IAP values. However contrary to our findings the studies by Kanwer et al [17] consisting of 60 patients did not find any statistical difference in HR, systolic or diastolic BP.

**Oxygen Saturation**
The mean oxygen saturation was significantly higher in group A as compared to group B and that of group B than group C at insufflation and the significant difference was maintained till 10 mins after exsufflation ($p<0.01$).

Ghosh BC et al.[14] compared 52 cases undergoing LC between low pressure laparoscopic cholecystectomy (LPLC) and normal pressure laparoscopic cholecystectomy (NPLC). Oxygen saturation (%) were recorded and analyzed in both groups at subsequent four interval of time namely before incision, 20 minutes intra-operatively, before reversal from GA and post-operatively. Authors observed that oxygen saturation was significantly more in low pressure group at 20 minutes intra-operatively, before reversal of GA and post-operatively. Similarly better oxygen saturation in low pressure group was observed in the study by Sohar S et al. [15] while no difference was observed in the study by Rishimani et al. [16] and Kanwer et al [17].

**End Tidal Carbon di-oxide**
The mean end tidal Co2 levels was significantly lower in group A as compared to group B and that of group B than group C at insufflation and the significant difference was maintained till exsufflation ($p<0.01$).

Singh SP et al. [12] in their study observed that mean EtCO2 of patients of Group II (normal pressure) was higher than that of Group I (low pressure) at all the periods of observations during LC. Ghosh BC et al. [14] observed that end tidal Co2 levels were significantly more in normal pressure group at 20 minutes intra-operatively, before reversal of GA and post-operatively than low pressure group. Sohar S et al. [15] however in their study observed no difference between low and normal pressure groups with respect to end tidal Co2 levels.

**Post-op Pain & Hospital Stay**
Visual analogue scale (VAS) was used to assess the level of pain. Mean VAS score was 2.83 in group A after 6 hours of laparoscopic cholecystectomy which decreased to 2.13 and 0.07 by the end of 12 and 24 hours respectively. The mean VAS scores for group B and C were 5.87; 8.03, 4.33; 7.10 and 2.40; 5.93 at 6, 12 and 24 hours post laparoscopic cholecystectomy respectively. Mean VAS score was significantly lower in group A as compared to group B and lower in group B as compared to group C respectively at all time intervals ($p<0.01$). Similarly mean hospital stay was highest in group C i.e. high intra-abdominal pressure group (A: B: C group - 23.9 hours, 12.2 and 6.47 hours; $p<0.01$).

Singh SP et al.[12] in their study observed that mean pain scores in low pressure pneumoperitoneum group was statistically less than normal pressure group. Gohil A et al. [13] in their study observed that need of additional analgesia post-operatively and postoperative pain referred to the tip of the right shoulder were significantly lower in low pressure (LP) LC group in compare with standard pressure (SP) LC group. It has also been found to be true by others like Barczynski M et al. [18] and Kanwer DB et al. [17]. However the duration of stay was observed to be unaffected by low pressure in the studies by Barczynski M et al. [18] and Kanwer DB et al.[17].

**CONCLUSION**
Present study concluded that low pressure pneumoperitoneum appears to be having less effects on blood pressure- both systolic and diastolic, as compared to standard pressure pneumoperitoneum in patients undergoing LC. It also appears to be causing fewer derangements in ETCO2 and better management of oxygen saturation. This may help in

smooth recovery and less post-operative problems. The other advantages included better pain management and decreased hospital stay.

**Table 1. Mean comparison of study groups as per end tidal carbon dioxide (CO2) values**

| EtCo2 | Group | N | Mean | SD | p-value | Intergroup Comparison (post-hoc Tukey's) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | A vs B | A vs C | B vs C |
| **Immediately** | **A** | 30 | 33.13 | 1.55 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 34.87 | 1.11 | | | | |
| | **C** | 30 | 37.60 | 1.38 | | | | |
| **5 mins** | **A** | 30 | 34.20 | 1.42 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 35.60 | 1.00 | | | | |
| | **C** | 30 | 38.73 | 1.08 | | | | |
| **10 mins** | **A** | 30 | 35.23 | 1.10 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 36.30 | 1.09 | | | | |
| | **C** | 30 | 41.67 | 1.40 | | | | |
| **20 mins** | **A** | 30 | 36.13 | 0.63 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 36.80 | 0.93 | | | | |
| | **C** | 30 | 42.03 | 1.16 | | | | |
| **30 mins** | **A** | 30 | 37.57 | 0.90 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 37.07 | 0.79 | | | | |
| | **C** | 30 | 43.20 | 0.85 | | | | |
| **At exsufflation** | **A** | 30 | 34.17 | 0.79 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 35.73 | 1.17 | | | | |
| | **C** | 30 | 41.40 | 1.00 | | | | |
| **10 mins after exsufflation** | **A** | 30 | 32.20 | 1.19 | **<0.01** | **Non- sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 32.00 | 1.15 | | | | |
| | **C** | 30 | 37.07 | 1.41 | | | | |

**Table 2. Mean comparison of study groups as per VAS score**

| VAS | Group | N | Mean | SD | p-value | Intergroup Comparison (post-hoc Tukey's) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | A vs B | A vs C | B vs C |
| **6 hrs** | **A** | 30 | 2.83 | 0.79 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 5.87 | 0.86 | | | | |
| | **C** | 30 | 8.03 | 0.96 | | | | |
| **12 hrs** | **A** | 30 | 2.13 | 0.86 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 4.33 | 0.92 | | | | |
| | **C** | 30 | 7.10 | 0.96 | | | | |
| **24 hrs** | **A** | 30 | 0.07 | 0.25 | **<0.01** | **Sig.** | **Sig.** | **Sig.** |
| | **B** | 30 | 2.40 | 0.50 | | | | |
| | **C** | 30 | 5.93 | 1.05 | | | | |

We thus recommend use of low pressure pneumoperitoneum in all cases undergoing laparoscopic cholecystectomy. Further prospective studies may throw additional light on these observations.

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