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Anaesthesia Section

Comparative Analysis of Haemodynamic and Capnographic Changes in Laparoscopic Cholecystectomy and Open Cholecystectomy: A Randomised Clinical Study

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ABSTRACT

Introduction: Laparoscopic cholecystectomy is now preferred over the open procedure due to advantages such as reduced blood loss and shorter hospital stays. However, concerns have been raised regarding the potential for increased Intra-abdominal Pressure (IAP) during laparoscopic procedures, which may impact haemodynamic stability and respiratory parameters. However, there is a lack of comprehensive analysis directly comparing both surgical approaches from both haemodynamic and capnographic perspectives.

Aim: To compare the haemodynamic and capnographic changes between laparoscopic and open cholecystectomy.

Materials and Methods: This randomised clinical study was conducted at Department of Anaesthesiology, Assam Medical College and Hospital, Dibrugarh, Assam, India from May 2021 to June 2022. The study included 300 patients scheduled for cholecystectomy, divided into two groups: Laparoscopic Cholecystectomy (LC) Group I (n=150) and Open Cholecystectomy (OC) Group II (n=150). Haemodynamic parameters, including Pulse Rate (PR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and Oxygen Saturation (SpO_2), were recorded. Capnographic parameters, such as End-Tidal Carbon Dioxide ($EtCO_2$) levels, were also measured at regular intervals. Data analysis was performed using the student's t-test and Chi-square test with Statistical Package for Social Sciences (SPSS) version 21.0 software and Microsoft excel.

Results: There were no significant differences in age, body weight, and sex distribution between Group I and Group II. However, significant differences were observed in PR and SBP at 15 minutes (PR: 101.46 and 95.86; SBP: 148.57 and 140.97), 30 minutes (PR: 104.52 and 99.82; SBP: 141.28 and 136.07), and 45 minutes (PR: 102.52 and 97.70; SBP: 140.59 and 133.95) (p-value <0.01). Highly significant differences were observed in MAP and $EtCO_2$ postinsufflation at 15 minutes (MAP: 118.38 and 108.61; $EtCO_2$: 36.48 and 33.89), 30 minutes (MAP: 111.11 and 106.01; $EtCO_2$: 41.02 and 36.15), 45 minutes (MAP: 110.73 and 103.48; $EtCO_2$: 42.65 and 38.36), and 60 minutes (MAP: 106.08 and 101.45; $EtCO_2$: 41.10 and 38.21) (p-value <0.01). DBP showed high significance at 15 minutes (103.21 and 93.23), 30 minutes (96.74 and 92.57), and 60 minutes (93.14 and 86.92) (p-value <0.01), and significant (p-value=0.01) at 45 minutes (95.53 and 87.59). Oxygen saturation showed significance (p-value <0.05) at 15 minutes (99.93 and 100).

Conclusion: The present study demonstrated a significant increase in both haemodynamic and capnographic parameters, even in American Society of Anaesthesiologists (ASA) Grade-I and Grade-II patients undergoing laparoscopic cholecystectomy compared to the open surgical technique. These findings emphasise the need for careful monitoring during laparoscopic procedures.

Keywords: Blood pressure, Carbon dioxide, Heart rate, Oxygen saturation, Postinsufflation

INTRODUCTION

Cholecystectomy is the surgical elimination of the gallbladder and is one of the most commonly performed surgeries worldwide. It can be performed using both open and laparoscopic techniques. In open cholecystectomy, the removal of the gallbladder is carried out through a single large incision, typically made in the right upper quadrant [1]. On the other hand, in the laparoscopic method, the creation of pneumoperitoneum is required, along with the insertion of a video camera and surgical instruments through multiple small incisions made in the abdomen.

The creation of pneumoperitoneum is the first and most critical step in any laparoscopic procedure due to the significant risk of bladder and bowel injury [2]. Hence, understanding the physiological changes resulting from pneumoperitoneum is crucial.

The increase in intravascular pressure caused by pneumoperitoneum leads to the compression of the heart and major blood vessels, resulting in decreased blood flow to the heart and an increase in Systemic Vascular Resistance (SVR). These changes further affect blood pressure, MAP, and PR. The restriction of diaphragm movement reduces lung expansion and lung compliance, leading to a decrease in total lung capacity and functional residual capacity. Moreover, increased intra-abdominal pressure can hinder the perfusion of abdominal organs and cause oliguria due to reduced blood flow to the kidneys [3].

However, the formation of pneumoperitoneum is not without its drawbacks, including detrimental effects on respiratory, cardiovascular, acid-base physiology, and stress response. When pneumoperitoneum is induced, there is an instantaneous rise in MAP and SVR, suggesting the involvement of the sympathetic nervous system [4]. These haemodynamic responses are attributed to increased release of catecholamines, vasopressin, or both [5,6]. $EtCO_2$ partial pressure monitoring is increasingly used during anaesthesia as an indirect measure of arterial carbon dioxide tension ($PaCO_2$). Therefore, the relationship between these two variables is of considerable interest [7].

Previous studies [8-11] have individually explored the haemodynamic or capnographic changes associated with laparoscopic or open cholecystectomy. However, a comprehensive analysis directly comparing both approaches is scarce, especially in the northeastern part of India. Some studies have reported advantages of laparoscopy, such as reduced blood loss and shorter hospital stays. Conversely, concerns have been raised regarding the potential for increased intra-abdominal pressure during laparoscopic procedures, which may impact haemodynamic stability and respiratory parameters [8-11]. The existing literature requires more in-depth research to directly compare the two surgical techniques, considering both haemodynamic and capnographic perspectives.

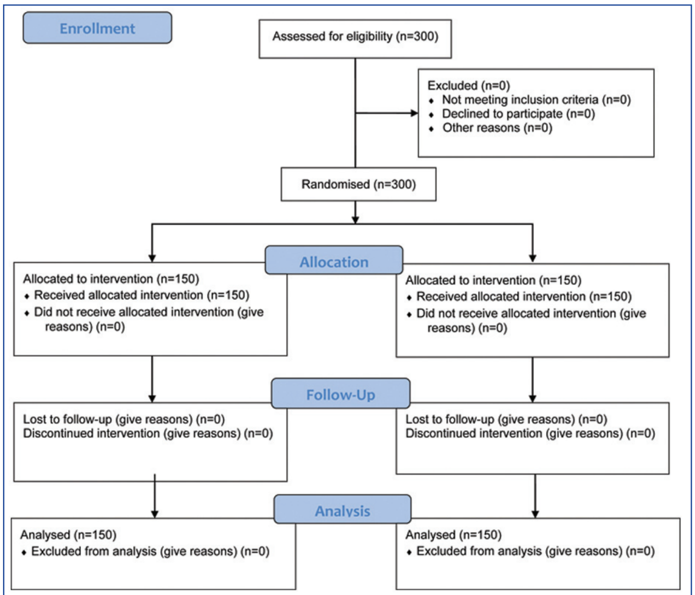
Panda BK et al., [12], Kumar A et al., [13], Chopra G et al., [14], and Banu MS et al., [15] evaluated 60 adults each, allocating them into open and laparoscopic surgery groups (30:30). Since both laparoscopic and open cholecystectomies are routine procedures at the present institute, and there is a paucity of previous research on this subject in this region, aimed to analyse and compare 300 adults based on changes in haemodynamic and capnographic parameters like PR, SBP, DBP, MAP, SpO_2 and $EtCO_2$.

MATERIALS AND METHODS

This randomised clinical study was conducted over a period of one year, from May 2021 to June 2022, at Department of Anaesthesiology, Assam Medical College and Hospital, Dibrugarh, Assam, India. Informed written consent was obtained from the patients who willingly agreed to participate. Ethical approval was obtained from the Institutional Ethics Committee of Assam Medical College, Dibrugarh, with approval no. (AMC/EC/ PG 5686) dated 24-07-2020.

Sample size calculation: The sample size was estimated based on an alpha error of 0.05 and a power of 80%, resulting in a calculated sample size of 150 for each group, totaling 300.

Patients were allocated into two groups. Group I (n=150) underwent laparoscopic cholecystectomy, and Group II underwent open cholecystectomy based on the list received from the Surgery Department. The Consolidated Standards of Reporting Trial (CONSORT) has been shown in [Table/Fig-1].



[Table/Fig-1]: Consolidated Standards of Reporting Trial (CONSORT) flow diagram.

Inclusion criteria: A total of 300 patients between the ages of 18 and 60, of either sex, with a Body Mass Index (BMI) <30 kg/m^2, and ASA Grade-I and II were included in the study.

Exclusion criteria: Patients' refusal, ASA ≥3, BMI ≥30; those with cardiorespiratory illness, renal dysfunction, metabolic or any uncontrolled systemic illness; conditions in which laparoscopic cholecystectomy may need to be converted into open cholecystectomy; those with bleeding disorders; and pregnant women were excluded from the study.

Study Procedure

All patients underwent a complete preanaesthetic evaluation in their respective wards the day before the operation. After obtaining the patient's complete medical history, including details of any previous operations, drug allergies, or prolonged medical treatment, a thorough clinical examination was conducted. The appropriate laboratory studies were then carried out based on the patient's clinical profile and the anticipated surgery.

Technique of anaesthesia: In the preoperative room, haemodynamic parameters like HR, MAP, SBP, DBP, PR, and SpO_2 were measured. Cannulation was performed, and Ringer's lactate infusion was initiated. ASA monitors, including blood pressure, Electrocardiogram (ECG), pulse oximeter, temperature probe, and $EtCO_2$, were attached, and monitoring continued throughout the operation. Premedication was administered intravenously, including Inj. Glycopyrrolate 4 μg/kg, Inj. Fentanyl 2 μg/kg, Inj. Pantoprazole 40 mg, Inj. Ondansetron 0.1 mg/kg, and Inj. Midazolam 1 mg. After preoxygenation with 100% oxygen for three minutes, all patients were induced with intravenous propofol (2 mg/kg), and neuromuscular blockade was achieved with Inj. Succinylcholine 1.5 mg/kg. Laryngoscopy was performed using a Macintosh laryngoscope blade, and endotracheal intubation was conducted. Inj. Atracurium loading dose (0.5 mg/kg) was administered, and a Ryle's tube was inserted. A capnograph was attached to the endotracheal tube, and $EtCO_2$ was recorded prior to CO_2 insufflation in laparoscopic cholecystectomy and prior to incision in open cholecystectomy. Anaesthesia was maintained using oxygen, N_2O, and sevoflurane inhalation at titrated doses. Intermittent doses of Inj. Atracurium (0.1 mg/kg) were administered, and Inj. Paracetamol was given for intraoperative analgesia. The rate of CO_2 insufflation was 1 to 2 litres/min, and the maximum allowed intra-abdominal pressure was 15 mmHg. The patient was positioned in a head-up position with a right-side-up tilt of 15 degrees, and the intra-abdominal pressure was maintained at 15 mmHg. The primary outcomes of interest were the comparison of changes in MAP, PR, $EtCO_2$ and SpO_2 between the two groups. These parameters were continuously monitored and recorded every 15 minutes for one hour, and then every 30 minutes until the end of the procedure. All patients were reversed using Inj. Neostigmine (0.05 mg/kg) and Inj. Glycopyrrolate (0.01 mg/kg) intravenously. After patients were awake and their vital parameters were within an acceptable range, Ryle's tube suction was performed and removed, and patients were extubated after oropharyngeal suction. In the postoperative period, all vital parameters were recorded for up to two hours. This study aimed to determine the haemodynamic and capnographic parameters like PR, SBP, DBP, MAP, $EtCO_2$, and SpO_2 (oxygen saturation), in laparoscopic and open cholecystectomy.

STATISTICAL ANALYSIS

The data were analysed with the help of the student's t-test and Chi-square test, using SPSS software version 21.0 and Microsoft excel.

RESULTS

Demographic data: There were no statistically significant differences in age and body weight (p-value >0.05) [Table/Fig-2]. There was no significant difference in the distribution of sex between Group I and Group II (p-value >0.05, Chi-square test) [Table/Fig-2].

Characteristics	Group I (Laparoscopic)	Group II (Open)	p-value*,†
Age (years)	47.83±7.52	47.29±7.94	0.97
Weight (kg)	53.15±6.19	52.15±6.89	0.23
Male:Female	80:70	85:65	0.639
ASA Grade 1:2	130:20	118:32	

[Table/Fig-2]: Demographic data of patients.
*Chi-square test
†p<0.05: Statistically significant; p<0.01: Highly significant

Pulse Rate (PR): In 15, 30, and 45 minutes perioperatively, Group I patients showed a greater rise in PR compared to Group II patients after carbon dioxide insufflation, and the differences between the groups were highly significant (p-value <0.01, Student's t-test). At 60 minutes, the difference was statistically significant (p<0.05) [Table/Fig-3].

Systolic Blood Pressure (SBP): In 15, 30, 45, and 60 minutes intraoperatively, Group I patients showed a greater rise in SBP compared to Group II patients, and the differences between the groups were statistically highly significant (p-value <0.01, Student's t-test) [Table/Fig-4].

Diastolic Blood Pressure (DBP): In 15, 30, and 60 minutes intraoperatively, Group I patients showed a greater rise in DBP compared to Group II patients, and the differences between the groups were statistically highly significant (p-value <0.01, Student's t-test). At 45 minutes, the difference was significant [Table/Fig-5].

MAP: In 15, 30, 45, and 60 minutes intraoperatively, Group I patients showed a greater rise in MAP post-insufflation compared to Group II patients, and the differences between the groups were statistically highly significant (p-value <0.01, Student's t-test) [Table/Fig-6].

	Group I (Laparoscopic)		Group II (Open)		
PR	Mean	SD	Mean	SD	p-value*,†
Preoperative	83.88	10.95	85	2.39	0.22
15 Min	101.46	17.40	95.86	7.49	<0.0001
30 Min	104.52	15.12	99.82	15.97	<0.0001
45 Min	102.52	12.36	97.70	10.10	<0.0001
60 Min	101.41	16.83	97.83	13.79	0.04
Postoperative 1 hour	84.01	10.95	85.29	4.39	0.18
Postoperative 2 hours	83.77	11.28	85.02	4.49	0.2

[Table/Fig-3]: Comparison of Pulse Rate (PR) between Group I and Group II.
*Student's t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

	Group I (Laparoscopic)		Group II (Open)		
SBP	Mean	SD	Mean	SD	p-value*,†
Preoperative	121.75	10.14	122.97	7.34	0.26
15 min	148.57	18.55	140.97	9.03	<0.0001
30 min	141.28	11.19	136.07	11.59	<0.0001
45 min	140.59	10.37	133.95	8.09	<0.0001
60 min	132.89	14.39	128.73	7.96	0.002
Postoperative-1 hour	121.86	9.69	123.49	7.60	0.08
Postoperative-2 hours	118.76	11.35	125.33	9.02	0.10

[Table/Fig-4]: Comparison of mean Systolic Blood Pressure (SBP) between Group I and Group II.
*Student t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

	Group I (Laparoscopic)		Group II (Open)		
DBP	Mean	SD	Mean	SD	p-value*,†
Preoperative	80.73	8.64	80.33	10.36	0.71
15 min	103.21	14.78	93.23	5.20	<0.0001
30 min	96.74	11.29	92.57	12.70	<0.0001
45 min	95.53	7.91	87.59	7.42	0.0174
60 min	93.14	10.85	86.92	1.77	<0.0001
Postoperative 1 hour	80.77	8.83	81.39	8.89	0.54
Postoperative 2 hours	80.70	8.79	81.89	3.39	0.49

[Table/Fig-5]: Comparison of mean Diastolic Blood Pressure (DBP) between Group I and Group II.
*Student t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

	Group I (Laparoscopic)		Group II (Open)		
MAP	Mean	SD	Mean	SD	p-value*,†
Preoperative	92.32	5.76	93.63	6.87	0.07
15 min	118.38	16.76	108.61	9.78	<0.0001
30 min	111.11	13.96	106.01	8.38	<0.0001
45 min	110.73	9.79	103.48	6.41	<0.0001
60 min	106.08	8.97	101.45	9.79	<0.0001
Postoperative 1 hour	92.22	6.55	93.44	6.64	0.11
Postoperative 2 hours	91.99	6.72	93.44	6.64	0.06

[Table/Fig-6]: Comparison of Mean Arterial Pressure (MAP) between Group I and Group II.
*Student's t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

End-Tidal CO_2 ($EtCO_2$): Perioperatively, after insufflation at 15, 30, 45, and 60-minute intervals, there was a greater rise of $EtCO_2$ in Group I patients with a minimum rise in Group II patients, and the differences between the two groups were statistically highly significant (p-value <0.01) [Table/Fig-7].

Oxygen Saturation (SpO_2): Preoperatively, the mean SpO_2 of both groups was 100%, but there was a significant difference between the two groups at 15 minutes post-carbon dioxide insufflation (p-value <0.05). At 30, 45, and 60 minutes, SpO_2 was maintained in the normal range in both groups [Table/Fig-8].

	Group I (Laparoscopic)		Group II (Open)		
$EtCO_2$	Mean	SD	Mean	SD	p-value*,†
15 min	36.48	1.51	33.89	3.14	<0.0001
30 min	41.02	2.59	36.15	1.67	<0.0001
45 min	42.65	3.12	38.36	10.18	<0.0001
60 min	41.10	3.20	38.21	2.77	<0.0001

[Table/Fig-7]: Comparison of mean End-Tidal CO_2 ($EtCO_2$) between Group I and Group II.
*Student's t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

	Group I (Laparoscopic)		Group II (Open)		
SpO_2	Mean	SD	Mean	SD	p-value*,†
Preoperative	100	0.00	100	0.00	-
15 min post in	99.93	0.31	100.00	0.00	0.003
30 min	99.99	0.08	100.00	0.00	0.31
45 min	99.99	0.12	100.00	0.00	0.15
60 min	99.99	0.12	100.00	0.00	0.15
Postoperative 1 hour	99.98	0.14	100	2.55	0.08
Postoperative 2 hours	100	0.00	100.00	0.00	-

[Table/Fig-8]: Comparison of mean Oxygen Saturation (SpO_2) between Group I and Group II.
*Student's t-test
†p<0.05: Statistically significant; p<0.01: Highly significant

At two hours postoperative, there was a decrease in all the parameters toward the preoperative values.

DISCUSSION

The present study aimed to compare the haemodynamic and capnographic changes between two groups undergoing laparoscopic cholecystectomy (Group I) and open cholecystectomy (Group II), respectively, using standard ASA monitors such as Non Invasive Blood Pressure (NIBP), ECG, pulse oximeter, and capnography.

[Table/Fig-9] presents a comparison of haemodynamic parameters from the current study and similar studies [12-15].

Haemodynamic parameters	Current study 2022	Panda BK et al., 2021 [12]	Banu MS et al., 2019 [15]	Kumar A et al., 2019 [13]	Chopra G et al., 2007 [14]
Pulse Rate (PR) Group I (Laparoscopic) Group II (Open)	Highly significant rise in Gp I than Gp II (p<0.01) at 15, 30, 45 and 60 minutes	Statistically significant rise in the laparoscopic group from 20 minutes to 60 minutes after intubation	More stable in Gp I than Gp II. Normal range in both gps.	Highly significant rise in PR in Group I (p<0.01) at 15, 30, 45 and 60 minutes per-operatively	In gp I the increase in heart rate was very highly significant at 30 and 40 minutes
Systolic Blood Pressure (SBP)	Highly significant rise was seen in Group I compared to Group 2 at 15, 30, 45 and at 60 minutes	Not recorded	Rise in Group II-O was more than Group I-L at different stages.	Not recorded	In gp I the increase in SBP was very highly significant at 30 and 40 minutes but in gp II, initial rise in SBP was insignificant
Diastolic Blood Pressure (DBP)	Highly significant rise was seen in Gp I compared to Gp II at 15, 30, and 60 minutes	Not recorded	Rise in Group II-O was more than Group I-L at different stages.	Not recorded	In gp I, the increase was very highly significant at 30 and 40 minutes compared to gp II.
Mean Arterial Pressure (MAP)	Gp I patients showed greater rise than gp II at 15, 30, 45 and at 60 minutes	Significant rise in gp I than gp II from 20 minutes to 60 minutes after intubation	More stable in gp I and fluctuation is more in gp II.	Highly significant rise was seen in gp I compared to gp II at 15, 30, 45 and 60 minutes	Very highly significant rise in gp I at 30, 40 min after intubation. Rise in gp II is insignificant

[Table/Fig-9]: Comparison of haemodynamic parameters of current study and similar published studies [12-15].
1. Group I: Laparoscopic cholecystectomy patients
2. Group II: Open cholecystectomy patients

Pulse Rate (PR): The comparison of PR revealed a statistically highly significant rise in Group I ($p<0.0001$) at 15, 30, 45 minutes, and a significant rise at 60 minutes (p-value was 0.04, i.e., $p<0.05$) perioperatively after pneumoperitoneum creation. Hypercarbia leads to widespread sympathetic stimulation, resulting in tachycardia and vasoconstriction, counteracting the direct vasodilatory effect of carbon dioxide [16].

SBP, DBP, and MAP: A highly significant rise in SBP was observed in Group I at 15, 30, 45, and subsequently at 60 minutes after CO_2 insufflation, caused by increased systemic and pulmonary vascular resistance and reduction of cardiac index when laparoscopy is performed at approximately 15 mmHg with head-up tilt. Significant rise in DBP was noted in Group I at 15, 30, 45, and 60 minutes intraoperatively after insufflation compared to Group II (open cholecystectomy). Similar observations were made by Chopra G et al., who found a highly significant rise at 30 and 40 minutes in both SBP and DBP [14]. Singh SP et al., showed that the DBP of patients in Group B (low pressure, <8 mmHg pneumoperitoneum) was higher than that of Group A (standard pressure, 12-14 mmHg pneumoperitoneum) at 30, 40, and 50 minutes after induction, while in the rest of the observation periods, the DBP of Group A was higher than that of Group B [8].

MAP also demonstrated a statistically significant rise in Group I at 15, 30, 45, and 60 minutes. This finding is supported by Kumar A et al., where a highly significant rise was observed in Group I (laparoscopic) compared to Group II (open) at 15, 30, 45, and 60 minutes [13]. Panda BK et al., found a highly significant rise in Group I at 30 and 40 minutes after intubation compared to an insignificant rise in MAP in Group II [12]. The rise in arterial blood pressure is caused by neurohumoural responses due to the activation of the Renin-angiotensin-Aldosterone System (RAAS), increased intra-abdominal pressure, and increased systemic and pulmonary vascular resistances. Therefore, the patient's cardiopulmonary status should be adequate to handle the stress response during pneumoperitoneum creation [17,18].

The observed haemodynamic variations in Group I individuals were not clinically concerning, and no therapies were necessary. Desufflation helped reduce the alterations in parameters, which returned to practically baseline within the first two hours following surgery. No patients in the present study experienced any dangerous arrhythmias. Peritoneal insufflation at IAPs greater than 10 mmHg significantly alters haemodynamic parameters [19]. Concrete steps should be taken to avoid unintended and abrupt haemodynamic changes.

In the pathogenesis of pneumoperitoneum, intra-abdominal pressure is an extremely significant factor [8,10]. In the present study, IAP was maintained at 15 mmHg during laparoscopic cholecystectomy (Group I patients). During insufflation, the patients were positioned with their right-side up and their head tilted up 15 degrees. Group I patients experienced significant haemodynamic changes due to elevated IAP, patient positioning, and CO_2 absorption. Galizia G et al., in their investigation of haemodynamic alterations after open and laparoscopic cholecystectomy, concluded that CO_2 pneumoperitoneum significantly altered heart performance [20].

In the current study, a highly significant rise in $EtCO_2$ levels was observed in Group I patients at 15, 30, 45, and 60 minutes after CO_2 insufflation, but it did not exceed the upper limit of normal. Panda BK et al., in their comparison of $EtCO_2$ between both groups, found a statistically significant increase in $EtCO_2$ in the laparoscopic group starting from t=20 minutes after intubation until 10 minutes before extubation [12]. Kumar A et al., also found a highly significant (p-value <0.01) rise in $EtCO_2$ in Group I compared to Group II [13]. Singh SP et al., observed that the mean $EtCO_2$ of patients in Group-B, where low pressure (<8 mmHg) pneumoperitoneum was used, was higher than that of Group-A (standard pressure 12-14 mmHg) at all periods except 30 minutes after induction. The differences in $EtCO_2$ levels between patients in Group-A and Group-B were statistically significant at all intervals after 30 minutes of induction (i.e., 30 minutes, 40 minutes, 50 minutes, 60 minutes, and 2 hours after induction) [8]. Umar A et al., found that in all groups under their study, $EtCO_2$ increased immediately after insufflation and continued to rise with the increasing duration of CO_2 insufflation until exsufflation [10]. Kachru N and Saha U observed a significant rise in $EtCO_2$ in the laparoscopic group at 30 minutes after insufflation [21].

Respiratory changes during laparoscopic procedures are important factors that can cause an increase in $PaCO_2$, leading to arterial and tissue acidosis. Increased intra-abdominal pressure produced by pneumoperitoneum impairs ventilation. The elevation of the diaphragm results in decreased Functional Residual Capacity (FRC), Total Lung Capacity (TLC), and pulmonary compliance [22]. Capnometry and capnography help prevent hypercarbia, and $EtCO_2$ generally provides reliable information about $PaCO_2$ during laparoscopy [23].

In the present study, capnography was used to monitor $EtCO_2$, and minute volume was adjusted during controlled ventilation to keep $EtCO_2$ within the normal range. However, $EtCO_2$ was higher in Group I patients than in Group II at different time periods during the operation.

In the current study, a significant difference was observed between the two groups at 15 minutes post-carbon dioxide insufflation, with a p-value <0.05. This dip in Group I at 15 minutes immediately after insufflation supports the fact that there are differences in respiratory mechanics and the emergence of ventilation and perfusion imbalances due to increased intra-abdominal pressure and CO_2 insufflation. Panda BK et al., found that there was a decrease in SpO_2 in the laparoscopic group during the intraoperative period, specifically from t=20 minutes after intubation to t=80 minutes, and the p-values during this period were significant [12].

Limitation(s)

As both ASA Grade-I and II patients were included in the present study, NIBP assessment was conducted instead of invasive arterial blood pressure monitoring. However, postoperative $EtCO_2$ monitoring after two hours was not performed due to the unavailability of capnographic monitors in the postoperative wards.

CONCLUSION(S)

The current research demonstrated a notable increase in key parameters, such as PR, SBP, DBP, MAP, and $EtCO_2$, even in ASA Grade-I and Grade-II patients undergoing laparoscopic cholecystectomy compared to the open surgical technique. There were significant differences in SpO_2 between the two groups at 15 minutes post carbon dioxide insufflation. The present study emphasises the need for careful monitoring during these common surgical procedures, despite the postoperative parameters returning to baseline levels within two hours.

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