Original Article

Comparison of Cardiovascular Status Between Pre-Induction Period and The Different Positions of Anaesthetized Patients in Laparoscopic Cholecystectomy

Mohammad Anisur Rahman[1], Moinul Hossain[2], AKM Faizul Hoque[3], Debabrata Banik[4]

[1]Deputy Program Manager, In-service Training, DGHS, Dhaka. [2]Professor, [3]Associate Professor, [4]Professor & Chairman, Department of Anaesthesia, Analgesia & Intensive Care Medicine, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka.

Corresponding Author: moinul.bsmmu@gmail.com

Abstract

The laparoscopic cholecystectomy nowadays is the method of choice for treatment of patients with cholelithiasis. This surgery involves different types of positioning of the anaesthetized patient. Our study was planned to compare the haemodynamic changes between the pre-induction period with the different positions of the anaesthetized patients during laparoscopic cholecystectomy. Thirty two (32) female patients of ASA physical status - 1 & 11, aged between 18 to 55 years, scheduled for elective laparoscopic cholecystectomy under general anesthesia, were enrolled in the study. All the patients were medicated with tablet clonazepam (0.5mg) on the night before surgery. On arrival to the operation theatre, baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial blood pressure (MAP), and arterial oxygen saturation (SpO_2) were recorded. The patients were then induced with Inj. propofol (1.5 to 2mg/kg). Endotracheal intubation was facilitated with Inj. vecuronium (0.1mg/kg). Anaesthesia was maintained with halothane 0.5% and nitrous oxide 60%, in oxygen. The propofol was infused to strengthen the maintenance of anaesthesia. During operation patient was monitored for HR, NIBP, ECG, $ETCO_2$, and SpO_2. The haemodynamic tools of the patients were continuously recorded. The pre-induction mean HR, SBP, DBP, MAP were compared with the values found after induction in trendelenburg and reverse trendelenburg position. The mean HR during pre-induction period & after induction in trendelenburg position, & reverse trendelenburg position were respectively 79.2±8.2, 76.6±9.6, and 70.1±5.9beats/min. The mean HR was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position. The mean SBP during pre-induction period & after induction in trendelenburg & reverse trendelenburg position were respectively 138.0±11.6, 130.3±9.9, and 119.3 ±12.7 mm Hg. The mean SBP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position. The mean DBP during pre-induction period, after induction in trendelenburg & reverse trendelenburg position were respectively 75.5±10.9, 72.6±6.1, and 70.6±6.1mm Hg. The mean DBP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position. The mean MAP during pre-induction period, after induction in trendelenburg & reverse trendelenburg position were respectively 96.3±10.7, 95.0±9.8, and 72.6 ±6.1mm Hg. The mean MAP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position. So, it can be concluded that the cardiovascular status was significantly decreased in both trendelenburg and reverse trendelenburg position than the pre-induction values found during laparoscopic cholecystectomy.

Key words: *laparoscopic cholecystectomy, haemodynamic status, pre-induction, trendelenburg position, reverse trendelenburg position.*

(JBSA 2017; 30(1): 27-33)

Introduction:

The laparoscopic cholecystectomy like other surgery is associated with neuroendocrine stress response. The stress response involves sympathetic & endocrine system. The sympathetic stimulation is associated with excessive activation of cardiovascular system. In addition, sympathetic stimulation causes release of catecholamines from adrenal medulla which further activates the cardiovascular system[1]. The involvement of cardiovascular system also varies with the extent of surgery. In major surgery, the neuroendocrine stress response is very significant, causing more stimulation of the cardiovascular system. Beside these factors, different positions of the patient in laparoscopic cholecystectomy may influence the cardiovascular status[2, 3].

The laparoscopic cholecystectomy nowadays is the method of choice for treatment of patients with cholelithiasis. The objective of the surgery is to minimize the surgical trauma through small abdominal incisions. The surgery involves the different positioning of the anaesthetized patient including – trendelenburg position, then insufflation of the peritoneal cavity with carbon dioxide and lastly the reverse trendelenburg position[4].

The trendelenburg position (15-20°) is used temporarily in the initial stage of surgery where trocar is inserted in to the peritoneal cavity[5]. This head-down position is associated with increases in venous return (VR), the right atrial pressure (RAP), the central blood volume and the cardiac output[6]. The next step of laparoscopic surgery is the insufflation of peritoneal cavity with carbon dioxide (pneumoperitoneum). The insufflation provides adequate surgical exposure and maintains operative freedom[7]. But, the intra-peritoneal insufflation with CO_2 however, can affect several homeostatic systems, including, alterations in acid-base balance, cardiovascular and pulmonary physiology. Beside these, pneumoperitoneum may also be associated with the mechanical compression of the inferior vena cava[7].

After pneumoperitoneum, patient needs to reverse the trendelenburg position. In the reverse trendelenburg position, all the functions of trendelenburg position are also reverses. This position might be associated with decrease in venous return (VR), right atrial pressure (RAP) and pulmonary capillary wedge pressure (PCWP), resulting fall in cardiac output and mean arterial blood pressure. These changes are further be exacerbated by the compression of the inferior vena cava and hormonal changes that occur during surgery[6].

So, the laparoscopic cholecystectomy creates complex situations in the cardiovascular system. The complex situation is due to interaction of the factors related with the surgery, including - extend surgery, the anesthetic agents used, ventilatory technique provided, different positioning of the anaesthetized patient, pneumoperitonium, high intra-abdominal pressure, volume of carbon dioxide absorbed and the patient's intravascular volume. This complex situation may be well tolerated by healthy individuals, but the patient with pre-existing cardiac impairment may cause perioperative complications. These complications could be reduced by modifying the factors involve in surgery and thereby the surgical outcome could be improved, which might shorten the length of the hospital stay as well as lower the total cost of patient care. Therefore our study was planned to compare haemodynamic changes found during different positioning in laparoscopic cholecystectomy with the values found during pre-induction period.

Methods:

Thirty two (32) female patients of ASA physical status - 1 & 11, aged between 18 to 55 years, scheduled for elective laparoscopic cholecystectomy under general anesthesia, were enrolled in the study. The patients with cardiovascular diseases including hypertension, diabetes mellitus, as well as the patients routinely using catecholamines or patient with diseases of adrenal medulla or the patients treated with the drugs that had a potential impact on serum catecholamines level were excluded from the study. The surgery taking more than one and half hour was also excluded. Written informed consent was taken from each patient before enrollment in the study. The protocol was approved by the local ethical committee. The study was carried out in the Department of Anaesthesia, Analgesia and Intensive Care Medicine, BSMMU, Dhaka.

The patients were medicated with tablet clonazepam (0.5mg) on the night before surgery. On arrival to the operation theatre, a short history was taken, monitoring devices were attached and baseline haemodynamic parameters like heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial blood pressure (MAP), and arterial oxygen saturation (SpO_2) was recorded. Then the intravenous access was obtained with 18-G IV cannula. After preoxygenation, patients were premedicated with injection fentanyl citrate intravenously at the dose of 2 μg/kg body weight. The patients were then induced with injection propofol 1.5 to 2mg/kg (according to verbal contact). Endotracheal intubation was facilitated by muscle relaxant vecuronium (0.1mg/kg). Anaesthesia was maintained with halothane 0.5% and nitrous oxide 60%, in oxygen. The propofol was infused to help in the maintenance of anaesthesia in the following infusion scheme which includes10mg/kg/hour for first 10 minutes, 8mg/kg/hour for next 10 minutes and 6mg/kg/hour for the rest of the operation period. During operation, dose of the fentanyl was adjusted according to haemodynamic variability and depending on the clinical signs of pain. The signs of inadequate analgesia was defined, when the heart rate and mean arterial blood pressure (MAP) were increased more than 20% above the baseline, and were managed by a bolus dose of fentanyl 0.5μg/kg body weight. Muscle relaxation was achieved by intermittent bolus doses of vecuronium. Normothermia was maintained during the operation. During operation patients were monitored continuously for HR, NIBP, ECG, $ETCO_2$, and oxygen saturation (SpO_2).

After intubation, patients were placed into trendelenburg position. Then the surgeon introduced varess needle through umbilical port and the abdomen was insufflated with CO_2 and, intra-abdominal pressure was maintained between 10 to 16 mm Hg. The patients were kept in trendelenburg position for about 10 minutes, during which haemodynamic parameter including HR, SBP, DBP and MAP were recorded.

Afterward, the patients were placed in reverse trendelenburg position. About 10 minutes after reverse trendelenburg position, the haemodynamic parameters were again recorded. The laparoscopic cholecystectomy was performed under video guide after performing four punctures on the abdominal wall.

At the end of the skin closer, all the anaesthetic agents and nitrous oxides were gradually withdrawn. Halothane was terminated at the start of skin closure. Residual neuromuscular block were reversed by an appropriate dose of neostigmine and atropine and the endotracheal tube was extubated. During extubation, adequate pharyngeal suction was given. After tracheal extubation patients were transferred to the recovery room, where all the vital signs were recorded and carefully observed for any adverse effect.

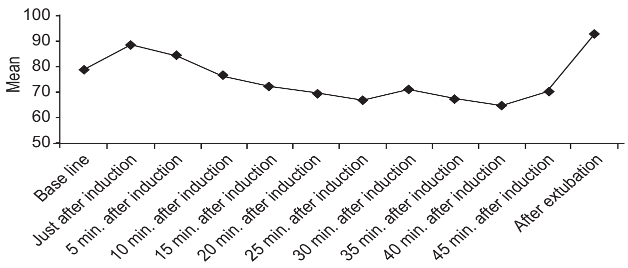
A descriptive analysis was performed for all data. The mean values were calculated for continuous variables. The data are expressed as Mean ±SD. Paired t-test was used to compare the mean heart rate, mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure of the pre-induction period with the record found at different time intervals during intra-operative period. Paired t-test was also used to compare the pre-induction haemodynamics with the haemodynamic values found during trendelenburg and reverse trendelenburg position. The P value d" 0.05 was considered statistically significant.

Results And Observation

We studied 32 female patients, where the mean ASA physical status was – I. The mean age of patients was 37.3±8.7 years with range from 24 to 55 years. The mean weight was found 58.1±6.7 kg with range from 43 to 75 kg.

Table 1 *Demographic data*

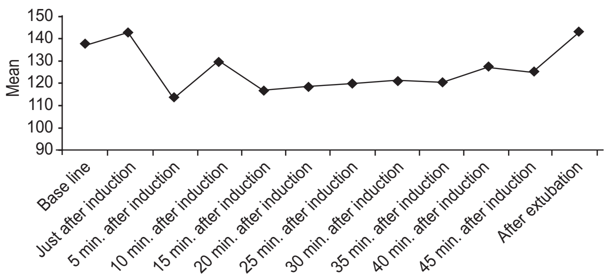
Number of patients	Age in year Mean ± SD	ASA physical status	Weight in Kg Mean ± SD
32	37.3±8.7	1	58.1±6.7 kg



Heart rate (beats per minute)

Fig 1 *Line diagram showing the changes of heart rate at different time intervals during intra-operative period*

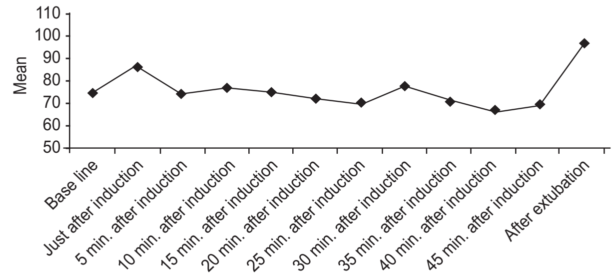
The mean heart rate during pre-induction period was 79.2±8.2 beats/min. During intra-operative period, the heart rate varied significantly as compared with the pre-induction values (P<0.05).



Systolic blood pressure (mmHg)

Fig 2 *Line diagram showing the changes of systolic blood pressure at different time intervals during intra-operative period*

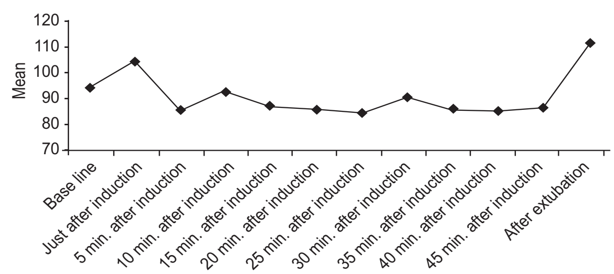
The mean systolic blood pressure during pre-induction period was 138.0±11.6 mm Hg. During intra-operative period, the mean systolic blood pressure varied significantly as compared with the pre-induction values (P value <0.05).



Diastolic blood pressure (mmHg)

Fig 3 *Line diagram showing the changes of mean diastolic blood pressure at different time intervals during intra-operative period*

The mean diastolic blood pressure during pre-induction period was found 75.5±10.9 mm Hg. During intra-operative period, the mean diastolic blood pressure varied significantly as compared with the pre-induction values (p<0.05).



Mean arterial pressure (mmHg)

Fig 4 *Line diagram showing the changes of mean arterial pressure at different time intervals during intra-operative period*

The mean arterial blood pressure during pre-induction period was 96.3±10.7 mm Hg. During intra-operative period, the mean arterial pressure varied significantly as compared with pre-induction values (p<0.05).

Table II *Mean Heart rate at 10 minutes before induction, 10 minutes after trendelenburg position and 10 minutes after reverse trendelenburg position*

Pre induction HR beats/min Mean±SD	10 minutes after Trendelenburg position HR beats/min Mean±SD	P value	Pre induction HR beats/min Mean±SD	10 minutes after reverse Trendelenburg position HR beats/min Mean±SD	P value	Ten minutes after Trendelenburg position HR beats/min	Ten minutes after reverse Trendelenburg position mean HR beats/min Mean±SD	P value
79.2±8.2	76.6±9.6	0.001^{s}	79.2±8.2	70.1 ±5.9	0.001^{s}	76.6±9.6	70.1±5.9	0.001^{s}

The mean heart rate was statistically significant (p<0.05) between pre induction, trendelenburg and reverse trendelenburg position

Table-III *Mean SBP 10minutes before induction, 10 minutes after trendelenburg and 10 minutes after reverse trendelenburg position*

Preinduction SBP mmHg Mean±SD	Ten minutes after Trendelenburg position SBP mmHg Mean±SD	P value	Preinduction SBP mmHg Mean±SD	Ten minutes after reverse Trendelenburg position SBP mmHg Mean±SD	P value	Ten minutes after Trendelenburg position SBP mmHg	Ten minutes after reverse Trendelenburg position mean SBP mm Hg Mean±SD	P value
138.0±11.6	130.3±9.9	0.001^{s}	138.0±11.6	119.3 ±12.7	0.001^{s}	130.3±9.9	119.3±12.7	0.001^{s}

The mean SBP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position.

Table IV *Mean DBP at 10 minutes before induction and 10 minutes after Trendelenburg position and 10 minutes after reverse Trendelenburg position*

Preinduction mean DBP mm Hg Mean±SD	Ten minutes after Trendelenburg position mean DBP mmHg Mean±SD	P value	Preinduction mean DBP mm Hg Mean±SD	Ten minutes After reverse Trendelenburg position mean DBP mm Hg Mean±SD	P Value	Ten minutes after Trendelenburg position mean DBP mm Hg	Ten minutes after reverse Trendelenburg position mean DBP mm Hg Mean±SD	P value
75.5±10.9	72.6±6.1	0.001^{s}	75.5±10.9	70.3 ±12.0	0.001^{s}	72.6±6.1	70.3 ±12.0	0.001^{s}

The mean DBP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position.

Table V *MAP at 10 minutes before induction and 10 minutes after trendelenburg position and 10 minutes after reverse trendelenburg position*

Preinduction MAP mm Hg Mean±SD	Ten minutes after Trendelenburg position MAP mmHg Mean±SD	P value	Preinduction MAP mm Hg Mean±SD	Ten minutes after reverse Trendelenburg position MAP mmHg Mean±SD	P value	Ten minutes after Trendelenburg position MAP mmHg	Ten minutes after reverse Trendelenburg position mean DBP mm Hg Mean±SD	P value
96.3±10.7	95.0±9.8	0.001^{s}	96.3±10.7	72.6 ±6.1	0.001^{s}	95.0±9.8	72.6±6.1	0.001^{s}

The mean MAP was statistically significant ($p<0.05$) between pre-induction, trendelenburg and reverse trendelenburg position

Discussion

The laparoscopic cholecystectomy involves creation of pneumoperitonium, trendelenburg and reverse trendelenburg position of an anaesthetized patient[2]. Like other surgery, laparoscopic cholecystectomy is associated with stress response. Beside these, many other factors are involved to create a complex situation in the cardiovascular system[1]. Our study was done to see, how the cardiovascular status is influenced by different body positioning of the anaesthetized patients during the laparoscopic cholecystectomy.

In the present study, average age was about 37.3±8.7 years, ranging between 24 to 55 years. Age of the patient of the present study has similarity with the *Sheta and Bastawy (2007[8])*, where the average age of the patients was 39.36±6.24 years. On the other hand, *Milosavljevic et al. (2014)[9]* had observed higher mean age in their patients undergoing laparoscopic cholecystectomy, which was 53.8±18.7 year. These variations may be due to geographical variations, racial and ethnic differences, genetic causes and different lifestyle of the patients group. In the current study, all patients were female. We deliberately took female patient for uniformity of the study. In this study, patients were ASA physical status-I. It is due to the exclusion criteria. Beside this, the mean age of the study population was relatively younger. So, probability of co-morbidities is comparatively less in our study. In the current study, pre-induction mean heart rate was 79.2±8.2 beats/min which was significantly ($p<0.05$) variable from the heart rate at different time intervals during intra-operative period. The pre-induction mean heart rate was significantly higher than the rate during trendelenburg and reverse trendelenburg position ($p<0.001$). This type of findings has a similarity with the rate found in the studies of *Sahajananda and Rao (2015)*[10], where the mean heart rate at pre-induction period was 79.59±5.59 beats/min, which was reduced to 74.25±1.11 beats/min at 15 minutes after pneumoperitonium, and 72±1.07 beats/min at reverse Trendelenburg position. In the current study, pre-induction mean systolic blood pressure was 138.0±11.6 mm Hg. The mean systolic blood pressure significantly changes at different time intervals during intra-operative period. The pre-induction mean systolic blood pressure was also compared with the pressure found during trendelenburg and reverse trendelenburg position. The pre-induction mean systolic blood pressure changed significantly ($p<0.001$) during trendelenburg and reverse trendelenburg position. Similarly, pre-induction mean diastolic blood pressure was statistically significant ($p<0.001$) between pre-induction vs. trendelenburg, pre-induction vs. reverse trendelenburg, and between trendelenburg vs. reverse trendelenburg position. In the same way, the record of mean arterial pressure significantly ($p<0.001$) changed between pre-induction vs. trendelenburg, pre-induction vs. reverse trendelenburg, and between trendelenburg vs. reverse trendelenburg position. *Sahajananda and Rao (2015)*[10] observed that the mean arterial pressure (MAP) was found 101.91±5.77 mmHg in pre-operative period, which was reduced to 72.91±3.74 mmHg at reverse trendelenburg position. This study is comparable with the current study.

McLaughlin et al. (1995)[11] had studied haemodynamic status after giving standard anesthesia in reverse trendelenburg position. Abdomen was insufflated with CO_2 up to 15 mmHg. Baseline measurements were taken after induction. Additional measurements were taken at 15-min intervals throughout the procedure. There was a significant reduction of mean arterial pressure of about 15.9%, systolic blood pressure of 11.3%, diastolic blood pressure of 19.7%, and CVP of 30.0% from the baseline values. These findings are consistent with the current study.

The cardiovascular parameters were found to be higher in the pre-induction period than the values found during trendelenburg and reverse trendelenburg position. All the haemodynamic parameters were reduced during trendelenburg and reverse trendelenburg position. The trendelenburg position with pneumoperitonium is a complex situation. In addition to stress response, there was increased venous return, which was supposed to increase the haemodynamic parameters. But the study result was opposite, where the cardiovascular parameters were reduced. The probable reason might be related to the reduction in stress response due to anaesthesia. Moreover, pneumoperitoneum caused increase in intra-abdominal pressure (IAP). The increased IAP was associated with excessive stretching of the peritoneum causing increased vagal tone which reduced haemodynamic parameters[12]. The haemodynamic parameters were further reduced due to compression of inferior vena cava[5].

In the reverse trendelenburg position, cardiovascular parameters were further reduced. This position was associated with decrease in venous return (VR), right atrial pressure (RAP) and pulmonary capillary wedge pressure (PCWP), resulting fall in the cardiac output and mean arterial blood pressure[12]. In addition, the increased IAP, stimulated the vagal tone at one hand and compress inferior vena cava on the other hand[5]

The IAP is related with the biphasic character haemodynamic status. Up to 10 mm Hg of IAP, the cardiac filling pressures are normal or increased. But if the inflation pressures are increased further (>15 mm Hg), the insufflated CO_2 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. The mean arterial blood pressure rises and the cardiac output falls by 25-35 per cent[13]. An IAP > 20 mm Hg reduces the renal and mesenteric blood flow markedly. The fall in cardiac output is directly proportional to the rise in the IAP. Thus increased IAP has two opposing effects on the cardiovascular system - it forces blood out of the abdominal organs and the inferior vena cava into the central venous reservoir, and at the same time it increases peripheral blood pooling in the lower extremities and thus tends to decrease central venous blood volume[14].

Conclusion

There was profound stress response during pre-induction period causing increased cardiovascular stimulation in laparoscopic cholecystectomy. But the cardiovascular status was reduced during both trendelenburg and reverse trendelenburg position. In trendelenburg position, the haemodynamic variables were reduced due to compression of the inferior vena cava, whereas in reverse trendelenburg position the reduced haemodynamic variables were related to the reduced venous return. But in both positions, the high IAP caused increased vagal tone, which further reduced the cardiovascular status.

References

1. Joris J, Lamy M. Neuroendocrine changes during pneumoperitoneum in laparoscopic cholecystectomy. Br J Anaesth 1993; 70: 33
2. Critchley LA, Critchley JA, Gin T. Haemodynamic changes in patients undergoing laparoscopic cholecystectomy: measurement by transthoracic electrical bioimpedance. British Journal of Anaesthesia 1993; 70: 681-83.
3. Wahba RWM, Beique F, Kleiman SJ. Cardiopulmonary function and laparoscopic cholecystectomy. Canadian Journal of Anaesthesia 1995; 42: 51-63.
4. Cunningham AJ, Brull SJ. Laparoscopic cholecystectomy: anesthetic implications. Anesthesia and Analgesia1993; 76:1120-1133.
5. Sood J, Kumra VP. Anaesthesia for laparoscopic surgery. Indian J Surg 2003; 65: 232-40.
6. Marco AP, Yeo CJ, Rock P. Anesthesia for a patient undergoing laparoscopic cholecy-stectomy. Anesthesiology 1990; 73: 1268-70.
7. Safran DB, Orlando R. Physiologic effects of pneumoperitoneum. Am J Surg 1994; 167 (2): 281-6.
8. Sheta A, Bastawy M. Neuro-endocrinal and inflammatory responses in laparoscopic versus open cholecystectomy. AAMJ 2007; 5 (1): 52-63.
9. Milosavljevic SB, Pavlovic AP, Trpkovic SV, Ilic AN, Sekulic AD. Influence of Spinal and General Anesthesia on the Metabolic, Hormonal, and Hemodynamic Response in Elective Surgical Patients. Med Sci Monit 2014; 20: 1833-1840.
10. Sahajananda H, Rao S. Effects of intravenous clonidine on haemodynamics and on plasma cortisol level during laparoscopic cholecystectomy. Indian Journal of Anaesthesiology 2015; 59 (1): 53–56.
11. McLaughlin JG, Scheeres DE, Dean RJ, Bonnell BW. The adverse hemodynamic effects of laparoscopic cholecystectomy. British Journal of Anaesthesia 1995; 9 (2): 121-124.
12. Dexter SP, Vucevic M, Gibson J, McMahon MJ. Hemodynamic consequences of high and low pressure capnoperitoneum during laparoscopic cholecystectomy. Surg Endosc 1999; 13: 376-81.
13. Johannsen G, Andersen M, Juhl B. The effect of general anaesthesia on the haemodynamic events during laparoscopy with CO_2 insufflation. Acta Anaesthesiol Scand 1989; 33:132-6.
14. Kelman GR, Swapp GH, Smith I, Benzie RJ, Gordon NL. Cardiac output and arterial blood gas tension during laparoscopy. Br J Anaesth 1972; 44: 1155-62.