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The hemodynamic and respiratory alterations associated with laparoscopic cholecystectomy

Dr. Gauri M Panjabi[1], Dr. Tarak K Modi[2]

[1] Associate Professor, Department of Anesthesia, Smt. S.C.L General Hospital, Smt NHL Medical College, Ahmedabad, Gujarat, India

[2] Third Year Resident, Department of Anesthesia, Smt. S.C.L. General Hospital, Smt NHL Medical College, Ahmedabad, Gujarat, India

Abstract

Background: Laparoscopic cholecystectomy requires pneumoperitoneum and reverse trendelenburg's position which causes different changes in physiology, ventilatory and hemodynamic changes. Both the mechanical (pressure related) and co_2 absorption-related effect of carbon dioxide pneumoperitoneum impact the cardio vascular system.

Aims of Study: The aim of this study was to examine the combined effects of pneumoperitoneum and the reverse trendelenburg position on physiological alterations during laparoscopic cholecystectomy particularly Hemodynamic changes and Ventilatory changes

Materials and Methods: Study was done in 30 adult ASA I/II patients during laparoscopic cholecystectomy. All patients were premedicated with inj. Emset 4mg, inj Glycopyrolate 0.2mg and inj Fentanyl 2ug/kg iv. Patient was induced with thiopental sodium 5-7 mg/kg and succinylcholine 2 mg/kg intravenously and intubated with appropriate size of cuff tube. General anesthesia was maintained with Oxygen (50%), Nitrous oxide (50%), Sevoflurane and intermittent inj. Atracurium. Patient was ventilated with low flow anesthesia using closed circuit. Hemodynamic and ventilatory changes were measured before anesthesia, after the induction of anesthesia, after head-up position, 5, 15 and 30 min after pneumoperitoneum.

Results: Heart rate did not change significantly after induction, head up position and 30 minutes after pneumoperitoneum. However MAP was decreased after head up position and elevated progressively after pneumoperitoneum. No significant changes in spo2 noted during surgery but etco2, Peak inspiratory pressure and Plateau airway pressure rises significantly.

Conclusions: Laparoscopic cholecystectomy causes significant hemodynamic and respiratory changes even in healthy patients due to mechanical effect of pneumoperitoneum and hypercarbia due to co_2 insufflation. To conclude with, Anesthesiologists should pay attention and do careful monitoring of cardiovascular and pulmonary function to prevent cardio-pulmonary complications during laparoscopic cholecystectomy.

Keywords: laparoscopic cholecystectomy, head up, pneumoperitoneum, hemodynamic changes, ventilatory changes

Introduction

Laparoscopic cholecystectomy is a minimally invasive technique commonly performed nowadays. It has advantages of small incision, improved cosmetic aspects, less postoperative pain and quick recovery time to normal activities [1].

Laparoscopic cholecystectomy requires pneumoperitoneum and head up position (reverse trendelenburg) which causes different physiological changes. Both the mechanical (pressure related) and co_2 absorption - related effect of carbon dioxide pneumoperitoneum impact the cardio vascular system. Further, increased intra-abdominal pressure may interfere with the adequacy of ventilation [2-5]. Changes in cardiovascular functions include decrease in venous return and cardiac output and an increase in mean arterial pressure, heart rate and systemic vascular resistance. Head up position during surgery also causes reduced venous return leading to hypotension, myocardial and cerebral ischemia. However ventilatory changes caused by pneumoperitoneum are neutralized by the head up position. Pulmonary function tends to improve in this position due to caudal shift of the viscera and decreased pressure on the diaphragm [6].

An understanding of physiologic impact of laparoscopic surgery on various systems is necessary to accurately assess the risk associated with it. Therefore this study was done to evaluate combined effect of pneumoperitoneum and head up position on hemodynamic and ventilatory changes associated with laparoscopic cholecystectomy [6].

Aims of Study

The aim of this study was to examine the combined effects of pneumoperitoneum and the reverse trendelenburg position on physiological alterations during laparoscopic cholecystectomy in respect to Hemodynamic changes and Ventilatory changes

Materials and Methods

The study was done in thirty adult patients aged 18-70 years, ASA-I/II scheduled for elective laparoscopic cholecystectomy. All patient kept nil by mouth overnight and Informed consent was taken.

Exclusion criteria

1. Emergency surgery
2. Patient with ASA-III/IV
3. Patient having cardiac, respiratory co morbidities or any other major systemic disease.

After the patient arrived in operation theatre, routine monitoring devices were applied and IV line secured. All patients were premedicated with IV inj. Emset 4mg, inj Glycopyrolate 0.2mg and inj Fentanyl 2ug/kg.

Preoxygenation with 100% O2 was done for 3 minutes. Patient was induced with Thiopental sodium 5-7 mg/kg and Succinylcholine 2 mg/kg intravenously and intubated with appropriate size of cuff tube. General anesthesia was maintained with Oxygen (50%), Nitrous oxide (50%), Sevoflurane and inj. Atracurium. Patient was ventilated with low flow anesthesia using closed circuit.

Pneumoperitoneum was established by insufflations of carbon dioxide gas through pelviscopic insufflators. Intra-abdominal pressure less than 14 mmHg was maintained. Hemodynamic and ventilatory parameters were recorded at baseline, after induction, immediately after reverse trendelenburg's position and at 5, 15, 30 minutes after pneumoperitoneum.

At the end of surgery patient returned to horizontal position. Reversal was done with IV inj. Neostigmine 2.5mg and inj. Glycopyrolate 0.4mg. After spontaneous breathing established, oral suctioning done and the trachea was extubated.

Statistical Analysis

Results were expressed as the mean ± sd and were analyzed using unpaired t test. P value of <0.05 was considered as statistically significant.

Results

Demographic characteristic of the patients are represented in table 1

Table 1: Demographic Data

Age(year)	50±15
Height(m)	1.60±10
Weight(kg)	60±15
BMI(kg/m2)	23±3
Duration of surgery(min)	120±30

Results expressed as mean ± sd

Table 2: Hemodynamic Changes during Laparoscopic Cholecystectomy

Hemodynamic Changes	Before induction	After induction	Head up		pneumoperitoneum	
				5 min	15 min	30 min
HR	100±10	105±10	102±10	100±10	105±10	105±10
SBP	120±10	110±10	105±5	126±10	136±10	130±10
DBP	80±5	70±5	70±5	85±5	95±5	90±5
MAP	93±5	83±5	81±5	98±5	108±5	103±5

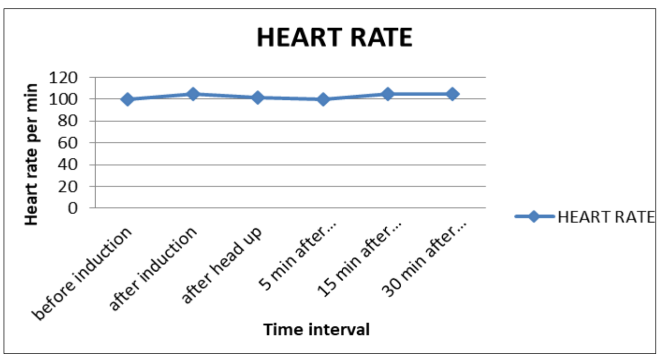

Fig 1: Heart rate changes at various time interval

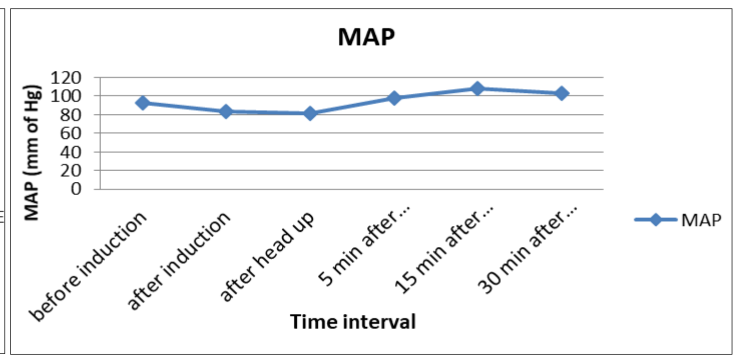

Fig 2: MAP changes at various time interval

Hemodynamic changes at various intervals were noted in table 2. Heart rate did not change significantly after induction, head up position and 30 minutes after pneumoperitoneum (figure 1). MAP was decreased after head up position and elevated progressively after pneumoperitoneum (figure 2).

Table 3: Ventilatory changes during laproscopic cholecystectomy

Ventilatory Changes	After induction	Head up		pneumoperitoneum	
			5 min	15 min	30 min
$Etco_2$	29±2	29±2	30±3	32±3	34±3
Spo_2	99±1	99±1	99±1	99±1	99±1
Peak inspiratory pressure (cm h_2o)	19±1	20±1	22±2	23±2	24±2
Plateau airway pressure (cm h_2o)	17±1	18±1	20±2	21±2	22±2

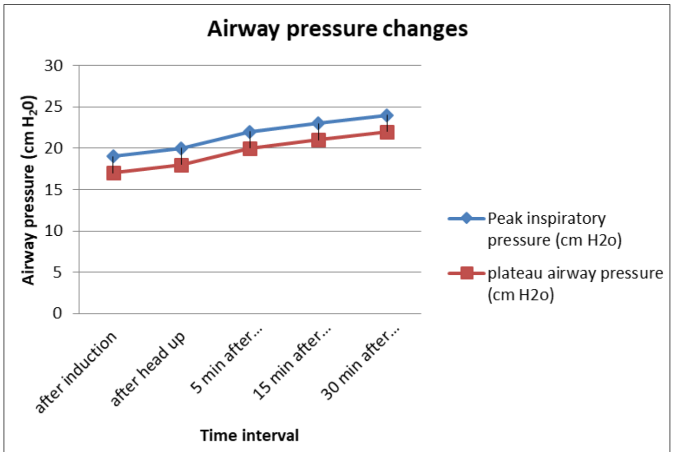

Fig 3: Peak inspiratory pressure and plateau airway pressure changes at various time interval

Ventilatory changes during surgery were noted in table 3. No significant changes in Spo2 noted during surgery but $etco_2$, Peak inspiratory pressure and Plateau airway pressure rises significantly (figure 3).

Discussion

An understanding of the physiologic impact of laparoscopic surgery on the body's various systems is necessary to accurately assess the risks associated with laparoscopic surgery. Laparoscopic cholecystectomy requires head up position and co_2 pneumoperitoneum [6].

Head up position causes pooling of blood in the lower extremities which decreases cardiac preload due to decreases in venous return. This may predispose to hypotension, especially in patients with poor hydration or inadequate volume replacement. Pulmonary function tends to improve in this condition due to caudal shift of the viscera and decreases pressure on diaphragm [6].

The CO2 pneumoperitoneum exerts its physiologic effects via two different mechanisms:

Mechanical effects relating to increased intra peritoneal pressure and co_2 absorption - related effect of carbon dioxide pneumoperitoneum.

Tachycardia is secondary to increased sympathetic discharge, hypercarbia, and impaired venous return from the abdomen and lower extremities. Mean arterial pressure may increase or remain unchanged depending on the relative effect of pneumoperitoneum.

Pulmonary function is affected by head up position, extent of intra-abdominal pressure and duration of pneumoperitoneum[7].

The elevated intra-abdominal pressure exerts mechanical effects that impair pulmonary function. The increased pressure pushes the diaphragm upward, increases the intrathoracic pressure and work of breathing. These alterations are associated with decreased lung compliance, tidal volume and vital capacity. Impaired oxygenation occurs from reduced lung volume and atelectasis due to displacement of diaphragm. Further it is associated with co_2 absorption (hypercarbia) due to carbon dioxide pneumoperitoneum. However, head up position improves pulmonary function by decreasing pressure on the diaphragm [6].

The present study was done in 30 adult ASA I/II patients aged 18-70 years for particularly hemodynamic and respiratory changes occurring during laparoscopic cholecystectomy.

Jean l. joris, m d *et al* (1993) studied hemodynamic changes during laparoscopic cholecystectomy. They concluded that significant hemodynamic changes occur even in healthy ASA-I/II patients undergoing laparoscopic cholecystectomy. MAP was significantly decreased by 25 mm of Hg ($p<0.05$) after head up position and increased by 9 mm of Hg from baseline value (96±13 mm of Hg) ($p<0.05$) after creation of pneumoperitoneum [8].

Min kyo suh *et al* (2010) [9] studied the effect of pneumoperitoneum and trendelenburg position on respiratory mechanics during pelviscopic surgery. They concluded that pneumoperitoneum significantly reduces dynamic lung compliance and increases peak inspiratory, plateau pressure and end tidal carbon dioxide tension. PIP and plateau pressure showed statistically significant elevation by 6 cmH2o ($p<0.05$) and 7 cmH2o ($p<0.05$) from 15.1 ± 2.4 cmH_2o after creation of pneumoperitoneum [9].

In our study, heart rate did not change significantly after induction, head up position and after pneumoperitoneum. MAP was decreased by 12 mm of Hg from the baseline value ($p=0.0001$) after head up position and elevated progressively after pneumoperitoneum by 10 mm of Hg ($p=0.0001$) which is statistically highly significant. No significant changes was noted in Spo2 during surgery but etco2 increased by 5 mm of Hg from baseline value ($p=0.0001$), Peak inspiratory pressure and plateau airway pressure rises by 5 cm H2o from baseline value ($p=0.0001$) after pneumoperitoneum which is statistically highly significant. Our results were comparable with above two studies [8-9].

The trend to readily propose laparoscopic approach for patients with impaired cardiac function because of easier and smoother postoperative recovery should be tempered by the risk related to the intra operative hemodynamic and ventilatory changes induced by Co_2 pneumoperitoneum.

Conclusion

Laparoscopic cholecystectomy causes highly significant hemodynamic and respiratory changes even in healthy patients due to mechanical effect of pneumoperitoneum and hypercarbia due to co_2 insufflation. These changes should not be hazardous in healthy patients but special care and monitoring are mandatory for patients with impaired cardiac and respiratory functions.

To conclude with, Anesthesiologists should pay attention and do careful monitoring of cardiovascular and pulmonary function to prevent cardio-pulmonary complications during laparoscopic cholecystectomy.

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