Haemodynamic and Pulmonary Changes During Laproscopic Versus Open Cholecystectomy

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ABSTRACT:

BACKGROUND:

Laproscopy is a minimally invasive procedure allowing endoscopic access the peritoneal cavity after insufflation of a gas (CO_2)to create space between the anterior abdominal wall and the viscera for safe manipulation.

OBJECTIVE:

Is to note the haemodynamic and pulmonary changes during laparoscopy in the early postoperative period in comparison with open cholecystectomy.

PATIENTS AND METHODS:

30 adult patients of ASA class I and II studied in each group according to surgical procedure used ,monitoring used pulse oximetry ,non invasive automatic blood pressure measurement ,peak inspiratory pressure and capnography.

RESULTS:

There is slight reduction of mean arterial pressure(MAP) and heart rate(HR) following induction of anesthesiain both groups.Howevere,these effects tended to normalize in open cholecystectomy over time while in laproscopy tend to normalize after desufflation.Postoperatively both groups sustain significant reduction in oxygen saturation(SPO_2) but in laproscopy was transient and clinically not significant.

CONCLUSION:

This study show that laproscopy give better recovery and may decrease the need for postoperative oxygen therapy.

KEY WORDS: haemodynamic, pulmonary, laproscopy.

INTRODUCTION:

Laparoscopy or (peritoneoscopy) is a minimally invasive procedure allowing endoscopic access to the peritoneal cavity after insufflations of a gas usually carbon dioxide (CO_2) to create space between the anterior abdominal wall and the viscera. The space is necessary for the safe manipulation of instruments and organs(1).

Laparoscopy was first employed in 1910 (2), early studies in the 1970s that investigated the physiology of laparoscopy on young healthy undergoing short gynecologic operations revealed only minor adverse effects. However, since general surgery adopted the laparoscopic approach to gastrointestinal disorders. There is growing number of clinical and experimental studies that reveal various adverse effects and complications(3)..

Laparoscopic abdominal surgery becoming the preferred technique for treatment for several intraabdominal diseases(4).

Physiological Changes: The three major forces that uniquely alter the patients' physiology during laparoscopy:

1- Intra-abdominal insufflations of carbon dioxide (CO_2).

Rapid absorption of CO_2 during pneumoperitoneum results in hypercapnia, which exerts systemic effects on hemodynamics and intra-abdominal organ blood flow(3). Among the systemic effects of CO_2 absorption are hypercarbia, acidosis, increased sympathoadrenal stimulation, hypertension, tachycardia and increased intracranial pressure(1).

2-Increased intraabdominal pressure (IAP).

Intraabdominal pressures in excess of 40 cm H_2O compresses the inferior vena cava and restricts venous return, with a consequent fall in cardiac output of up to 40% (5). The resulting increase in

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IAP displaces the diaphragm cephalad causing a decrease in lung compliance and an increase in peak inspiratory pressure(PIP). Atelectasis diminished functional residual capacity (FRC), ventilation / perfusion mismatch and pulmonary shunting contribute to a decrease in arterial oxygenation[6].

3- The patients' position.

Laparoscopic cholecystectomy is performed with the patient in a head-down position(to avoid trauma to the viscera)[5] that causes a cephalid shift in abdominal viscera and the diaphragm so functional residual capacity(FRC), total lung volume and pulmonary compliance will be decreased [6].

Advantages Laparoscopic surgery reduces morbidity and shortens recovery after surgery[7]. Avoiding a major abdominal incision decreases postoperative pain and minimizes an impairment of pulmonary function[8] ,also laparoscopy reduces the inflammatory stress response [9].

Disadvantage Narrow two-dimensional visual field on video and longer duration(1).

Open Cholecystectomy This is an open abdominal procedure. The usual access is via an oblique subcostal (Kocher's), right paramedian or midline incision. The frequency of this procedure is declining due to laparoscopic techniques. It is still important for:

- The emergency.
- When laparoscopy proves difficult or complications occur(5).

PATIENTS AND METHOD:

This study was conducted on 30 patients , 15 scheduled for elective laparoscopic cholecystectomy (group A) and 15 scheduled for open cholecystectomy (group B) in the department of general surgery of Baghdad Hospital in Medical City collected during 3 months.The criteria required, an American Society of Anesthesiology (ASA) class I or II with absence of cardiovascular or respiratory dysfunction. Morbidly obese patients and any operation with intraoperative surgical complication were excluded. The patients studied were of different sex and their ages range between 24 -61 years.

Anesthesia and operation

Anesthesia was standardized as follows:

All the patients have preinduction with Fentanyl 1 μg/kg body weight (BW) and Atropine 0.01 mg/kg (BW) given intravenously (i.v.) followed by preoxygenation with 100% O_2 for 5 minutes.

Induction: general anesthesia was induced with sleeping dose of Sodium Thiopental , muscular relaxation was obtained with Atracurium 0.6mg /kg given i.v., tracheal intubation and mechanical ventilation was performed at a rate of 12 breaths /min. and a tidal volume of 10 ml /kg using 100% O_2.

Maintenance: with inhalational agent (Halothane) 0.5 – 1% concentration and supplemental doses of Atracurium 25% of the initial dose every 30 min. Ringers' solution infused at a rate of 5ml/kg (BW) /hr.

Patients in group A had a 12 mmHg pneumoperitoneum .Patients in group B had open cholecystectomy performed through a right subcostal incision and in supine position.

Monitoring: was standardized for all the patients and started before induction including noninvasive blood pressure measurement (NIBP), pulse oximetery and continued intraoperatively in addition to capnography to measure the end tidal CO_2 ($P_{ET}CO_2$) and measurement of peak inspiratory pressure (PIP).

Five variables were monitored and recorded at the following time points:

- Before the induction (T_1)
- After induction of anesthesia (T_2)
- 5 min. after achievement of a 12 mmHg (PP) in group A, 5 min. after laparotomy in group B (T_3)
- After 20 min. from T_3 (T_4)
- After desufflation in group A, after abdominal closure in group B (T_5).

The haemodynamic variables including the mean arterial pressure (MAP) and the heart rate (HR) beats / min.

The pulmonary data including the peak inspiratory pressure (PIP) in cm H_2O, arterial O_2 saturation (SPO_2) % and end tidal CO_2 pressure ($P_{ET}CO_2$) in mmHg .

Postoperatively monitoring continues by pulse oximetry measuring SPO_2 (arterial oxygen saturation) at the following time points:

5 min. after extubation (P_1)

15 min. after extubation (P_2)

30 min. after extubation (P_3)

1 h. after extubation (p_4)

Note: the patient breathing room air.

Statistical analysis

Data were collected and analyzed using SPSS version 10.0 for Windows (SPSS, Chicago, Illinois, and USA).

Differences between groups were examined by student t-test, difference of variables between different times examined by paired t-test. P.value < 0.05 was considered as statistically significant.

RESULTS:

The demographic features of the patients in this study showed no significant differences regarding the gender, age and weight in the two groups but there is significant long operative time with laparoscopic procedures.

Haemodynamic(MAP and HR) monitoring: (T_1) showed no differences between the two groups. (T_2) ,a slight but significant reduction in the MAP ,which was not counterbalanced by an increase in the HR.(T_3) in(group B) , the haemodynamic parameters tending to remain stable. On contrary, in(groupA) all the values differ significantly between T_2 and T_3, thus showing that pneumoperitoneum produced significant impairment of cardiovascular functions ,pneumoperitoneum caused a significant increase in MAP, whereas heart rate remained stable .This trend was observed at T_3, and worsened at T_4.(T_5)MAP returned nearly to preinduction value, whereas HR increase slightly but not reached preinduction value.

Pulmonary (PIP, $P_{ET}CO_2$ and SPO_2) monitoring: before intubation, PIP and $P_{ET}CO_2$ could not be recorded. Therefore, only SPO_2 was available as a basal measurement for the analysis of difference between (T_1)and (T_2) which show significant increase after induction of anesthesia in both groups and remain stable throughout the operation .However, for PIP and $P_{ET}CO_2$ anesthesia and its related cardiovascular impairment did not produce any significant effects on these variables so laparotomy was not associated with significant changes in PIP and $P_{ET}CO_2$ over time during the operative steps and values were shown to be stable. On the contrary, CO_2 pneumoperitoneum was followed by a marked elevation of PIP and $P_{ET}CO_2$ at (T_3) and further increase at (T_4) .However, no attempts were made to compensate for these changes , and minute ventilation was held fixed .PIP value normalized after desufflation while $P_{TE}CO_2$ although it decreased but remain significantly higher than preinsufflation value.

Only monitoring of SPO_2 continue postoperatively which show significant decrease at (P_2) then further decrease at (P_3) tend to remain stable at (P_4) in both groups then there is significant increase at (P_5) which tend to normalize and reach preinduction value in group A but there is no significant difference between (P_4) and (P_5) in group B.

Table 1: Comparison of MAP values in different time points between group A and B.

MAP	Group A		Group B		t	df	p.value	Sig.
	Mean	SD	Mean	SD				
T1	101	10.48	96.93	9.73	1.101	28	0.28	NS
T2	95.47	11.44	91.2	7.75	1.196	28	0.242	NS
T3	102.93	10.62	91.87	7.83	3.249	28	0.003	HS
T4	104.4	10.91	92	8.05	3.541	28	0.001	HS
T5	101.67	9.69	94	8.26	2.331	28	0.027	S

Table 2: Comparison of SPO_2 values in different time points between group A and B.

SPO_2	Group A		Group B		t	df	p.value	Sig.
	Mean	SD	Mean	SD				
T1	97.93	1.1	98.27	0.8	-0.95	28	0.35	NS
T2	99.4	0.74	99.53	0.64	-0.529	28	0.601	NS
T3	99.2	0.68	99.47	0.52	-1.214	28	0.235	NS
T4	99	0.65	99.13	0.74	-0.521	28	0.606	NS
T5	99.2	0.68	98.4	0.83	2.898	28	0.067	NS

Table 3: Comparison of $P_{ET}CO_2$ values in different time points between group A and B.

$P_{ET}CO_2$	Group A		Group B		t	df	p.value	Sig.
	Mean	SD	Mean	SD				
T1	.	.	.	.				
T2	28.33	2.09	29	1.65	-0.969	28	0.341	NS
T3	35.13	2	28	1.65	10.677	28	<0.001	HS
T4	36.77	2.27	27.93	1.58	12.354	28	<0.001	HS
T5	31.23	1.59	28	1.51	5.706	28	<0.001	HS

Table 4: Comparison of PIP values in different time points between group A and B.

PIP	Group A		Group B		t	df	p.value	Sig.
	Mean	SD	Mean	SD				
T1	.	.	.	.				
T2	20.07	2.34	20.93	3.65	-0.773	28	0.446	NS
T3	30.67	3.72	21.2	3.21	7.465	28	<0.001	HS
T4	31.4	3.33	21.33	3.02	8.673	28	<0.001	HS
T5	23	2.3	21.4	3.29	1.544	28	0.134	NS

DISCUSSION:

The increasing use of laparoscopy has resulted in an increased number of elderly patients undergoing minimally invasive surgery, with an increased incidence of associated medical diseases, lengthened operation time, and higher surgical and anesthetic risks [(10)]. It is important to establish the true effects of pneumoperitoneum on the cardiovascular function and other physiologic functions [(11)].Many studies have demonstrated that CO_2 PP may exert negative effects on cardiopulmonary functions and that it therefore is not very safe in patients with such underlying diseases [(12)]. In this study we compare laparoscopic with open cholecystectomy to elucidate the effects of these procedures on cardiopulmonary functions which can be monitored noninvasivly during the operation in addition to monitoring arterial O_2 saturation in the early postoperative period. To avoid misinterptation the anesthesia kept fixed for all operations and we exclude patients with cardiopulmonary dysfunction who require pulmonary adjustment or cardiovascular drugs.

After induction of anesthesia, no critical but significant reduction in MAP and HR were recorded in the two groups which could be atributed to the effect of anesthetic agents used in the induction.Although in many reports a heart rate increase after anesthesia induction is well described on [(13)].

Throughout operative period, the MAP and HR tended to be stable, with slow but progressive trend to normalize in patients undergoing open cholecystectomy. On the contrary, CO_2 PP was associated with elevation of MAP and HR and these effects disappeared after desufflation. This agree with major problems with CO_2 PP has been reported after an increase in intra-abdominal pressure and transperitoneal absorption of CO_2 [(14)]. A high abdominal pressure is known to cause both increase catecholamines release and urinary output reduction. The latter is believed to result from direct renal compression and renal vein hypertension, with release of angiotensin II and vasopressin[(15)].Hypercapnia-induced vasoconstriction could have contributed as well [(13)].

Regarding the marked elevation of PIP and $P_{ET}CO_2$ during CO_2 PP could easily explained as the diaphragm lifting by increased intra-abdominal pressure and increased thoracic pressure which lead to elevation of both pulmonary vascular resistance and mean pulmonary arterial pressure [(16)]. creation of PP reduces respiratory system compliance, and increases peak inspiratory and mean airway pressures, which quickly returned to normal values after desufflation [(17)].

For $P_{ET}CO_2$, insufflation of the abdominal cavity with CO_2 may be associated with pulmonary atelectasis, decreased functional residual capacity and high peak airway pressure in addition to absorption of CO_2 via the peritoneum causes hypercarbia [18].In PP, CO_2 eliminated in expired gas (CO_2 output) contain both CO_2 of metabolic production and also absorbed CO_2 from the peritoneal cavity [19]. Although the CO_2 load in the PP was clinically safe in patients without cardiac or pulmonary disease with controlled ventilation during PP, excess of CO_2 /basal surface area still 30 min. after desufflation[20]and 60 min. was necessary to attain steady state of $P_{ET}CO_2$ after starting mechanical ventilation [21], and that explain elevated $P_{ET}CO_2$ after desufflation.

Regarding SPO_2 increased significantly after intubation and ventilation with 100% O_2 and remains stable throughout the operation in both groups, when the patients extubated and return to breathing room air spontaneously there is significant decrease in SPO_2, which tend to stabilize within 1 hr. in both groups with no significant difference between them. This early postoperative hypoxemia is expected in open cholecystectomy as it one of the important causes of postoperative hypoventilation .Hypoventilation may be caused by restriction of diaphragmatic movement resulting from abdominal distention, obesity, tight dressing or pain particularly from thoracic or upper abdominal wounds may cause reduced ventilation [22].This situation is avoided in laparoscopic procedure because the small incision decrease postoperative pain and minimize an impairment of pulmonary function, thereby decreasing analgesic uses [8] so the hypoxemia after laparoscopy could be attributed mainly to increased ventilation /perfusion abnormalities and increased shunt in the consolidated or collapsed alveoli .As anesthesia per se result in atelectasis development in the dependent regions of the lung, PPat an intra-abdominal pressure level of 11-13 mmHg increased the volume of atelectasis [23].

CONCLUSION:

CO2 PP was associated with an important cardiopulmonary impairment, which quickly return to normal values after desufflation .

The hypoxemia that occur after laparoscopy is mild ,transient and not critical clinically in comparison with open method.

The disadvantages of longer operative time in laparoscopy could be solved with progressive surgical skill and improved surgical instruments.

It needs less postoperative ventelation support than open method.

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