Low Pressure versus Standard Pressure Pneumoperitoneum in Laparoscopic Cholecystectomy

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ABSTRACT

Background: the laparoscopic cholecystectomy (LC), one of the utmost commonly assumed operations in general surgery. Adequate working space inside the abdominal cavity is required. Carbon dioxide (CO_2) is used with a definite pressure to establish this working space.
Aim: our study was to compare the hemodynamic symptoms, post-operative shoulder-tip pain and the frequency of nausea and vomiting between standard and low-pressure CO_2 pneumoperitoneum (PP) in patients undergoing LC.
Patients and Methods: a prospective randomized study was done on 50 patients aged 18 to 75 years in Bab El-Shaaria hospital, Al-Azhar University with symptomatic gallstones. Patients were allocated into two groups: standard pressure (Group A: 12-14 mmHg) and low-pressure (Group B: 8-10 mmHg). Hemodynamics were assessed pre insufflation and 15 min post insufflation and desufflation. The frequency of nausea and vomiting were assessed at 0, 8, 16, 24-hour post-operative. Post-operative shoulder- tip was assessed 1, 6, 12, 24-hour post-operative. Statistical analysis was postulated using SPSS V.25.
Results: a noticeable difference between the two groups was observed with respect to the mean systolic blood pressure ($p=0.003$) and the mean heart rate ($p=0.001$). Furthermore, a significant difference as regard post-operative shoulder-tip pain, which was higher in the standard pressure group ($p< 0.05$). There were no major differences between the two groups concerning the frequency of nausea and vomiting.
Conclusion: low-pressure PP can be used instead of standard pressure considering its low side effects without any effect on the working space and quality of the surgical procedure.
Keywords: cholethiasis, laparoscopic cholecystectomy, low-pressure, pneumoperitoneum.

INTRODUCTION

LC is one of the utmost commonly assumed operations in general surgery, with over all complication rates are less than 1.5%, and the mortality is lower than 0.1% **(1)**. During the operation, suitable working field is mandatory in the abdominal cavity for acceptable exposition that results in reasonable outcomes and patient protection. Common procedures to establish a working field in the abdominal cavity are PP and abdominal wall lifting devices for examples, the laparo-tensor and laparo-lift **(2)**.

PP for LC is most often created by insufflating CO_2 gas into the peritoneal cavity and then holding it at constant pressure until the end of surgery when it is released at the time of withdrawal of the ports **(3)**. Standard pressure PP, using a pressure range of 12-14 mmHg. It is proven that standard pressure PP has been related to multiple adverse events such as decreased pulmonary compliance, altered blood gas parameters, impaired functioning of the circulatory system, elevated liver enzymes and renal functions, and even increased intra-abdominal venous pressures **(4)**.

An emerging trend has been used, insufflating of low pressures to create PP in the range of 7-10 mm Hg instead of the standard pressure PP in an attempt to lower the impact of PP on human physiology while providing adequate working space **(5)**.

This method appears to have little adverse effect on the cardiac and respiratory functions and is suitable for the older patients and for those with long-lasting cardiac or pulmonary illnesses. Other possible advantages of low pressures during PP appear to be lower frequency of post-operative shoulder-tip pain as well as enhanced quality of life in the week post-operative **(6)**. However, the lower pressures involved in the low pressure LC might lead to an inadequate exposure of the surgical field resulting in increased the operating time, intra-operative complications rate and as well as increase rate of conversion to standard pressure LC or conventional cholecystectomy **(7)**.

AIM OF THE WORK

We established the present study to compare the hemodynamic symptoms, post-operative shoulder-tip pain and the frequency of nausea and vomiting between standard and low-pressure PP in patients undergoing LC.

PATIENTS AND METHODS

Ethical Committee: after Ethical Committee approval (06/09/2014) and informed consent from

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patients, this prospective randomized study was carried out in Bab El-Shaaria hospital, Al-Azhar University on 50 patients with symptomatic gallstone disease who were undergoing LC in the period from July 2014 to July 2015, of which 25 patients were subjected to standard pressure PP during the procedure (14 -15mmHg) and 25 patients to low pressure PP (8-10 mmHg).

Inclusion criteria: included Age 18-75 years old, American Society of Anesthesiologist (ASA) [8]: I, II and III, and Benign gallbladder disease.

Exclusion criteria: age < 18 years, Patients refused to sign the informed consent, Patients have previous abdominal exploratory scar, Complicated gall stones (gallbladder perforation, empyema, gall stone pancreatitis and common bile duct stone) and Pregnancy.

During the surgery, the first port was inserted at a pressure of 14 mm Hg. In group A, the pressure was taken up to 14 mm Hg whilst in group B the pressure was decreased to 8-10 mmHg for the remaining surgery duration. A standard LC with similar technique that undertaken using general anesthesia with same anesthesia protocol in all patients was used.

Shoulder-tip pain was assessed in both groups established on the verbal rating scale (VRS) [9] at 1, 6, 12, and 24 h post-operative. The rate of nausea and vomiting were also documented in the two groups at 0, 8, 16, 24 h after the surgery. Systolic blood pressure, Heart rate, and diastolic blood pressure were recorded during the time intervals pre-insufflation, 15 min after insufflation and desufflation.

Statistical analysis: designated data lists were transmitted into SPSS V.25. The analysis of quantitative and qualitative measures were done separately by t-test and Chi-square tests. ANOVA and repeated measurement were used for parameter changes assessment in the two groups. Results were presented as means ± standard deviation (SD) and the data were considered significant if p-value was ≤0.05 and highly significant if p- value <0.01

RESULTS

In this prospective study, Data of 50 patients in the two groups were analyzed. In group A, 21 patients (84 %) were females and 4 patients (13.3 %) were males. In group B, 17 patients (56.7 %) were females and 8 patients (26.7 %) were males with classified ASA status I: II: III (16:5:4 in group A and 5:10:10 in group B). on behalf of the current study results, there was no significant difference concerning the age (36.9 ± 15.19 vs. 43.9 ± 14.37, P = 0.103), BMI (33.8± 4.99vs. 35.48± 3.56, P = 0.177), and operative time (44.95± 10.57 vs 40.80± 8.36, P=0.130) (Table 1).

Table (1): Comparison between groups as regards patient's data, ASA classification, and operative time.

Demographic	oup A (14-15 mmHg, n=25)	oup B (8-10 mmHg, n=25)	value
Age, mean ± SD, years	36.96± 15.19	43.92± 14.37	03
Sex (M:F), N	4:21	8:17	
BMI, mean ± SD, kg/m^2	33.8± 4.99	35.48± 3.56	77
ASA (I:II:III)	16:5:4	5:10:10	
Operative time	44.95± 10.57	40.80± 8.36	30

There was a significant difference regarding the mean systolic blood pressure (Figure 1) and heart rate (Figure 2) at the 15 min after insufflation between the two groups (P= 0.001, 0.003 respectively). Otherwise, there was no significant difference between the groups regarding the mean diastolic blood pressure at the same time interval (P = 0.06) (Figure 3).

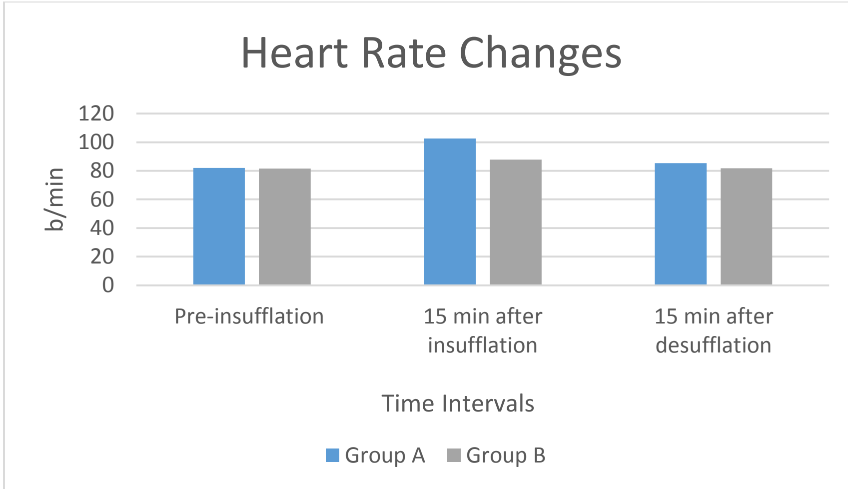

Figure (1): Mean Heart rate (mean± SD) of the two groups in beats/min.

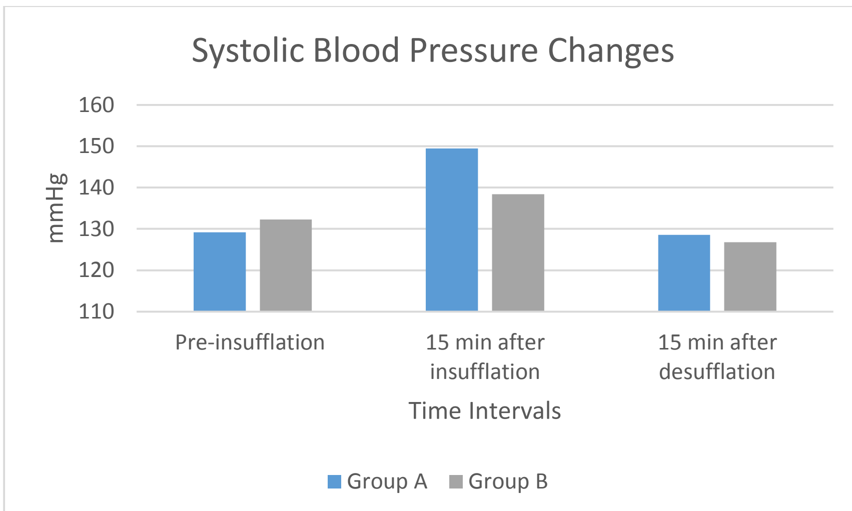

Figure (2): Mean systolic blood pressure (mean± SD) of the two groups in mmHg.

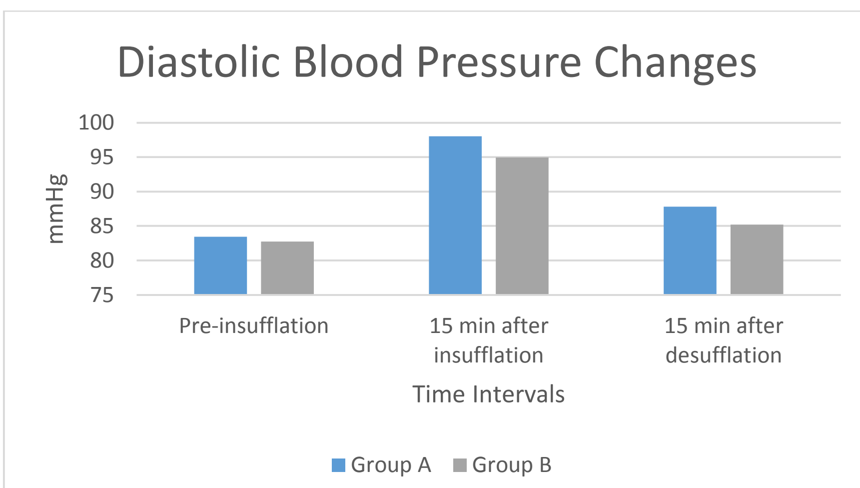

Figure (3): Mean diastolic blood pressure (mean± SD) of the two groups in mmHg.

The rate of shoulder-tip pain was matched between the groups at 1, 6, 12, and 24 h after the surgery using Chi-square test. Our results determined that there are significant differences between the two groups in all time intervals sets (p-value: 0.005, 0.008, 0.001, 0.033 respectively) (Table 2).

Table (2): Matching the frequency of patients regarding shoulder- tip pain at different time intervals.

Time intervals	Groups	Pain Scores					p-value
		0	1	2	3	4	
1h	A	2	8	12	3	0	0.005
	B	4	16	5	0	0	
6h	A	4	10	5	6	0	0.008
	B	10	10	5	0	0	
12h	A	10	4	10	1	0	0.001
	B	18	7	0	0	0	
24h	A	14	8	3	0	0	0.033
	B	20	5	0	0	0	

The rates of nausea and vomiting were matched between the two groups at 0, 8, 16, and 24 h post-operative using Chi-square test. There was no significant difference between the two groups (p-value= 0.254, 0.066, 0.187 respectively). (Table 3, 4).

Table (3): Differences of frequency of nausea between groups.

Time Intervals	Group	Mild	Moderate	Severe	p-value
0-8h	A	5	4	1	0.254
	B	3	3	1	
8-16h	A	4	7	1	0.066
	B	1	1	0	
16-24h	A	0	0	2	0.187
	B	0	0	0	

Table (4): Differences of frequency of vomiting between groups.

Time Intervals	Group	Mild	Moderate	Severe	p-value
0-8h	A	2	2	1	0.259
	B	2	1	1	
8-16h	A	2	2	0	0.125
	B	1	0	0	
16-24h	A	1	0	0	0.187
	B	0	0	0	

DISCUSSION

Laparoscopy is a type of minimally invasive procedures and is currently favored to open surgery. Laparoscopic surgeries are resulted in better outcomes in comparison with conventional surgeries due to significant benefits for examples, less hospital stay, minor complications, and lower expenses.

In addition, there is lesser post-surgical pain in laparoscopic surgeries compared to conventional surgeries. Laparoscopy is extensively used in numerous surgeries; one of most popular procedures is laparoscopic cholecystectomy [(10)]. Common complication of laparoscopy is the hemodynamic changes during peritoneal insufflation of CO_2 associated with reduced cardiac output, elevated systemic vascular resistance, heart rate, hypertension changes, decreased respiratory capacity, and increased airway pressure [(11)].

Cunningham and Brull [(12)] reported that the high intra-abdominal pressure immobilizes the diaphragm that lead to decreased functional capacity of the lung, increased ventilation pressure and increase the possibility of pulmonary complications.

LC is the gold standard in the treatment of symptomatic gallstone disease. The adverse side effects of LC include postoperative pain, circulatory and respiratory changes that have been noticed with standard pressure PP [13].

Several efforts have been tried to overcome the adverse hemodynamic and cardiopulmonary consequences of PP without any effects on possibility and safety of the operation [14].

Detrex *et al*. [14] reported that the heart rate changes, lessened cardiac output and decreased stroke volume in patients subjected to low pressure were lower than those subjected to standard pressure, and the two groups had satisfied post-operative outcomes.

On the other hand, a study done by **Kanwer and his colleagues** compared the effects of two different CO_2 pressures, 10 and 14 mmHg, demonstrated that no significant difference between the two groups regarding the changes in blood pressures, heart rate, and post-operative pain (6 h post-operative) [15].

In our study, we compared the hemodynamic changes, the level of shoulder-tip pain and nausea and vomiting using standard pressure (group A, n=25, 12-15 mmHg) and low pressure (group B, n=25, 8-10 mmHg) CO_2 PP in patients undergoing LC.

It showed that there was no substantial difference regarding age, gender, BMI, ASA status and operative time between the groups. There was a significant difference between the two groups regarding heart rate and the mean of systolic blood pressure in the similar time interval (15 min after insufflation), somehow, the means in group B were lower than those in group A ($p < 0.05$), but no significant difference was detected in the means of diastolic blood pressure between both groups (p= 0.06). The incidences of shoulder-tip pain were lower in the low-pressure group ($p<0.05$).

There was no significant difference between the two groups as regard nausea and vomiting levels (p= 0.169, 0.190 respectively). A double blind study done by **Nasajiyan *et al*.** [16] on the effectiveness of low-pressure PP in LC on the frequency of nausea and vomiting demonstrated that there was no significant difference between the groups ($p> 0.05$) and this results are matched with the present study.

A randomized study done by **Vesakis *et al*.** [17] reported that the post-operative shoulder-tip pain was exaggerated in the high pressure group. In the current study, the levels shoulder-tip pain were higher in group A (12-15 mmHg), compared to group B (8-10 mmHg). In another prospective study, patients were randomized into two groups as 8 mmHg CO_2 (low-pressure) and of 12 mmHg CO_2 (high-pressure). Matching the post-operative pain between the groups showed that the level of 4, 8, 12, and 24 h post-operative shoulder-tip pain was lower in the low-pressure group (P = 0.01) [5]. Our results are compatible with the results of these studies.

CONCLUSION

To conclude, low-pressure PP was an adequate option in LC. It provides suitable surgical field, safety and good surgical view. It has a benefit of being safe in cardiac patients and patients with lung diseases because it has a lower effect on the hemodynamics. Furthermore, it significantly reduces the intensity and frequency of post-operative shoulder-tip pain in different time intervals that results in decrease the total amount of post-operative analgesia. Mastery of working with low-pressure PP comes with practice, attention to details and persistence.

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