

# HEMODYNAMIC PROFILE DURING LAPAROSCOPIC CHOLECYSTECTOMY VERSUS LAPAROSCOPIC BARIATRIC SURGERY: THE IMPACT OF MORBID OBESITY

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## Abstract

The present study investigated the hemodynamic profile using impedance cardiography (ICG) monitor during pneumoperitoneum for laparoscopic cholecystectomy versus bariatric surgery in order to determine the impact of body weight on hemodynamics.

**Methods.** 32 adult patients (two groups, each 16 patients) were studied. Group 1 (16 patients) scheduled to undergo laparoscopic cholecystectomy (lapchole) with body mass index (BMI)  $28 \pm 5$  kg/m<sup>2</sup>. Group 2 (16 patients) scheduled to undergo laparoscopic adjustable band (LAGB) surgery for treatment of morbid obesity with BMI  $45.3 \pm 8$  kg/m<sup>2</sup>. under general anesthesia. Besides routine monitoring, impedance cardiography was used for hemodynamic monitoring. Three stages were identified for statistical analysis A, pre-insufflation, B, during vere pneumoperitoneum and C, at gas deflation.

**Results.** The mean values of cardiac index in group 1 at stages A, B and C were,  $3.0 \pm 1.7$ ,  $2.5 \pm 0.5$  and  $2.7 \pm 0.5$  L/min/m<sup>2</sup> respectively with significant low values in stage B compared to stage A ( $p < 0.05$ ). The same trend continue in group 2 where the mean values were,  $2.4 \pm 0.6$ ,  $1.8 \pm 0.6$  and  $2.3 \pm 0.9$  L/min/m<sup>2</sup> respectively with significant differences

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compared to group 1 mean values ( $p < 0.05$ ). Other hemodynamic variables showed non-significant differences ( $p > 0.05$ ).

**Conclusions.** Cardiac index showed significant decreasing trend in morbid obese patients compared to nonobese, which may reflect the effect of body weight on hemodynamics. On the other hand other hemodynamic parameters was not altered by body weight. We believe that hemodynamics should be closely monitored during laparoscopic surgery with pneumoperitoneum.

**Key words.** Hemodynamics, laparoscopy, impedance cardiography, bariatric surgery, cholecystectomy.

## Introduction

Laparoscopic surgery has become the standard procedure for many surgical pathologies. Pneumoperitoneum (ppm) with carbon dioxide ( $\text{CO}_2$ ) is an essential step during surgical laparoscopy. The physiological effects of pneumoperitoneum are of concern<sup>1</sup>. The increased intra-abdominal pressure during pneumoperitoneum, together with the head-up tilt in laparoscopic cholecystectomy has led to decreased cardiac index (CI) by 20% compared with the baseline awake level<sup>2</sup>. In another study,  $\text{CO}_2$  insufflation caused significant decrease in stroke volume (SV), left ventricular end diastolic volume but not CI in patients undergoing laparoscopic cholecystectomy<sup>3</sup>. In morbid obese patients undergoing laparoscopic bariatric surgery, impaired cardiac function was reported<sup>4</sup>. In a previous study during laparoscopic bariatric surgery under general anesthesia, we have reported high cardiac output (CO) and CI during pneumoperitoneum, which might be due to hypervolemia, increased preload in addition to sympathetic stimulation secondary to  $\text{CO}_2$  absorption<sup>5</sup>. In another study using impedance cardiography (ICG) during laparoscopic bariatric surgery, we have reported non-significant differences in the thoracic fluid content (TFC), with significant high systemic vascular resistance during pneumoperitoneum<sup>6</sup>.

The present study investigated the hemodynamic profile using ICG

monitor during pneumoperitoneum for lean patients undergoing laparoscopic cholecystectomy versus obese patients undergoing laparoscopic bariatric surgery.

## Patients and Methods

After obtaining written informed consent and hospital ethics committee approval, 32 adult patients (two groups, each 16 patients) were studied. Group 1 (16 patients) scheduled to undergo laparoscopic cholecystectomy (lapchole). Group 2 (16 patients) scheduled to undergo laparoscopic adjustable band (LAGB) surgery for treatment of morbid obesity with body mass index  $45.3 \pm 8 \text{ kg/m}^2$ . Swedish band (SAGB, Obtech associated with Ethicon Endo-Surgery) was used.

The demographic data of patients in both groups are given in Table 1.

*Table 1*  
*Demographic data of patients in both groups. Group 1*  
*(lapchole) and group 2 (LAGB)*

Data	Group 1 (n = 16)	Group 2 (n = 16)	P-value
Age (yr)	$38 \pm 10$	$31 \pm 10$	0.43
Gender (M:F)	12:4	13:3	0.32
BMI ( $\text{kg/m}^2$ )	$28 \pm 5$	$45.3 \pm 8$	0.02*
Height (cm)	$154 \pm 11$	$162 \pm 9$	0.87

\* significant.

Chest X-ray and ECG were normal for all patients in both groups preoperatively.

As a routine, arterial blood gases and pulmonary function tests were done for patients in LAGB group preoperatively.

All patients in both groups were premedicated with oral lorazepam 2 mg 2h preoperatively. Intraoperative monitoring consisted of ECG lead II; heart rate; arterial oxygen saturation (SpO<sub>2</sub>) measured by pulse oximeter,

blood pressure measured by non-invasive automated method, end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>), muscle relaxation by Myotest (Datex-Ohmeda, Helsinki, Finland) and temperature (Hewlett Packard, Sarno, Italy).

After preoxygenation, induction of anesthesia for all patients in both groups was achieved with sufentanil 0.1 mcg/kg and propofol 3 mg/kg b.w. “ideal b.w. = height – 100 cm” followed by rocuronium 0.6 mg/kg of ideal b.w. to facilitate endotracheal intubation. The lungs were ventilated with 50% O<sub>2</sub>/air and 1 MAC sevoflurane using anesthesia delivery unit (Datex Ohmeda type A\_Elec, Promma, Sweden). Analgesia was maintained with incremental dosages of sufentanil when required. Rocuronium was used for muscle relaxation based on the reading from the Myotest to ensure zero train-of-four. Surgery was performed in all patients in both groups by the same surgeon.

Intraperitoneal pressure using CO<sub>2</sub> gas was kept around 15 mmHg for all patients. The position of patients during surgery for both groups was reverse Trendelenburg (RTP). Upon completion of surgery atropine and neostigmine were give i.v (1.2/2.5 mg) followed by tracheal extubation.

Impedance cardiography monitor (Cardiodynamics International Corporation, Bioz ICG, model 4110, California, USA) was used for measuring TFC (represents total thorax conductivity), and heart rate (HR). It calculates CO, CI, SV and SVR. It employs a tetrapolar lead system with paired inner electrodes placed on either side in the supraclavicular fossa just above the level of the suprasternal notch and along the midaxillary line at the level of the xiphoid. The outer electrodes are placed 6 cm cephalad and caudad, respectively. The software program used a modification of the Sramek-Bernstein equation based on empirical corrections for body habitus<sup>7</sup>. A single measurement of impedance cardiac output was made once each minute from all cardiac cycles over an 8-s interval, by computing beat by beat stroke volume and multiplying by heart rate.

For statistical analysis, three phases were defined: A1 (lapchole) and A2 (LAGB), prior to ppm, B1 and B2, during ppm, and C1 and C2, after gas deflation. Data collected every minute were: HR (beat/min), MAP

(mmHg), CO (l/min), CI (l/min/m<sup>2</sup>), SVR (dynes sec cm<sup>-5</sup>), and TFC (k/Ohm). Data are presented as mean ( $\pm$  standard deviation (SD)). Statistical analyses were performed with a computer program SPSS, version 11.0 for Windows (SPSS Inc., Chicago, IL). The results were expressed as mean  $\pm$  SD. Analysis of variance with repeated measures was used to compare group differences over time of the data before, during and after ppm, and Post-Hoc (Bonferoni test) for multiple comparisons of the data obtained within each group. Student's t-test for unpaired observations was used for comparisons of data between both groups at different times of study period. For all comparisons,  $p < 0.05$  was considered significant.

## Results

There were no significant differences between the two groups in terms of age, gender, and height. Obviously there was significant difference in terms of patient's weight between both groups (Table 1).

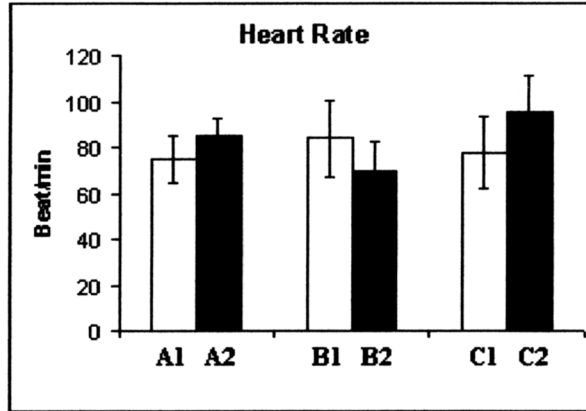
The mean values of the heart rate in group 1 at stages A, B and C were,  $75 \pm 10$ ,  $84 \pm 17$  and  $78 \pm 16$  beat/min respectively. While in group 2 at same stages were,  $85 \pm 8$ ,  $70 \pm 12$  and  $96 \pm 16$  beat/min with non-significant differences ( $p > 0.05$ ) (Fig. 1).

The mean values of MAP in group 1 were  $82 \pm 22$ ,  $108 \pm 16$  and  $96 \pm 11$  mmHg respectively. In group 2 at same stages MAP mean values were,  $96 \pm 10$ ,  $85 \pm 17$  and  $102 \pm 13$  mmHg respectively with non-significant differences ( $p > 0.05$ ) (Fig. 2).

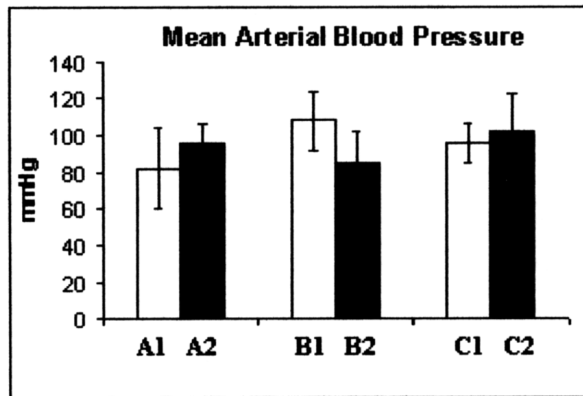
Mean values of CO showed non-significant differences between groups 1 and 2 ( $p > 0.05$ ) (Fig. 3).

The mean values of CI in group 1 at stages A, B and C were,  $3.0 \pm 1.7$ ,  $2.5 \pm 0.5$  and  $2.7 \pm 0.5$  L/min/m<sup>2</sup> respectively with significant low values in stage B compared to stage A ( $p < 0.05$ ). The same trend continue in group 2 where the mean values were,  $2.4 \pm 0.6$ ,  $1.8 \pm 0.6$  and  $2.3 \pm 0.9$  L/min/m<sup>2</sup> respectively with significant differences compared to group 1 mean values ( $p < 0.05$ ) (Fig. 4).

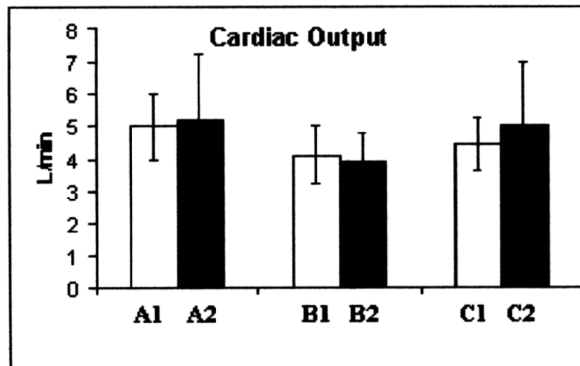
**Fig. 1**  
Heart rate mean  $\pm$  SD  
in both groups. Group  
1  $\square$  (lapchole), group  
2  $\blacksquare$  (LAGB)



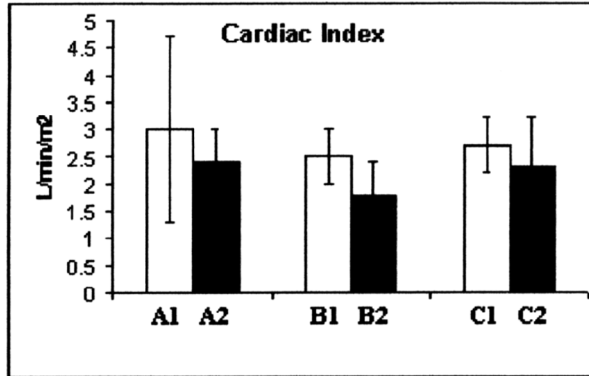
**Fig. 2**  
Mean arterial blood  
pressure, mean  $\pm$  SD  
in both groups, group  
1  $\square$  (lapchole), group  
2  $\blacksquare$  (LAGB).



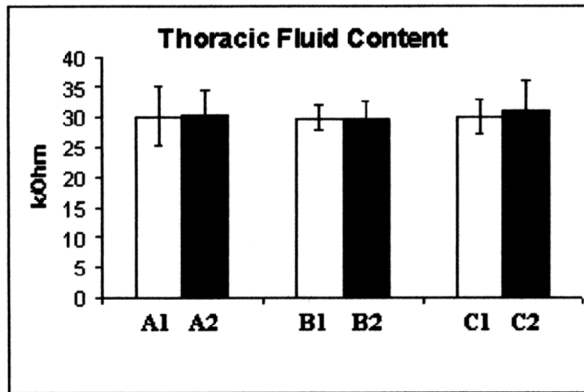
**Fig. 3**  
Cardiac output mean  $\pm$   
SD in both groups,  
group 1  $\square$  (lapchole),  
group 2  $\blacksquare$  (LAGB)



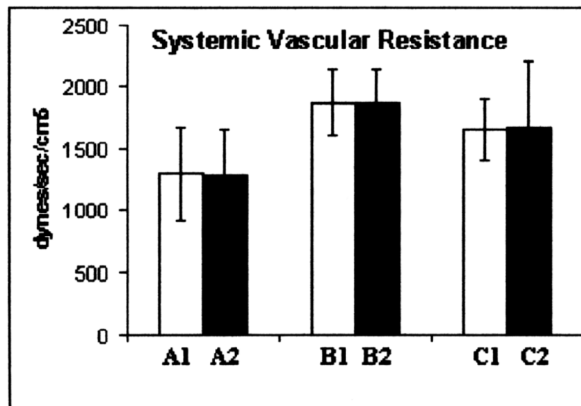
**Fig. 4**  
 Cardiac index mean  $\pm$  SD, in both groups, group 1  $\square$  (lapchole), group 2  $\blacksquare$  (LAGB)



**Fig. 5**  
 Thoracic fluid content mean  $\pm$  SD, in both groups, group 1  $\square$  (lapchole), group 2  $\blacksquare$  (LAGB)



**Fig. 6**  
 Systemic vascular resistance mean  $\pm$  SD, in both groups, group 1  $\square$  (lapchole), group 2  $\blacksquare$  (LAGB).



TFC mean values in both groups 1 and 2 showed non-significant differences ( $p > 0.05$ ) (Fig. 5).

The mean values of SVR in group 1 at stages A, B and C were,  $1299 \pm 374$ ,  $1873 \pm 276$  and  $1648 \pm 246$  dynes sec  $\text{cm}^{-5}$  respectively with significant high value at stages B and C compared to stage A ( $p < 0.05$ ). In group 2 the same trend continues where the mean values at same stages were,  $1290 \pm 276$ ,  $1870 \pm 273$  and  $1669 \pm 537$  dynes sec  $\text{cm}^{-5}$  respectively with non-significant differences compared to group 1 ( $p > 0.05$ ) (Fig. 6).

## Discussion

The increased intra-abdominal pressure due to  $\text{CO}_2$  insufflation during laparoscopic surgery can lead to impaired cardiac performance. Pneumoperitoneum with laparoscopic techniques are of concern. Hemodynamics during laparoscopic cholecystectomy under general anesthesia were investigated in obese patients by using a flow-directed pulmonary artery catheter where peritoneal insufflation resulted in a significant increase of mean arterial pressure, a significant reduction of CI, and a significant increase of systemic and pulmonary vascular resistances. The combined effect of anesthesia, head-up tilt, and peritoneal insufflation produced a 50% decrease in CI. These results demonstrate that laparoscopy for cholecystectomy in head-up position results in significant hemodynamic changes in healthy patients, particularly at the induction of pneumoperitoneum<sup>8</sup>. In another study using transesophageal Doppler during laparoscopic cholecystectomy, significant decreased cardiac output, stroke volume, and increased systemic vascular resistance were reported following creation of positive-pressure pneumoperitoneum<sup>9</sup>. The results for directional changes in the lean lapchole group in our study were consistent with the literature.

In the present study of morbid obese group who underwent LAGB surgery, significant reduction of CI were recorded during pneumoperitoneum compared to pre-insufflation period. Also, there was significant differences in CI between the lapchole and LAGB groups with lower trend of CI in LAGB group which may reflect the impact of morbid

obesity. In terms of systemic vascular resistance we have reported significant high values in both groups compared to the pre-insufflation period. Also we reported non-significant differences of SVR during CO<sub>2</sub> insufflation between both groups, which implies that morbid obesity factor does not increase SVR compared to nonobese patients. In the present report, we found non-significant differences of thoracic fluid content between both groups. Also thoracic fluid content did not change significantly during gas insufflation versus pre-insufflation period. That was in accordance with our previously published report<sup>6</sup>.

In conclusion, morbid obese patients undergoing LAGB surgery are at risk of intraoperative hemodynamic changes secondary to CO<sub>2</sub> pneumoperitoneum. Cardiac index showed significant decreasing trend in morbid obese patients compared to nonobese, which may reflect the impact of body weight on hemodynamics. On the other hand systemic vascular resistance and other hemodynamic parameters were not altered by body weight.

**Acknowledgment!** The author would like to thank anesthesia technicians at King Khalid University Hospital for their clinical assistance during study period. Also I would like to thank Nooran Eldawlatly for designing the figures.

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