Evaluation of hemodynamic changes during laparoscopic cholecystectomy by transthoracic echocardiography

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Abstract

Background and Aims: The purpose of this study was to prospectively examine the effects of pneumoperitoneum and the reverse Trendelenburg position on cardiac hemodynamics during laparoscopic cholecystectomy using transthoracic echocardiography (TTE).

Material and Methods: In this prospective observational study, after institutional review board clearance, forty patients of either sex of ASA I-II status undergoing laparoscopic cholecystectomy were enrolled in the study. Changes in cardiac output, stroke volume, and ejection fraction were recorded using TTE at different time intervals: Preoperatively, before creation of pneumoperitoneum, 5 min after creation of pneumoperitoneum, and 5 min after setting the operative reverse Trendelenburg position with legs at the level of the hips. All statistical analyses were performed using the statistical program SPSS version 16 and P value less than 0.05 was considered as statistically significant. Data were examined using mixed analysis of variance (ANOVA) followed by post hoc Bonferroni correction.

Results: There was significant fall in cardiac output (CO) (45%, $P < 0.001$), stroke volume (SV) (42%, $P < 0.001$), and ejection fraction (EF) (31.8% change, $P < 0.001$) after creation of pneumoperitoneum with significant rise in MAP (11%, $P < 0.001$). But with reverse Trendelenburg position, there was a significant improvement of CO (30%), SV (28%), and EF (21% change) in comparison to values after pneumoperitoneum, but still remained below baseline. There was no change in heart rate at different time intervals. There was no significant difference in hemodynamics between ASA I and II patients.

Conclusion: Patients undergoing laparoscopic cholecystectomy undergo significant hemodynamic changes after pneumoperitoneum and reverse Trendelenburg position.

Keywords: Cardiac output, hemodynamics, laparoscopic cholecystectomy, pneumoperitoneum, transthoracic echocardiography, Trendelenburg position

Introduction

Laparoscopic cholecystectomy has rapidly emerged as a popular alternative to traditional open cholecystectomy in the management of cholelithiasis.[1] Despite these advantages, laparoscopic surgery results in complications due to important physiological changes occurring during the procedure.[2] The physiological changes associated with laparoscopy are due to pressure effect of instilled gas into a closed cavity, the systemic effects of the gas, almost universally CO_2 that is instilled (absorbed or embolized), patient positioning during surgery, the anesthetic used, and the cardiopulmonary status of the patient.[3,4] Most investigators have used pulmonary artery catheterization or transesophageal echocardiography to evaluate the hemodynamic changes occurring during laparoscopic cholecystectomy, but these are not routinely used in ASA I-II patients as monitoring techniques.[5] The use of transthoracic rather than transesophageal echocardiography, by non-cardiac anesthetists, is increasing. Currently, there is a particular

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emphasis on the use of transthoracic echocardiography (TTE) for perioperative management.[6] As echocardiography is an upcoming monitor for assessment of circulatory changes during perioperative period, we evaluated the hemodynamic changes during laparoscopic cholecystectomy under general anesthesia using TTE.

The aim of our study was to evaluate the hemodynamic changes on echocardiography in patients undergoing laparoscopic cholecystectomy under general anesthesia with regard to cardiac output, stroke volume, ejection fraction, left ventricular volumes and area along with heart rate and blood pressure.

Material and Methods

The present prospective study was conducted in "a tertiary care teaching institution" after obtaining approval from the Institutional Review Board and Ethics Committee (01.12.2014). Written informed consent was obtained from all the patients after explaining the objective of the study. Forty patients of either sex, belonging to American Society of Anesthesiologist (ASA) physical status I–II between 20 and 50 years of age scheduled to undergo laparoscopic cholecystectomy were included in the study. Any patient having BMI >35, chronic obstructive lung disease (COPD), ischemic and valvular heart disease, and in whom satisfactory echocardiographic window was not obtained were not included in the study. All patients underwent a detailed clinical history and a complete general physical examination. Routine investigations such as hemogram, bleeding time (BT), clotting time (CT), and complete urine examination were noted in all patients. Other investigations such as blood urea, blood sugar, serum electrolytes, X-ray chest, electrocardiogram (ECG), and any other specific investigations were carried out as and when required. Patients were kept fasting for 8 h prior to scheduled time of surgery. They were premedicated with tab. alprazolam 0.25 mg and tab. ranitidine 150 mg at bedtime and also in the morning along with tab. metoclopramide 10 mg 2 h prior to surgery with sip of water. On patient arrival in the operating room, echocardiographic assessment of cardiac output (CO), stroke volume (SV), and ejection fraction (EF) were carried out by M-Turbo Ultrasound Sonosite machine with P21x 3 MHZ phased array transthoracic cardiac probe using area-length method. Noninvasive monitoring [electrocardiogram, heart rate, noninvasive blood pressure (NIBP), respiratory rate, pulse oximetry, and baseline end-tidal CO_2] was recorded with Philips intellivue MP50 monitor. Intravenous line with 18G cannula was secured in all patients and concurrent administration of ringer lactate solution was initiated.

Biplane modified Simpson's method: In the modified Simpson method (disc method), we simply trace the counter of the endocardium on a four-chamber view. Based on the tracing, the system automatically performs a short-axis segmentation from base to apex. The long axes (L) of apical two- and four-chamber views are divided equally into 20, and the inside diameters of the short axes of 20 discs in directions perpendicular to the long axis are obtained. The areas of the left ventricular cavity are obtained on the assumption that each disc is oval. Left ventricular volume is calculated from the total sum of the cross-sectional areas of the 20 discs [Figures 1 and 2].

After preoxygenation, general anesthesia was induced with intravenous glycopyrrolate 0.2 mg, thiopentone 5–7 $mgkg^{-1}$, fentanyl 2 μgkg^{-1}, and vecuronium bromide 0.1 $mgkg^{-1}$. Balanced anesthesia was maintained with isoflurane in the concentration of 0.75% and nitrous oxide and oxygen in ratio of 67:33. The airway was secured with tracheal tube. Ventilation was controlled with a tidal volume of 8 to 10 $mlkg^{-1}$ and the ventilator rate was adjusted to maintain EtCO2 value between 30 and 35 mmHg. At the end of surgery, residual neuromuscular block was reversed with 2.5 mg of neostigmine methylsulfate and 0.4 mg of glycopyrrolate.

Pneumoperitoneum was established with CO_2 administration at a low flow rate of 1-2 $Lmin^{-1}$ and "a reverse Trendelenburg position of 30° with the legs flexed 30° upward at the hips, so that the lower limbs were kept horizontal with the ground." During laparoscopy, intra-abdominal pressure (IAP) was maintained at or below 12 mmHg by CO_2 insufflator.

The following data were recorded: Cardiac output, stroke volume, ejection fraction, heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial blood pressure. Measurements were taken at the following time intervals: T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of

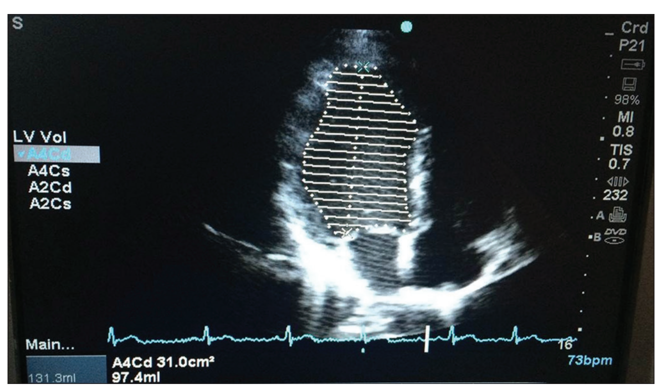

Figure 1: Calculation of the End Diastolic Left Ventricular Area and End Diastolic Left Ventricular Volume by Modified Simpson's Method

pneumoperitoneum, T3: 5 min after setting the operative anti-Trendelenburg position. Rest of the monitoring was continued throughout in the usual manner.

Sample size

To detect at least 20% difference of cardiac output in the patients at different time points during laparoscopic cholecystectomy under general anesthesia, with a power of 90% and alpha error over 0.05, 37 patients were required. We have taken 40 patients for our study.[5]

Results

Demographic profile and ASA status of patients in our study are given in Tables 1a and b, 2a and b. In our study in comparison to baseline (29.55 ± 4.85 cm^2), there is a statistically significant decrease in end-diastolic area 5 min after GA (27.38 ± 5.07 cm^2, $P = 0.034$), 5 min after creation of pneumoperitoneum (26.41 ± 5.11 cm^2, $P < 0.001$), and 5 min after reverse Trendelenburg position (27.65 ± 4.42 cm^2, $P < 0.025$), thus reflecting decreased preload [Table 3].

In comparison to baseline (102.12 ± 29.41 ml), there is a statistically significant decrease in end-diastolic volume 5 min after induction of GA (88.22 ± 25.97 ml, $P = 0.020$), which further decreased 5 min after creation of pneumoperitoneum (83.04 ± 23.72 ml, $P < 0.001$) and 5 min after reverse Trendelenburg position (87.23 ± 27.69 ml, $P < 0.025$), reflecting a decrease in preload [Table 4].Changes in the left ventricular end-systolic area (LVESA) were not statistically significant when compared at different time intervals. However, there was a small increase after creation of pneumoperitoneum (18.83 ± 4.07 cm^2) in comparison to after induction values (17.15 ± 3.43 cm^2, $P = 1.00$). There was overall statistically significant change ($P < 0.029$) in left ventricular end-systolic volume (LVESV). We also found that there was a statistically significant increase in LVESV after pneumoperitoneum (50.28 ± 18.08 ml) when compared to postinduction values (41.77 ± 14.71 ml, $P < 0.030$), thus indicating a decrease in left ventricular forward flow due to increased resistance or afterload [Table 5].

When compared to baseline values (4.39 ± 1.09 L/min), cardiac output (CO) decreased significantly 5 min after induction of general anesthesia (3.64 ± 0.97 L/min, 20.60%, $P = 0.01$), 5 min after pneumoperitoneum (2.41 ± 0.82 L/min, 45%, $P < 0.001$), and 5 min after reverse Trendelenburg position (3.46 ± 0.99 L/min, 21%, $P < 0.001$). CO recorded after creation of pneumoperitoneum (2.41 ± 0.82, 33.8%,) was significantly low when compared to postinduction values (3.64 ± 0.97 L/min, $P < 0.001$) [Table 6 and Figure 3].

When compared to baseline values (55.76 ± 14.03 ml), stroke volume decreased significantly after induction of general anesthesia (47.76 ± 15.22 ml, 14%, $P = 0.013$), pneumoperitoneum (32.16 ± 10.47 ml, 42%, $P < 0.001$), and reverse Trendelenburg position (44.71 ± 14.91 ml, 20%, $P = 0.001$). The decrease in stroke volume seen after creation of pneumoperitoneum (32.16 ± 10.47 ml, 32%) was also significant

Table 1a: Distribution of patients in various age groups

Age groups	No. of patients	%
21-30 years	11	27.5%
31-40 years	12	30.0%
41-50 years	17	42.5%
Total	40	100%
Mean±Sd	38.68±9.10	
Min-Max	23-50 years	

Table 1b: Sex distribution

Sex	No. of patients	%
Female	30	75.0%
Male	10	25.0%
Total	40	100%

Table 2a: ASA status

ASA	No. of patients	%
I	31	77.5%
II	9	22.5%
Total	40	100%

Table 2b: Distribution of patients as per comorbid conditions

Comorbidity	No. of patients	%
DM	1	2.5%
Hypertension	5	12.5%
Hypothyroid	3	7.5%
Nil	31	77.5%

Table 3: Changes in mean left ventricular end-diastolic area (LVEDA) at different time intervals

Time interval	Mean±SD	Changes of Mean LVEDA		Std. Error (±)	*P*
T0	29.55±4.85 cm^2				
T1	27.38±5.07 cm^2	T0	-2.167* cm^2	0.739	0.034
T2	26.41±5.11 cm^2	T0	-3.137* cm^2	0.71	<0.001
		T1	-0.97 cm^2	0.918	1.000
T3	27.65±4.42 cm^2	T0	-1.903* cm^2	0.626	0.025
		T1	0.265 cm^2	0.786	1.000
		T2	1.235 cm^2	0.595	0.268

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

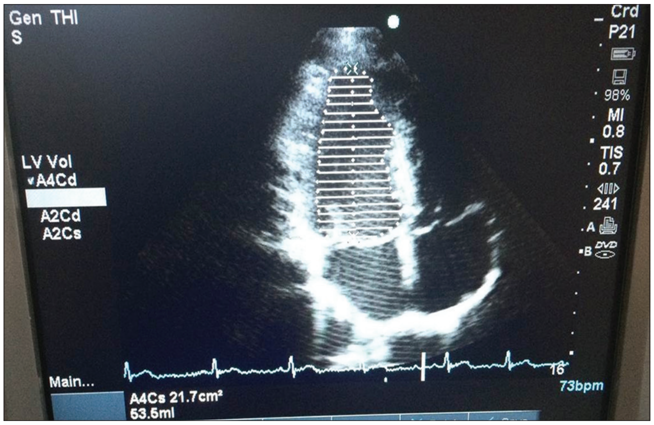

Figure 2: Calculation of the End Systolic Left Ventricular Area and End Systolic Left Ventricular Volume by Modified Simpson's Method

when compared to postinduction values (47.76 ± 15.22 ml, $P < 0.001$) [Table 7 and Figure 4].In comparison to baseline values (56.88 ± 7.72%), ejection fraction decreased significantly after the induction of general anesthesia (52.42 ± 5.90%), pneumoperitoneum (38.78 ± 8.27%), and reverse Trendelenburg position (48.69 ± 7.80%). The decrease in EF seen after the creation of pneumoperitoneum (38.78 ± 8.27%) and after change in position (48.69 ± 7.80%) was also significant when compared to postinduction values (52.42 ± 5.90%). But with change to reverse Trendelenburg position (48.69 ± 7.80%), a statistically significant increase in EF was observed in comparison to value after pneumoperitoneum (48.69 ± 7.80%) [Table 8 and Figure 5]. Mean arterial pressure (MAP) increased significantly after creation of pneumoperitoneum (100.05 ± 14.94 mmHg, 11%, $P = 0.001$) and reverse Trendelenburg position (98.80 ± 12.89 mmHg, 10%, $P = 0.002$) when compared to preoperative MAP (88.73 ± 10.31 mmHg). When compared to the MAP after general anesthesia (83.12 ± 11.77 mmHg), a significant increase is seen after creation of pneumoperitoneum (100.05 ± 14.94 mmHg, 17%, $P < 0.001$) and change to reverse Trendelenburg position (98.80 ± 12.89 mmHg, 15.7%, $P < 0.001$) [Table 9].

In our study, there was no significant change in heart rate at any time intervals during the study period and throughout the laparoscopic cholecystectomy.

Discussion

Larsen *et al.*[6] in their study on 28 patients reported a statistically significant increase in LVED diameter with pneumoperitoneum by using transesophageal echocardiography, which is attributed to an increase in venous return. Both Cunningham[7] in 13 healthy patients and Dorsay *et al.*[8] in 14 healthy patients studied hemodynamic changes during laparoscopic cholecystectomy by transesophageal echocardiography and found no changes in LVED area during carbon dioxide pneumoperitoneum. The fall is attributed to the decreased venous return with increase in intra-abdominal pressure due to pneumoperitoneum and compression of the inferior vena cava. Reverse Trendelenburg favors respiratory mechanism but can adversely affect hemodynamics by further decreasing venous return by pooling in lower extremities. However, in our study after attaining reverse Trendelenburg position, there was some improvement in LVEDV as compared to the value after pneumoperitoneum but it still remained significantly below baseline ($P = 0.025$) and after induction values.

Table 4: Changes in mean left ventricular end-diastolic volume (LVEDV) at different time intervals

Time interval	Mean±SD	Changes of Mean LVEDA		Std. Error (±)	*P*
T0	102.12±29.41 ml				
T1	88.22±25.97 ml	T0	-13.905* ml	4.457	0.020
T2	83.04±23.72 ml	T0	-19.085* ml	3.968	<0.001
		T1	-5.18 ml	4.61	1.000
T3	87.23±27.69 ml	T0	-14.898* ml	4.888	0.025
		T1	-0.992 ml	4.55	1.000
		T2	4.188 ml	4.061	1.000

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

Table 5: Mean left ventricular end-systolic volume (LVESV)

Time interval	Mean±SD	Changes of Mean LVESV		Std. Error (±)	*P*
T0	44.02±15.83 ml				
T1	41.77±14.71 ml	T0	-2.25 ml	2.304	1.000
T2	50.28±18.08 ml	T0	6.265 ml	2.855	0.205
		T1	8.515* ml	2.857	0.030
T3	43.71±14.88 ml	T0	-0.305 ml	3.291	1.000
		T1	1.945 ml	3.156	1.000
		T2	-6.57 ml	3.211	0.285

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

Table 6: Changes in mean cardiac output (CO) at different time intervals

Time interval	Mean±SD	Changes of Mean CO		Std. Error	*P*
T0	4.39±1.09 L/min				
T1	3.64±0.97 L/min	T0	-0.748* L/min	0.18	0.001
T2	2.41±0.82 L/min	T0	-1.979* L/min	0.176	<0.001
		T1	-1.231* L/min	0.168	<0.001
T3	3.46±0.99 L/min	T0	-0.932* L/min	0.174	<0.001
		T1	-0.184 L/min	0.147	1.000
		T2	1.047* L/min	0.122	<0.001

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

Table 7: Changes in mean Stroke Volume (SV) at different time intervals

Time interval	Mean±SD	Changes of Mean Stroke volume		Std. Error (±)	P
T0	55.76±14.03 ml				
T1	47.76±15.22 ml	T0	-8.008* ml	2.436	0.013
T2	32.16±10.47 ml	T0	-23.608* ml	2.218	<0.001
		T1	-15.600* ml	2.53	<0.001
T3	44.71±14.91 ml	T0	-11.033* ml	2.534	0.001
		T1	-3.025 ml	2.145	0.998
		T2	12.575* ml	1.88	<0.001

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

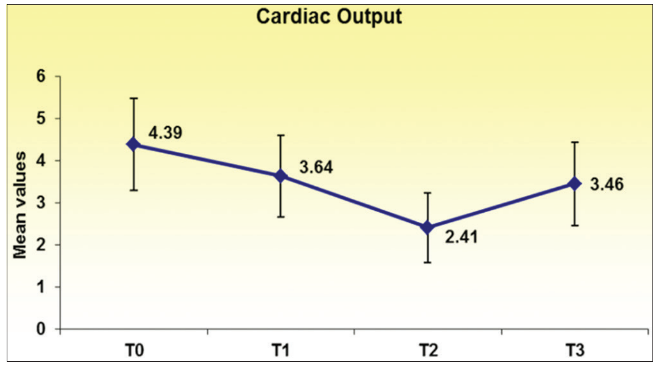

Figure 3: Changes in mean Cardiac Output (l/min) at different time intervals. (T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 mins after creation of pneumoperitoneum, T3: 5 mins after Reverse Trendelenburg position

Table 8: Changes in mean ejection fraction (EF) at different time intervals

Time interval	Mean±SD	Changes of Mean EF		Std. Error (±)	P
T0	56.88±7.72%				
T1	52.42±5.90%	T0	-4.466* %	1.458	0.024
T2	38.78±8.27%	T0	-18.110* %	1.762	<0.001
		T1	-13.644* %	1.338	<0.001
T3	48.69±7.80%	T0	-8.198* %	1.712	<0.001
		T1	-3.732* %	1.301	0.040
		T2	-9.912* %	1.592	<0.001

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

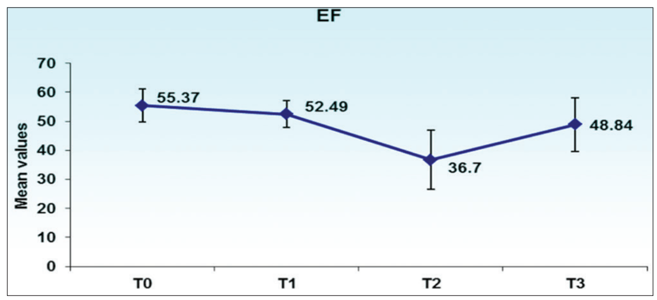

Figure 4: Changes in mean Ejection Fraction (%) at different time intervals. (T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 mins after creation of pneumoperitoneum, T3: 5 mins after Reverse Trendelenburg position)

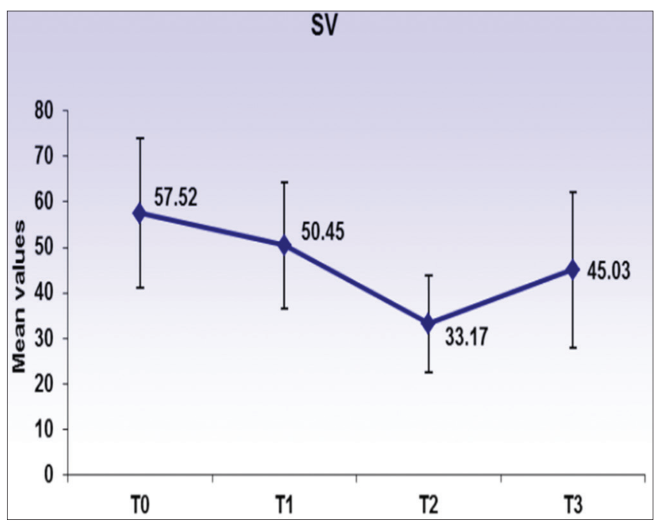

Figure 5: Changes in mean Stroke Volume (ml) at different time intervals. (T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 mins after creation of pneumoperitoneum, T3: 5 mins after Reverse Trendelenburg position)

The improvement in LVEDV in our study is contrary to the expected further fall which may be attributed to the fact that in our study, the lower limbs were kept horizontal to the ground in the same level as hips so venous pooling in the lower limbs might be less.

Zuckerman *et al.*[9] did not report any change in LVEDV 5 min after induction of anesthesia in thirty-nine patients undergoing laparoscopic cholecystectomy. Russo and Stasio[10] also observed no change in LVEDV immediately after induction as measured by TTE and non-invasive hemodynamic monitoring in twenty healthy women undergoing laparoscopic gynecological surgery. The observed difference in findings from our study may be due to difference in recording modality, inducing agent used, or timings of measurement of observed parameters. Zuckerman *et al.*[9] reported a significant reduction in LVEDV with creation of pneumoperitoneum (from baseline value of 123 ml to 102 ml, $P < 0.05$) which is in accordance with our study but Gannedahl *et al.*[11] showed an increase in LVEDV in eight healthy patients, scheduled for laparoscopic cholecystectomy with good cardiovascular reserve.

A decrease in cardiac output and stroke volume could be attributed to the fact that the increase in the intra-abdominal pressure due to creation of pneumoperitoneum could compress the aorta increasing afterload and by compressing inferior vena cava could decrease venous return (preload). But with change to reverse Trendelenburg position, a statistically significant increase in CO (3.46 ± 0.99 L/min, 30%, $P < 0.001$) and stroke volume (44.71 ± 14.91 ml, 28%, $P < 0.001$) was observed in comparison to values after pneumoperitoneum.

Table 9: Changes in mean mean arterial Pressure (MAP) at different time intervals

Time interval	Mean±SD	Changes of Mean MAP		Std. Error (±)	P
T0	88.73±10.31 mmHg				
T1	83.12±11.77 mmHg	T0	-5.6 mmHg	2.246	0.102
T2	100.05±14.94 mmHg	T0	11.325* mmHg	2.744	0.001
		T1	16.925* mmHg	2.271	<0.001
T3	98.80±12.89 mmHg	T0	10.075* mmHg	2.532	0.002
		T1	15.675* mmHg	2.428	<0.001
		T2	-1.25 mmHg	1.588	1.000

T0: Before induction of anesthesia, T1: Before creation of pneumoperitoneum, T2: 5 min after creation of pneumoperitoneum, T3: 5 min after reverse Trendelenburg position

This change could be attributed to the fact that with reverse Trendelenburg position, there is downward displacement of the diaphragm and abdominal contents which improves lung compliance and pressure on the chambers of the heart, thus improving venous return. The effect of venous pooling with reverse Trendelenburg position was less in our study as we kept legs at the level of hips.

In accordance with our study, Zuckerman *et al.*[9] reported a significant decrease in cardiac index (fell 11% from 3.48 L/min/m^2 to 2.63 L/min/m^2) with induction of anesthesia but Russo and Stasio[10] observed no change in CO as measured by TTE and non-invasive hemodynamic monitoring. This difference could be attributed to the effect on heart rate as other authors have reported a decrease in heart rate while we did not find any such increase. Dorsay *et al.*[8] observed that insufflation to 15 mmHg decreased cardiac index (C.I.) by 3% (3.34 to 3.23 l/min/m^2) while both heart rate (HR) and mean arterial pressure (MAP) increased by 7% and 16%, respectively. Hirvonen *et al.*[12] showed 20% reduction in CO during pneumoperitoneum (IAP 12 mmHg) using transesophageal Doppler imaging and Alishahi *et al.*[13] showed a similar reduction in CO during pneumoperitoneum (IAP 12 mmHg). These findings are in accordance with our study. But Russo and Stasio[10] (IAP 14-15 mmHg) and Larsen *et al.*[6] (IAP 12 mmHg) found a non-significant drop in CO due to pneumoperitoneum in patients undergoing laparoscopic hysterectomy and laparoscopic cholecystectomy, respectively. The lack of effect of pneumoperitoneum on CO may be explained by the observed increase in HR in their study. McLaughlin *et al.*[14] found a significant decrease in stroke volume (29.5%) and cardiac index (29.5%) within 30 min of the induction of pneumoperitoneum and positioning ($P < 0.05$, ANOVA).

Zuckerman *et al.*[9] found a significant decrease in stroke volume of 7.2% from baseline 83.69 ml to 73.88 ml ($P < 0.05$) with induction of anesthesia but Russo and Stasio[10] observed no change in stroke volume as measured by TTE and non-invasive hemodynamic monitoring. Russo and Stasio[10] and Dorsay *et al.*[8] reported considerable decrease in stroke volume of 9% and 10%, respectively, while Larsen *et al.*[6] and Irwin and Ng[15] reported similar results with creation of pneumoperitoneum which is in agreement with our study.

MAP increased significantly after creation of pneumoperitoneum (100.05 ± 14.94 mmHg, 11%, $P = 0.001$) and reverse Trendelenburg position (98.80 ± 12.89 mmHg, 10%, $P = 0.002$) when compared to preoperative MAP (88.73 ± 10.31 mmHg). More the afterload, lesser the left ventricular forward flow due to increased resistance. Mean arterial pressure (after load) opposing left ventricular ejection is also increased in the study done by Larsen *et al.*[6] Dorsay *et al.*[8] Joris *et al.*,[16] and Irwin and Ng.[15] This increase in afterload can be considered as a simple sympathetic reflex response to decreased cardiac output. Systemic vascular resistance was also increased in studies reported by Odeberg *et al.*[17] and Cunningham *et al.*[7] but with no decrease in cardiac output.

In our study, there was no significant change in heart rate at any time intervals during the study period and throughout the laparoscopic cholecystectomy. This is in agreement with the study done by Zuckerman *et al.*[9] but Russo *et al.*[10] and Larsen *et al.*[6] observed an increase in heart rate with creation of pneumoperitoneum and change to reverse Trendelenburg position. In our study, there was no significant difference in hemodynamics between ASA I and II patients.

In our study, TTE was used to record the hemodynamic parameters. The limitations of the study were formation of poor echocardiographic windows due to interference from soft tissue in few ventilated patients. We did not face much difficulty in placing the probe to get a four-chamber apical view during pneumoperitoneum and reverse Trendelenburg position.

Conclusion

Significant improvement of cardiac output, stroke volume, and ejection fraction after reverse Trendelenburg position of 30°

with the legs kept horizontal to the ground at the hips during laparoscopic cholecystectomy was found in comparison to values after pneumoperitoneum by using TTE.

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Conflicts of interest

There are no conflicts of interest.

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