Original Research Article

Study of laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction

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Abstract

Background: Laparoscopic cholecystectomy procedure results cosmetically more acceptable , decreased hospital duration, less postoperative pain and lesser disability from daily work as compared to open cholecystectomy .Intensive intraoperative monitoring and vigilance in the anesthetic management is of utmost importance for a smooth perioperative course in patients with cardiac dysfunction. In present study, we studied laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction at a tertiary hospital. **Material and Methods:** Present study was single-center, open label, prospective, observational controlled study, conducted in patients 18-65 years, either gender, with presence of moderate to severe left ventricular systolic dysfunction, planned for laparoscopic cholecystectomy, willing to participate in present study. **Results:** 15 patients with moderate to severe LV dysfunction undergoing laparoscopic cholecystectomy were enrolled in the study. In present study, mean age was 55.57 ± 7.52 years. Gender wise male (26.67 %) were less than female (73.3 %) patients. Medical comorbidities were Hypertension (80 %), Diabetes mellites 3 (20 %) and Previous history of cardiac intervention (20 %). 73.3 % patients had moderate Left ventricular dysfunction (LVEF 36–40%) while 26.67 % had severe Left ventricular dysfunction (LVEF < 36%).The mean HR values, decrease in mean HR was 6.5% On intragroup statistical analysis, no significant change in mean HR is seen at T2, T3, T4 or T5 from T1 was noted. From T1 to T2, the fall in mean MAP was 9.7% while from T2 to T3, 32.5% increase in MAP was seen. On intragroup statistical analysis, no significant change in mean MAP was noted. Out of the 15 patients in the study group, 4 patients had episodes of hypotension, 1 patient in had an episode of bradycardia requiring intervention. No significant complications occurred during immediate postoperative period as well as during the hospital stay. On 3 month follow up of these patient (telephonically), no mortality or morbidity has been recorded. **Conclusion:** cholecystectomy may be safely done in cardiac patients with moderate to severe left ventricular systolic dysfunction patients under the supervision of an experienced consultant anaesthesiologist. Optimization of cardiac status, administered of balanced anaesthesia and 10-12 mmHg pressure pneumoperitoneum are essential steps for patients' safety. Life threatening complications are low and can be easily managed in hospital with adequate cardiology support.

Keywords: laparoscopic cholecystectomy, left ventricular systolic dysfunction, balanced anaesthesia, pneumoperitoneum

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INTRODUCTION

Over the years surgical skills have been improved and also there is better understanding of pneumoperitoneum so now laparoscopic cholecystectomy is done by most of the surgeons. Laparoscopic cholecystectomy procedure results cosmetically more acceptable, decreased hospital duration, less postoperative pain and lesser disability from daily work as compared to open cholecystectomy.[1] But in patients with moderate to severe left ventricular dysfunction whether the laparoscopic cholecystectomy is beneficial as it will cause less physiological stress or there

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will be cardiovascular disadvantage of pneumoperitoneum, is a matter of concern for both laparoscopic surgeon and anesthetist. Intensive intraoperative monitoring and vigilance in the anesthetic management is of utmost importance for a smooth perioperative course in patients with cardiac dysfunction.[2,3] This requires a thorough knowledge into the effect of pneumoperitoneum and reverse Trendelenburg positioning on the cardiac physiology especially with respect to patients with a diseased myocardium.[4,5] In present study, we studied laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction at a tertiary hospital.

MATERIAL AND METHODS

Present study was single-center, open label, prospective, observational controlled study, conducted in Department of Anaesthesia & Intensive Care, PGIMER, Chandigarh, India. Study period was April, 2019 to March, 2020 (1 year). After approval from the Institute Ethics Committee and written informed consent (prior to enrolment) of the participants, present study was conducted.

Inclusion criteria: Patients 18-65 years, either gender, with presence of moderate to severe left ventricular systolic dysfunction, planned for laparoscopic cholecystectomy, willing to participate in present study.

Exclusion criteria: BMI > 35 kg/m^2. Coexisting stenotic valve lesions or right ventricular dysfunction. Presence of electrocardiographic findings of arrhythmia. NYHA IV physical status. End stage hepatic/renal/pulmonary disease Demographic variables, history of cardiac medications and prior history of admission to the ER or cardiac adverse events was noted. Patients were evaluated as per standard operative procedures for laparoscopic surgery,

The formal echocardiography was done by an experienced cardiologist and LV systolic dysfunction was graded as mild (LVEF 41–45%), moderate (LVEF 36–40%), or severe (LVEF < 36%).[6]

In operation theatre, standard ASA monitors including 5 lead ECG, pulse oximeter and NIBP were attached and baseline echocardiography was done. A broad gauge intravenous cannula was placed in the right internal jugular vein and connected to the pressure transducing system (Edward Life Science) for central venous pressure(CVP) measurement. Under aseptic conditions and local anaesthetic, a 20G arterial cannula was inserted in the radial artery and connected to the FloTrac system for continuous cardiac output, SVV monitoring. CVP measured from the venous cannula was also transduced for calculation of SVR. A baseline ABG sample was taken at T1 for measurement of baseline PaCO2.

Under general anaesthesia, after creation of pneumoperitoneum, once IAP of 12mm Hg was achieved, 2D echocardiography was done (T2). Intraoperatively IAP was maintained to < 12 mmHg. Following this reverse Trendelenburg positioning was done. 10 min after the positioning the 2nd sample of ABG was taken. IBP, HR, MAP, SpO2, EtCO2, intra abdominal pressures were monitored continuously. CO (both from 2D echo, FloTrac system), IBP, NIBP, HR, SVV, CVP, SVR, SPV, PPV were noted at the predefined study time points. After 10 min after desufflation (T5), third ABG sample was taken. All study parameters were recorded at the following time points.

- T1 - Pre-induction
- T2 - 10 minute after induction
- T3 - when pneumoperitoneum with intra-abdominal (IAP) pressure of 12mm Hg is achieved,
- T4 - 10 minute after reverse Trendelenburg position,
- T5 - 10 minute after deflation of pneumoperitoneum.

The patient was shifted to PACU after fulfilling the criteria that patient was able to respond to verbal stimuli and ensuring that pain was adequately managed. Any post procedure nausea and vomiting were addressed and anti-emetics were prescribed. All cardiac patients were followed till hospital discharge and any in hospital morbidity were noted. Any patients with symptoms suggestive of failure or ischemic event in the postoperative period were subjected to quantitative analysis of cardiac biomarkers. 30-day morbidity and mortality were for telephonic communication with the patients.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

15 patients with moderate to severe LV dysfunction undergoing laparoscopic cholecystectomy were enrolled in the study. In present study, mean age was 55.57 ± 7.52 years. Gender wise male (26.67 %) were less than female (73.3 %) patients. Medical comorbidities were Hypertension (80 %), Diabetes mellites 3 (20 %) and Previous history of cardiac intervention (20 %). 73.3 % patients had moderate Left ventricular dysfunction (LVEF 36–40%) while 26.67 % had severe Left ventricular dysfunction (LVEF < 36%).

Table 1: Demographic characteristics of both groups

Parameter	No. of cases (%)/ Mean ± SD
Age in years	55.57 ± 7.52
Gender	
Male	4 (26.67 %)
Female	11 (73.3 %)
Weight in kg	64.43±14.62
Height in cm	164.29±11.15
BMI in kg/m^2	23.66±2.77
BSA in m^2	1.7±0.25
Medical comorbidities	
Hypertension	12 (80 %)
Diabetes mellites	3 (20 %)
Previous history of cardiac intervention	3 (20 %)
Left ventricular dysfunction	
Moderate (LVEF 36–40%)	11 (73.3 %)
Severe (LVEF < 36%)	4 (26.67 %)

The mean HR values, decrease in mean HR was 6.5% On intragroup statistical analysis, no significant change in mean HR is seen at T2, T3, T4 or T5 from T1 was noted.

Table 2: Heart rate at the defined time points of the study.

Heart rate (beats/min)	Mean ± SD	P value from T1
HR at T1	81±10.82	-
HR at T2	75.71±12.84	.411
HR at T3	74.29±14.16	.338
HR at T4	75.43±15.21	.464
HR at T5	71.86±13.31	.106

From T1 to T2, the fall in mean MAP was 9.7% while from T2 to T3, 32.5% increase in MAP was seen. On intragroup statistical analysis, no significant change in mean MAP was noted.

Table 3: Mean arterial pressure at defined time points of the study

Mean arterial pressure (mm Hg)	Mean ± SD	P value from T1
MAP at T1	92±12.81	-
MAP at T2	83±13.18	.316
MAP at T3	102.43±16.46	.083
MAP at T4	97.57±13.15	.368
MAP at T5	97.29±13.95	.472

From T1 to T2, the increase in mean CVP was 29.3% and mean CVP values decrease from T4 to T5 and reach values approximately similar to the T1 levels. On intragroup statistical analysis, significant increase in mean CVP was seen at T3, T4 from T1.

Table 4: Mean CVP at the defined time points of the study.

Central venous pressure (mm Hg)	Mean ± SD	P value from T1
CVP at T1	7.86±2.41	-
CVP at T2	10.14±4.71	.121
CVP at T3	12.86±3.24	.006
CVP at T4	12.57±3.26	.008
CVP at T5	8.57±3.21	.593

From T1 to T2, no change in mean SVR was seen, while from T2 to T3 and T4, there was an increase in the mean SVR, mean SVR values at T5 return to the approximately the T1 levels after CO2 exsufflation.

Table 5: Mean SVR at the defined time points of the study.

Systemic vascular resistance (Dynes.sec.cm^{-5})	Mean ± SD	P value from T1
SVR at T1	1503.71±674.3	-
SVR at T2	1505±463.33	.995
SVR at T3	1988.86±755.96	.041
SVR at T4	1970.57±629.86	.058
SVR at T5	1702.86±849.44	.387

From T1 to T2, the fall in mean CO was 15.9% while at T3 9.7% (from T2) fall in CO was noticed and the CO does return to similar pre-induction T1 values at T5.

Table 6: Mean cardiac output at the defined time points of the study.

Cardiac output (L/min)	Mean ± SD	P value from T1
CO at T1	4.98±1.46	-
CO at T2	4.19±1.33	.180
CO at T3	3.78±1.12	.092
CO at T4	3.71±1.13	.067
CO at T5	4.66±1.3	.507

The mean EtCO2 values were statistically significant when compared from P1 values.

Table 7: Mean EtCO2 in the two groups at the defined time points of the study.

EtCO2 (mm Hg)	Mean ± SD	P value from T1
EtCO2 at T1	29.86±2.34	-
EtCO2 at T2	35.43±5.32	.011
EtCO2 at T3	34.71±5.94	.045
EtCO2 at T4	37.29±4.57	.006
EtCO2 at T5	37.57±5.86	.012

The PaCO2 values were comparable between predefined time points in the study.

TABLE 8: Mean PaCO2 in the two groups at the defined time points of the study.

PaCO2 (mm Hg)	Mean ± SD	P value from T1
PaCO2 at T1	36.19±6.75	-
PaCO2 at T4	39.86±4.95	.249
PaCO2 at T5	39.69±6.71	.354

Out of the 15 patients in the study group, 4 patients had episodes of hypotension, 1 patient in had an episode of bradycardia requiring intervention. No significant complications occurred during immediate postoperative period as well as during the hospital stay. On 3 month follow up of these patient (telephonically), no mortality or morbidity has been recorded.

DISCUSSION

Pneumoperitoneum stimulate a neuro-hormonal stress response which lead to increases heart rate, mean arterial blood pressure and systemic vascular resistance.[1] Myocardial oxygen demand is increased by these factors having deletiorus effects on patients having cardiac dysfunction.[7] Venous return and preload is decreased by increased intra-abdominal pressure and reverse Trendelenburg position , and it increases afterload which would eventually increase cardiac burden. These could precipitate cardiac ischemia or infarction. With pneumoperitoneum the variation in cardiovascular parameters will depend on the patient's intravascular volume, the ventilatory technique , anesthetic agents employed, rate insufflations on the intra-abdominal pressure attained , amount of CO_2 absorbed and patient characteristics.[8] The hemodynamic consequences of intraoperative hypercarbia were addressed by Rasmussen *et al.* In a study of 12 patients with ischemic heart disease in whom $PaCO_2$ levels reached to 55-65 mmHg and resulted in a significant increase in heart rate, systolic blood pressure and cardiac output .It was also suggested the two- to threefold increase in plasma catecholamine concentrations due to sympathetic nervous system stimulation because of hypercarbia.[9] According to the demographic data, the patients belong to a significantly older age group (55± 7 years), which can be very well explained by the fact that incidence of LV systolic dysfunction and hypertension increases significantly with age.[10] Patients in the study per se are predominantly females (72%). A population based study done in the north Indian population confirms a greater prevalence of cholecystitis in females as compared to males. [11] Dhoste *et al.*,[12] in a similar study evaluated the hemodynamic and respiratory changes during laparoscopic cholecystectomy in patients aged >75 years, ASA III category and concluded that the main cardiovascular depression was noted after induction of anesthesia[14]. In their study the CI dropped by 41%, MAP by 27% while the HR by 20% from the baseline value. The fall in these hemodynamic parameters is greater as compared to observations in our study. This difference in results could be because of titrated and graded induction of anesthesia, along with rescue pharmacological interventions done to maintain the hemodynamic parameters. We relied on echocardiographic parameters for measurement of CO; a pulmonary artery catheter was utilized by Dhoste *et al.* Various noninvasive monitoring techniques are available to obtain a better insight into the pathophysiological effects of creation of pneumoperitoneum. TTE is a non invasive, cost effective technique which gives us a quick, repeatable and reliable real time image of the ongoing changes in cardiac function as well as helps us in early diagnosis of the cause of any adverse hemodynamic event encountered during surgery. It also serves as a good guide in perioperative management.[13] Tools like transthoracic echocardiography

and dynamic fluid responsiveness monitoring using IABP or FloTrac (Edwards Life Sciences, Irvine, CA, USA) done perioperatively come in handy in these clinical scenarios. Present study intends to project that patients with moderate to severe systolic dysfunction can also undergo cholecystectomy using the laparoscopic technique keeping in mind the various changes in cardiac output and different stages of the surgery. A tailored anaesthetic technique keeping in mind the physiological changes of pneumoperitoneum, limited pneumoperitoneum time, and anesthetic as well as surgical expertise play a very important role in achieving stable hemodynamics perioperatively. The expertise of surgeon (same surgeon performing all the procedures) and an average time of pneumo-peritoneum of 29 minutes significantly reduce the duration of exposure of the patients with impaired left ventricular systolic function to the deleterious effects of pneumoperitoneum.

CONCLUSION

Present study showed that laparoscopic cholecystectomy may be safely done in cardiac patients with moderate to severe left ventricular systolic dysfunction patients under the supervision of an experienced consultant anaesthesiologist. Optimization of cardiac status, administered of balanced anaesthesia and 10-12 mmHg pressure pneumoperitoneum are essential steps for patients' safety. Life threatening complications are low and can be easily managed in hospital with adequate cardiology support.

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