Original Research Article

Study of hemodynamic parameters and cardiac function in patients undergoing laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction

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Abstract

Background: Laparoscopic cholecystectomy has gained much popularity as being an effective surgical procedure to cholelithiasis as compared to open cholecystectomy**.** Whether the laparoscopic cholecystectomy be beneficial in patients having cardiac dysfunction as the advantage will be less physiological stress and disadvantage of pneumoperitoneum is a matter of concern for surgeon as well as anesthetist. In present study, hemodynamic parameters and cardiac function in patients undergoing laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction was studied. **Material and Methods:** Present study was prospective, comparative study, conducted in p patients 18-65 years age, with echocardiographic findings consistent with presence of moderate to severe left ventricular systolic dysfunction, planned for laparoscopic cholecystectomy, **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. 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. **Conclusion:** 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.

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

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Laparoscopic cholecystectomy has gained much popularity as being an effective surgical procedure to cholelithiasis as compared to open cholecystectomy.[1] Laparoscopic cholecystectomy minimizes abdominal incision and therefore pulmonary function and diaphragmatic function remain preserved. Laparoscopic cholecystectomy decreases the incidence of postoperative ileus, helps early ambulation, has economic benefits, helps early ambulation with shorter hospital stay, early return to work and normal daily activities.[2] Pneumoperitoneum

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created during laparoscopic surgeries have serious impacts on various systems including cardiovascular system. So in patients with cardiac abnormality laparoscopic cholecystectomy should be better avoided.[3] But, patients undergoing laparoscopic cholecystectomy , experience less physiological stress as compared to those who underwent open surgery.[2,4] Whether the laparoscopic cholecystectomy be beneficial in patients having cardiac dysfunction as the advantage will be less physiological stress and disadvantage of pneumoperitoneum is a matter of concern for surgeon as well as anesthetists. Also 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.[5] In present study, hemodynamic parameters and cardiac function in patients undergoing laparoscopic cholecystectomy in patients with moderate to severe left ventricular dysfunction was studied.

MATERIAL AND METHODS

Present study was prospective, comparative study, conducted in Department of Anaesthesia & Intensive Care, PGIMER, Chandigarh, India. Study duration was of 1 year (April, 2019 to March, 2020). Institutional ethical committee approval was obtained prior to start of study.

Inclusion criteria: Patients 18-65 years age, with echocardiographic findings consistent with presence of moderate to severe left ventricular systolic dysfunction, planned for laparoscopic cholecystectomy, Consented for participation

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

Study was explained and a written informed consent was taken. Apart from the demographic variables, history of cardiac medications and prior history of admission to the ER or cardiac adverse events was also noted. The 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 (35%).[6]

Pre-operative 8 hour fasting was advised. followed. Patients were informed on the day prior to the surgery about the study and a written informed consent was taken. In operation theatre, cardiac output, Invasive blood pressure monitoring and Systemic vascular resistance (both from 2D echo, FloTrac system), non-invasive blood pressure monitoring, heart rate, stroke volume variation, central venous pressure (right internal jugular vein canula connected to the pressure transducing system), systolic pressure variation, pulse pressure variation were noted at the predefined study time points.

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.

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. After 10 min after exsufflation (T5), third ABG sample was taken.

The surgery was done according to the standard protocol. If any complication was refractory to medical management or surgical conversion to open procedure was deemed necessary, the patient was excluded from the study. The adverse complications anticipated during creation of pneumoperitoneum and surgery were hemodynamic changes like hypotension, hypertension, and rhythm abnormalities

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. All cardiac patients were followed till hospital discharge and any in hospital morbidity were noted. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Group comparisons of values of data were made with Mann-Whitney test for 2 groups. For Normally distributed data Student t-test was applied to compare 2 groups. A P value < 0.05 was considered 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

Laparoscopic cholecystectomy is a widely accepted surgical procedure for treatment of gall bladder stones. The superior cosmesis ,early return to daily activities, appeal of diminished pain and fatigue are responsible for its popularity in surgery field.[2] Laparoscopic cholecystectomy minimizes abdominal incision and therefore pulmonary function and diaphragmatic function remain preserved. Laparoscopic cholecystectomy decreases the incidence of postoperative ileus, helps early ambulation, has economic benefits, helps early ambulation with shorter hospital stay , early return to work and normal daily activities. 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.[7] 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.[8] Hein *et al.*,[9] in his study, included patients with severe cardiac dysfunction for evaluated the hemodynamic changes in laparoscopic cholecystectomy .They studied in 17 patients with ASA physical status III and IV undergoing elective laparoscopic cholecystectomy. They used standardized general anesthetic and surgical technique for all patient. In addition to routine monitoring they used pulmonary artery cannulation and radial. They noticed that significantly decreased in CI ($p < 0.05$) following insufflation and remained low until exsufflation. After CO_2 insufflation MAP, SVR, and PA occlusion pressure increased significantly ($p < 0.05$) Required administration of nitroglycerin to maintain the MAP and SVR in three out of 17 patients.[9] Dhoste *et al.*,[10] did study in elderly ASAIII patients for monitoring hemodynamic changes in laparoscopic cholecystectomy. They included 16 patients of aged > 75 years. The author had used radial and pulmonary artery cannulation in addition to routine ASA monitoring techniques. After anesthetic induction they noted that patients had cardiovascular depression and post peritoneal insufflation, they noted an improvement of cardiovascular function with increases in cardiac index (+19%), heart rate (+21%), MAP (+19%). They hypothesized this effect to be as a result of a sympathetic stimulation during creation of pneumoperitoneum.[14] The other cardiac output measurement technique which is lesser invasive to the standard techniques (eg.thermodilution method through pulmonary artery catheters) is pulse contour analysis of arterial waveform. Flo Trac is one such moniter which uses the above principle to obtain continuous cardiac output measurements. Its calculations are based on arterial waveform characteristics after adjustment for vascular compliance. It does not require frequent calibration unlike the PiCCO techniques.[11,12] Strength of present study was use of less invasive technique for monitoring of cardiac

parameters. Limitations of present study were small sample size and Flow track was not available for all patients due to resources limitation. Also observations were taken at defined time points; however continuous monitoring of the cardiac parameters can be of more help to observe the trend.

CONCLUSION

Optimization of cardiac status, administered of balanced anaesthesia and 10-12 mmHg pressure pneumoperitoneum are essential steps for patients' safety. 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..

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