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RESEARCH ARTICLE

THE EFFECT OF DIFFERENT ABDOMINAL PRESSURES ON LIVER FUNCTION TESTS AFTER LAPAROSCOPIC CHOLECYSTECTOMY

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ABSTRACT

Laparoscopic cholecystectomy is the gold standard technique for gall stone disease. More than 90 per cent of cholecystectomies today are done laparoscopically. It is beyond doubt advantageous over laparotomy and has gained worldwide popularity. However, pneumoperitoneum is mandatory before any intracavitary laparoscopic procedure is done. New concerns arose regarding the effects of pneumoperitoneum on hemodynamics especially cardiovascular and respiratory system. The present study aims at evaluation and effects of intra-abdominal pressure on hemodynamic changes caused by varied pressures on the liver function tests in particular. The study was performed by performing laparoscopic cholecystectomy at different intra-abdominal pressures viz. 10 mmHg, 12 mmHg and 15 mmHg. The results were evaluated by taking four blood samples at 1 hour, 24 hour, 1 week and 3 weeks and liver function tests were evaluated on respective pressures with particular effect on liver enzymes. The study concluded that there is a definite elevation in liver enzymes (Bilirubin, AST, ALT, GGT, LDH and ALP) which is proportionate to the rise in pressure and duration of surgery. However, the enzyme levels come to pre-operative level after one week. The theme is that laparoscopic cholecystectomy has to be performed with caution in patients of hepatic insufficiency and gasless laparoscopy may be an alternative method in such patients to avoid hazardous effects of pneumoperitoneum.

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INTRODUCTION

It has been over 25 years, laparoscopic cholecystectomy (LC) has replaced open cholecystectomy (OC) in the management of benign gallbladder diseases and has become the gold standard for symptomatic cholelithiasis. As it gained worldwide popularity, it has become one of the most common operations performed in general surgical practice. More than 90% of cholecystectomies today are done laparoscopically (Gurusamy *et al.,* 2010) Although laparoscopic cholecystectomy offered many advantages over laparotomy, new concerns arose regarding the effects of a pneumoperitoneum on the hemodynamics, cardiovascular and respiratory system (Odeberg-Wernerman, 2000). One of the important hemodynamic changes is the transient reduction in hepatic blood flow caused by pneumoperitoneum (Saber *et al.,* 2000; Morino *et al.,* 1998). The pressure of a created pneumoperitoneum and its duration was shown to influence the degree of hepatic ischemia by causing elevations in liver enzymes (Hasukic, 2005; Giraudo *et al.,* 2001).

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An intra-abdominal pressure of 15 mm Hg used in laparoscopic surgery is higher than the normal portal blood pressure (7-10 mm Hg). This pneumoperitoneum could therefore reduce portal flow and cause alteration in liver function. It has been demonstrated in experimental studies that hepatic perfusion exhibited a movement towards reduction as the intra-abdominal pressure increased above 6 mmHg (Tauro *et al.,* 2008). Various other factors have also been blamed including traction to the liver and electrocautery. Changes in LFT (liver function tests) after Laparoscopic cholecystectomy were first studied by Halevy in 1994, who demonstrated an increase of up to 70% in postoperative levels of enzymes with no adverse clinical outcome. In the last decade, several studies have shown 'unexplained' changes in postoperative liver function tests (LFT) in patients undergoing laparoscopic procedures (Tauro *et al.,* 2008). To date conflicting results have been reported regarding the effects of carbon dioxide pneumoperitoneum on splanchnic and liver perfusion. Most reports have suggested that there is a direct correlation between duration of carbon dioxide pneumoperitoneum and hepatic injury (Tan *et al.,* 2003; Gupta *et al.,* 2013). Knowing the fact that normal portal venous pressure is between 7-

10mm of Hg and about half of the hepatic blood flow comes from the portal venous system, 14mmHg of pneumoperitoneum created with CO_2 is stated to be the major cause of transient hepatic ischemia during Laparoscopic cholecystectomy (Jakimowicz *et al.,* 1998; Neudecker *et al.,* 2002). Preoperative and postoperative levels of AST (Aspartate transaminase), ALT (Alanine aminotransferase), GGT (Gamma-glutamyltransferase), ALP (Alkaline phosphatase), LDH (Lactate dehydrogenase), prothrombin time and bilirubin have been investigated in various studies to determine the physiological basis of hepatic malfunction (Andrei *et al.,* 1998. Some recent trials have shown that the high intraabdominal pressure during laparoscopic cholecystectomy leads to reduced portal venous flow. An elevation of serum liver enzymes after uncomplicated laparoscopic cholecystectomy has been reported (Halevy *et al.,* 1994) and that seems to be attributed to splanchnic ischemia (Andrei *et al.,* 1998). Due to all these observations, gasless laparoscopy has been proposed by some surgeons. Although laparoscopic cholecystectomy is associated with transient elevation of liver enzymes, the disturbances after the procedure are self-limited and not associated with any morbidity in patients with normal liver function tests (Omari *et al.,* 2007). Working space in laparoscopic cholecystectomy is created by insufflating carbon dioxide into the peritoneal cavity to the pressure of 12-14 mmHg, which is considered standard (Joris *et al.,* 1992; Berggren *et al.,* 1994). Despite many clinical advantages of laparoscopic surgery, the adverse effects of carbon dioxide (CO_2) pneumoperitoneum are cardiopulmonary, renal, splanchnic and hepato-portal ischemic effects (Hasukic *et al.,* 2002). Jakimowicz et al reported the decrease in portal flow by 53%, with increase in intraperitoneal pressure up to 14mmHg (Berggren *et al.,* 1994). Laparoscopic cholecystectomy under low pressure pneumoperitoneum (7-10mmHg) has also been reported to be feasible (Davides *et al.,* 1999; Wallace *et al.,* 1997). Generally, pneumoperitoneum is the standard pre-requisite for the laparoscopic surgery, although gas-less laparo-lift techniques have been practiced to avoid the adverse effects of the capnopneumoperitoneum but the exposure during surgery in laparo-lift cases is compromised (Vezakis *et al.,* 1999).

Aims and Objectives

1. To study the incidence of alteration in serum liver function tests at different abdominal pressures and their clinical significance.
2. To study the effect of duration of surgery on the liver function tests.

MATERIALS AND METHODS

A prospective study was carried out in the Postgraduate department of General surgery Government Medical College Srinagar over a period of 2-years. During this period laparoscopic cholecystectomy was done in 150 patients suffering from symptomatic cholelithiasis. Laparoscopic cholecystectomy was performed under general anaesthesia with the patient in a slight reverse Trendelenburg position with the 4-trocar technique (Fig.1-2). All patients received similar anaesthetic drugs. The pneumoperitoneum was created by insufflation of carbon dioxide via an open access technique. Intraabdominal pressure was maintained stable at 10 mm Hg in 50 cases, 12 mm Hg in 50 cases and 15 mm Hg in 50 cases (Fig. 3-5) Monopolar diathermy was used for haemostasis and gallbladder detachment from its liver bed. Six liver function parameters were measured preoperatively and at 1hr, 24 hours, 1 week and 3 weeks following surgery: bilirubin (direct and indirect),aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), γ-glutamyl-transpeptidase (γ-GT) and lactate dehydrogenase (LDH). No other medication was administered to the patients prior to or after the operation except for i.v. antibiotics (ceftriaxone) and diclophenac sodium or tramadol for postoperative pain control. All patients were given saline and dextrose solutions for the first 24 hours.

Inclusion Criteria

- Patients of any age group undergoing laparoscopic cholecystectomy in Medical College Hospital with preoperative Liver Function tests within normal limits.

Exclusion Criteria

- Any patient with pre-operative abnormality in liver enzymes
- Suspected/Proven chronic liver diseases
- Common bile duct pathology
- Conversion to open cholecystectomy
- Haematological Disorders
- Intra – Operative Complication – CBD injury
- Patients who had undergone endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy
- Patients having history of taking hepatotoxic drugs.

Fig. 1. Laparoscopic Cholecystectomy Instrument Tray

Fig. 2. Port Placement in Laparoscopic Cholecystectomy

Fig. 3. The insufflator showing intra-abdominal pressure of 10mmHg

Fig. 4. The insufflator showing intra-abdominal pressure of 12mmHg

Fig. 5. The insufflator showing intra-abdominal pressure of 15mmHg

OBSERVATIONS AND RESULTS

Age distribution and gender distribution of study patients is shown in table 1, fig.1 and table 2, fig 2 respectively.

Table 1. Age distribution of Study Patients

Age	Mean	Range	P-value
IAP 15	43.26	22-70	0.329
IAP 12	46.88	28-70	
IAP 10	45.88	27-70	

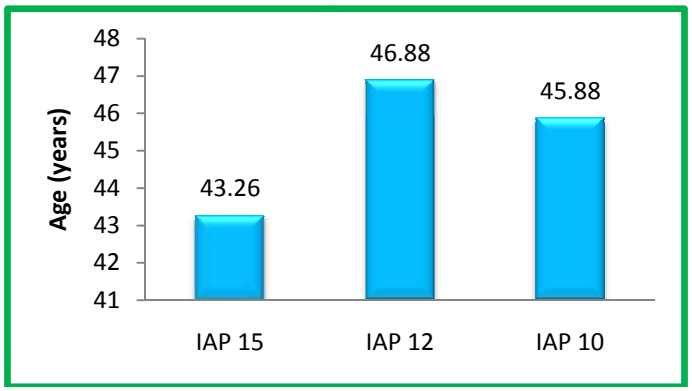

Fig. 1. Age distribution of study patients

Table 2. Gender distribution of study patients

Group	Male	Female	P-value
IAP 15	26	74	0.109
IAP 12	28	72	
IAP 10	12	88	

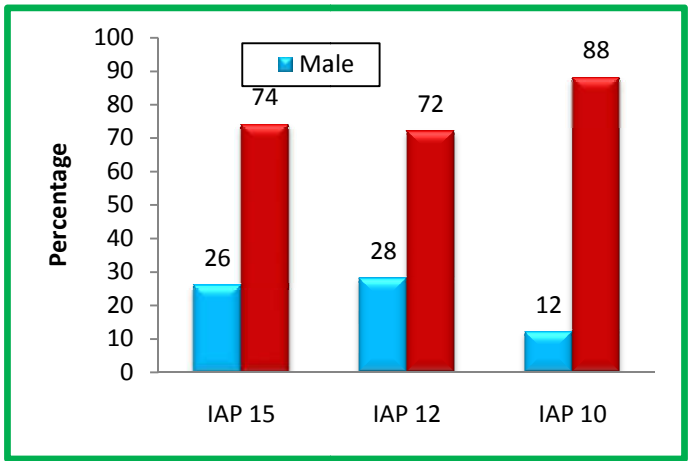

Fig. 2. Gender distribution of study patients

Preoperative serum levels of different enzymes in study patients is shown in table 3, Fig 3.

Table 3. Comparison based on Pre-operative Serum Bilirubin, AST, ALT, GGT, ALP and LDH among various groups

Preop Parameter	IAP 15	IAP 12	IAP 10
Serum Bilirubin	0.583	0.552	0.584
AST	31.52	25.52	28.24
ALT	30.28	24.24	27.20
GGT	57.48	50.26	52.16
ALP	85.74	90.60	78.46
LDH	196.86	209.30	212.88

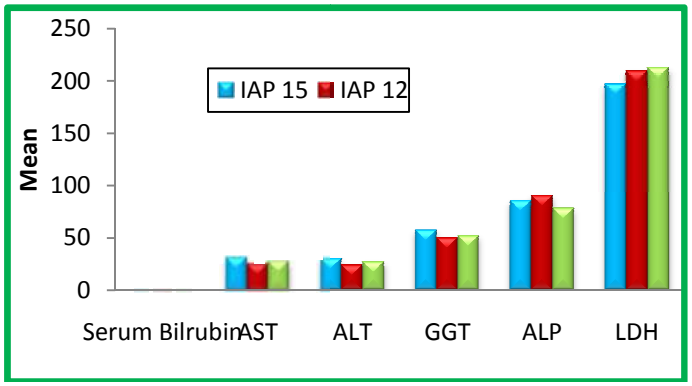

Fig. 3. Preoperative serum bilrubin, AST, ALT, GGT, ALP and LDH among various groups

Effect on postoperative levels of serum bilirubin with pressure is depicted in table 4, fig 4 which shows that at high intra-abdominal pressure postoperative values of serum bilirubin are higher than preoperative values which return to preoperative levels after one week whereas at low pressure there is no increase in bilirubin levels and at moderate intra-abdominal pressure (12mm Hg) return to preoperative levels occurs after 24 hrs.

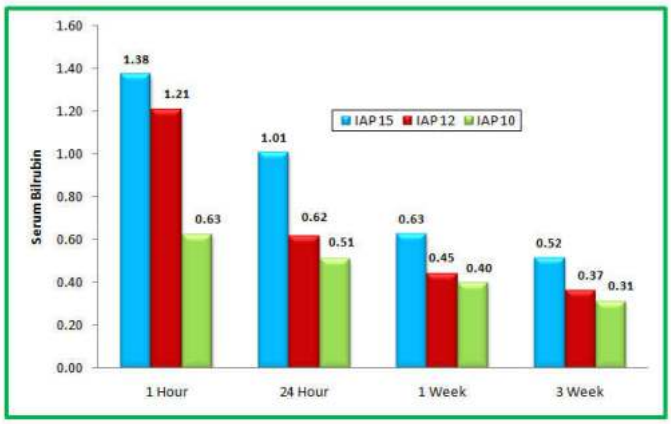

Fig. 4: Comparison based on serum bilrubin among different groups at various time intervals

Table 4. Comparison based on serum bilirubin among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	1.38	1.21	0.63	<0.001*
24 Hour	1.01	0.62	0.51	<0.001*
1 Week	0.63	0.45	0.40	<0.001*
3 Week	0.52	0.37	0.31	<0.001*

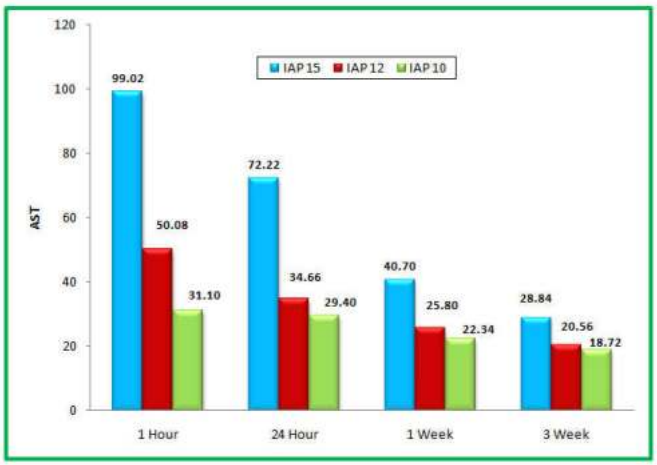

Fig. 5. Comparison based on AST among different groups at various time intervals

Effect on postoperative levels of serum AST and ALT is depicted in table 5, fig 5 and table 6, fig. 6 respectively. There is no increase in levels of AST and ALT at 10 mm of Hg but there is significant increase in both enzyme levels at 12 and 15 mm of Hg pressure which return to preoperative levels after 24hrs and one week respectively.

Table 5. Comparison based on AST among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	99.02	50.08	31.10	<0.001*
24 Hour	72.22	34.66	29.40	<0.001*
1 Week	40.70	25.80	22.34	<0.001*
3 Week	28.84	20.56	18.72	0.002*

Table 6. Comparison based on ALT among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	96.88	47.08	33.90	<0.001*
24 Hour	70.18	29.86	29.22	<0.001*
1 Week	38.14	22.32	21.72	<0.001*
3 Week	29.48	19.94	19.52	0.005*

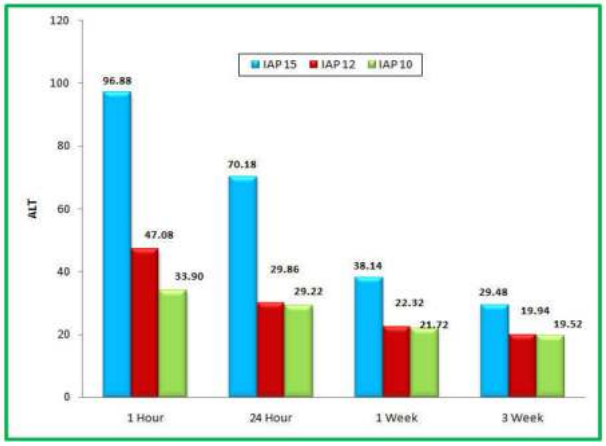

Fig. 6. Comparison based on ALT among different groups at various time intervals

Effect on postoperative GGT and ALP levels is shown in table 7, fig 7 and table 8, fig. 8 respectively which shows that levels of the enzymes are significantly higher at higher pressures and return to preoperative levels is after one week as compared to laparoscopic cholecystectomies done at lower pressures where rise is not too much and also return to preoperative levels occurs after 24 hrs.

Table 7. Comparison based on GGT among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	88.44	69.36	59.88	<0.001*
24 Hour	75.94	58.46	47.44	<0.001*
1 Week	58.64	44.82	43.28	<0.001*
3 Week	47.48	40.42	36.64	<0.001*

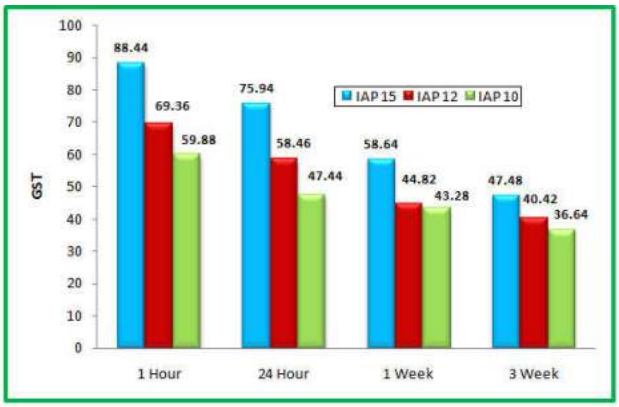

Fig. 7. Comparison based on GGT among diffeent groups at various time intervals

Table 8. Comparison based on ALP among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	139.38	107.50	88.34	<0.001*
24 Hour	106.60	94.04	81.02	<0.001*
1 Week	87.82	82.56	68.26	<0.001*
3 Week	72.30	58.46	55.36	<0.001*

Fig. 8. Comparison based on ALP among different groups at various time intervals

Effect on postoperative levels of serum LDH levels is shown in table 9, fig. 9, which show that LDH levels are higher postoperatively after one hr both at low as well as high pressures and return to preoperative levels occurs after 24 hrs. of surgery.

Table 9. Comparison based on LDH among different groups at various time intervals

	IAP 15	IAP 12	IAP 10	
1 Hour	408.52	381.46	222.40	<0.001*
24 Hour	293.66	220.06	217.80	<0.001*
1 Week	226.08	200.42	194.50	0.018*
3 Week	188.76	183.56	168.40	0.117

Fig. 9. Comparison based on LDH among different groups at various time intervals

Table 10. Postoperative values of liver enzymes at constant pressure with respect to duration of pneumoperitoneum after 24 hours of surgery

Parameter	30-60 Min		> 60 Min		P-value
	Mean	SD	Mean	SD	
Serum Bilirubin	0.81	0.265	2.21	0.293	<0.001*
AST	25.43	5.08	66.82	4.71	<0.001*
ALT	31.16	5.06	65.46	4.94	<0.001*
ALP	56.42	4.75	53.45	5.12	0.218
GGT	50.25	5.34	53.33	6.77	0.157
LDH	215.27	11.53	218.47	9.68	0.301

*Statistically Significant Difference (P-value<0.05)

Effect on post-operative enzyme levels with duration of pneumoperitoneum at constant pressure is show in table 10. Which show that post-operative levels of serum bilirubin, AST and ALT are significantly increased in patients where DOP exceeds 60mins and there is no change in levels of ALP, GGT and LDH.

Table 11. Postoperative values of liver enzymes at constant pressure with respect to duration of pneumoperitoneum after 72 hours of surgery

Parameter	30-60 Min		> 60 Min		P-value
	Mean	SD	Mean	SD	
Serum Bilirubin	0.61	0.235	0.65	0.312	0.785
AST	24.24	5.43	27.23	4.95	0.283
ALT	30.28	4.73	28.19	4.86	0.472
ALP	60.25	6.31	58.47	5.81	0.557
GGT	45.11	5.82	47.28	5.63	0.433
LDH	214.42	8.91	217.34	9.78	0.351

Table 12. Preoperative values of enzymes with respect to duration of pneumoperitoneum at constant pressure (10mmHg)

Parameter	30-60 Min		> 60 Min		P-value
	Mean	SD	Mean	SD	
Serum Bilirubin	0.41	0.283	0.72	0.452	<0.001*
AST	23.95	6.75	29.48	5.13	0.008*
ALT	29.21	5.53	35.43	6.12	0.002*
ALP	59.57	4.52	54.36	4.87	0.023*
GGT	51.06	5.13	56.58	6.52	0.017*
LDH	213.52	12.73	220.84	9.52	0.036*

DISCUSSION

Once considered as incidental, elevation of liver enzymes after non complicated laparoscopic cholecystectomy has become a well-known finding. Although the clinical importance of these enzyme elevations has not been clarified, transient hepatic malfunction was suspected. Many studies have disclosed unexpected changes in postoperative liver function in patients undergoing laparoscopic cholecystectomy and CO_2 pneumoperitoneum might be one of the main reasons for this. This study is therefore intended to assess the presence of unexplained disturbances in liver enzymes following laparoscopic cholecystectomy at different abdominal pressures. The primary mechanism for elevation of liver enzymes after laparoscopic cholecystectomy is likely due to increased intra-abdominal pressure and its effect on portal venous flow. The 15mm of Hg of CO_2 that is used is higher than normal portal pressure of 7-10 mm of Hg, resulting in reduced portal blood flow. In our in 150 patients who underwent 4 port laparoscopic cholecystectomy, 50 patients were carried out at intra-abdominal pressure of 15 mm of Hg, 50 at 12 mm of Hg and rest 50 at 10 mm of Hg. there was no significant difference in operative parameters like duration of symptoms and duration of pneumoperitoneum in between three groups.

At 15 mm of Hg: 50 patients were operated at 15 mm Hg of intra-abdominal pressure, 13 were males and 37 were females. All the patients were between 22-70 yrs of age with majority of cases (39%) in age group of 30-40 yrs. The mean level of serum bilirubin pre-operatively was 0.583±0.246. Postoperatively after one hour and on day 1 levels were 1.38±0.54 and 1.01±0.46 respectively. Mean was on higher side on day 1 and comparable with the study done by Dr Mahendra Bendre *et al.* 2017 who have pre-operative mean of 0.70±0.14 and post operatively on day 1 mean was 1.10±0.32.

On day 7 levels were 0.63±0.27 which were comparable with same study as 0.75±0.18. The mean value of AST preoperatively was 31.52±15.13 and post operatively on day 1 were 72.22±28.03 which were comparable with preoperative mean of 27±16.1 and post-operative mean of 72.9±15.1 in the study done by Rikki Singal *et al.,* 2016. The mean value of ALT preoperatively was 30.28±15.61 and post-operatively on day 1 levels were 70.18±24.63. These levels were comparable with study done by Srikantaiah Hiremath with pre-operative levels of 33.61±12.23 and post-operatively on day 1 as 67.10±20.8. The mean value of ALP pre-operatively was 85.74±25.75 and post-operatively on day 1 were 106.6±18.18, on day 7 levels were 87.82±23.49. Values were comparable with study done by Joshi MR et al whose pre-operative mean was 79.4±30.91 and post-operative mean on day 1 and day 7 were 74.53±48.57 and 78.47±44.51 respectively. The mean value of GGT pre-operatively was 57.48±18.91 and post-operatively on day 1 levels were 75.94±18.45. Mean values of GGT pre-operatively and post-operatively on day 1 were 45.13±19.14 and 67.84±19.49 respectively in the study conducted by Srikantaiah Hire math and the results are comparable. The mean value of LDH pre-operatively was 196.86±47.19 which is comparable with study done by H.Erhan et al[25] who have pre-operative mean of 178±38.2. Post-operative mean on day 1 is 293.66±99.03 which is comparable with the study who have post-operative mean of 273.14±74.92.

At 12 mm of Hg: Mean pre-operative levels of serum bilirubin were 0.552±0.261 and post-operatively levels on day 1 and day 7 were 0.62±0.25 and 0.45±0.19. There was no significant change seen in post-operative values as is also shown in study by Hasukic et al Mean pre-operative levels of serum AST were 25.52±13.50 and on day 1 and day 7 post-operatively levels were 34.66±12.97 and 25.80±12.21. On day 1 mean was on higher side which is comparable with study by Hasukic et al. Mean pre-operative levels of serum ALT were 24.24±9.54. Post-operatively on day 1 levels were 29.86±13.03 which is again on higher side and comparable with the study done by Hasukic et al. Mean values of GGT, ALP and LDH were on higher side after 24 hrs. post-operatively and on day 7 levels were normal to pre-operative levels.

At 10 mm of Hg: 50 patients were operated at 10 mm of Hg out of which 6 were males and 44 were females. The preoperative mean of serum bilirubin was 0.584±0.244. post-operative mean on day 1 and day 7 were 0.51±0.19 and 0.40±0.17 respectively. Post-operative mean on day 1 and day 7 in the study conducted by Joshi MR et al were 0.879±.27 and 0.391±0.16 respectively. Results of our study are comparable with the study done by Joshi MR et al. Mean pre-operative levels of AST was 28.24±13.17. On day 1 and day 7 postoperatively levels were 29.40±9.47 and 22.34±8.13. According to study done by Joshi MR et al postoperative values were 32.87±11.53 and 26.33±9.82 on day 1 and day 7 respectively and the results are comparable to our study. Mean pre-operative values of ALT was 27.20±14.57 and post-operative values are 29.22±9.99 and 21.72±10.97 on day 1 and day 7 respectively. Study by Joshi MR et al had post-operative values of 40.56±11.22 and 30.27±15.11 on day 1 and day 7 respectively and the results were comparable. Mean pre-operative levels of ALP were78.46±34.60. Post-operative levels of ALP on day 1 and day 7 were 81.02±22.72 and 68.26±20.05 respectively. According to study by Joshi MR et al post-operative mean values on day 1 and day 7 were 83.03±48.23 and 76.60±54.60 respectively which are comparable to our study. Mean pre-operative levels of GGT were 52.16±17.61 and on day 1 and day 7 postoperatively were 47.44±13.64 and 43.28±12.52 respectively. There is no elevation of GGT levels post operatively. According to S.Hasukic et al, GGT levels remained unchanged from baseline in both HPLC as well as LPLC. Mean pre-operative levels of serum LDH were 212.88+55.98 and post-operatively levels were 217.80+76.77 on day 1 and 194.50+55.09 on day 7. According to S.Hasukic et al levels of serum LDH remains unchanged both at high as well as low pressures.

In our study we also observe effect of duration of pneumoperitoneum at constant pressure (10 mm of Hg) on levels of liver enzymes. Duration of pneumoperitoneum was taken from insertion of veress needle upto the deflation of pneumoperitoneum. Patients were grouped into two groups with one group of patients as those where duration of pneumoperitoneum was 30-60 mins and another where duration of pneumoperitoneum was >60 mins. Pre-operative serum bilirubin levels in patients with DOP 30-60 mins was 0.41±0.283 and 0.72 ±452 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 0.81± 0.265 and 2.21± 0.293 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs. levels in two groups were 0.61± 0.235 and 0.56± 0.312 respectively. Pre-operative serum AST levels in patients with DOP 30-60 mins was 23.95±6.75 and 29.48 ± 5.13 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 25.43 ± 5.08 and 66.82 ± 4.71 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs. levels in two groups were24.24 ± 5.43 and 27.23 ± 4.95 respectively. Pre-operative serum ALT levels in patients with DOP 30-60 mins was 29.21 ± 5.53 and 35.43 ± 6.12 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 31.16 ± 5.06 and 65.46 ± 4.94 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs.

Levels in two groups were.30.28±4.73 and 28.19±4.86 respectively. Pre-operative ALP levels in patients with DOP 30-60 mins was 59.57±4.52 and 54.36±4.87 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 56.42±4.75 and 53.45±5.12 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs. levels in two groups were 60.25± 6.31 and 58.47± 5.81 respectively. Pre-operative serum GGT levels in patients with DOP 30-60 mins was 51.06± 5.13 and 56.58±6.52 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 50.25 ± 5.34 and 53.33± 6.77 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs. levels in two groups were 45.11± 5.82 and 47.28±5.63 respectively. Pre-operative serum LDH levels in patients with DOP 30-60 mins was 213.52± 12.73 and 220.84± 9.52 in patients with DOP >60 mins. Post-operative levels after 24 hrs. were 215.27±11.53 and 218.47±9.68 in patients with DOP 30-60 mins and >60 mins respectively and after 72 hrs. levels in two groups were 214.42±8.91 and 217.34±9.78 respectively. The results are comparable with the study done by Rikki Singhal et al which shows that in patients where DOP was more than 60 mins post-operative levels of bilirubin, AST and ALT were significantly on higher side after 24 hrs. of surgery and there was no significant elevation in levels of ALP, GGT and LDH irrespective of DOP.

Conclusion

Our study demonstrated that elevations in liver enzymes (bilirubin, AST, ALT, GGT, ALP and LDH) could occur after

laparoscopic cholecystectomy at high pressures and also at low pressures with DOP exceeding 60 mins. When analysed together with the data collected from previous studies, changes may be attributed to reduction of portal venous flow under high pressures of pneumoperitoneum. Enzyme levels come to pre-operative levels after 1 week. There has been no proof to state that these enzyme changes are reflecting a true hepatic ischemia in otherwise healthy patients, but surgeons should be cautious before planning to perform LC in patients with known hepatic insufficiency. LC performed under a low pressure pneumoperitoneum or gasless LC using abdominal wall retractors might be feasible in these patient populations.

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