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COMPARATIVE STUDY BETWEEN LOW PRESSURE VERSUS STANDARD PRESSURE PNEUMOPERITONEUM IN LAPAROSCOPIC CHOLECYSTECTOMY

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ABSTRACT **Background:** Laparoscopic cholecystectomy is the gold standard for treating symptomatic cholecystolithiasis, offering benefits like shorter hospital stays and faster recovery. However, postoperative pain due to standard-pressure pneumoperitoneum is a challenge. **Aim and Objectives:** This study compares low-pressure and standard-pressure pneumoperitoneum in laparoscopic cholecystectomy cases at Santosh Medical College and Hospital, Ghaziabad, focusing on shoulder tip pain evaluation, operative time, complications, and patient safety. **Methods:** The comparative observational study was conducted at Santosh Medical College and Hospital's Department of General Surgery, Ghaziabad over a period of one year. Sample size –total 126 (63 in each group A and group B) patients included in the study. All patients aged 18-65 with uncomplicated symptomatic cholelithiasis, those aged <18 or >65 with gallbladder malignancy, acute cholecystitis, cholelithiasis associated with choledocholithiasis, patients unfit for general anaesthesia surgery, and pregnant women. **Results:** Total 126 adult patients aged 18 to 65 years was conducted to study upper abdominal pain. The patients were divided into two groups: Group A-63 (low pressure) and Group B-63 (standard pressure pneumoperitoneum). The study found that the majority of patients were aged 39 years or older and 43 out of 63 were female. The peak shoulder pain scores were higher in the standard pressure group at 6 hours, while the low pressure group had lower mean pain scores. The mean changes in systolic, diastolic, and pulse rate were higher in the standard pressure group. The mean hospital stay was significantly lower in the low pressure group compared to the standard pressure group.**CONCLUSION:** Low-pressure pneumoperitoneum reduces postoperative shoulder discomfort, but doesn't improve intraoperative hemodynamics, operational time, injuries, or mortality.

KEYWORDS : Laparoscopic cholecystectomy, Low-pressure pneumoperitoneum, standard pressure pneumoperitoneum, pain score, operation time, Hospital stay,

INTRODUCTION

Laparoscopic cholecystectomy (LC) is the gold standard for surgical treatment of symptomatic cholecystolithiasis, offering advantages such as shorter hospital stays, faster recovery times, less postoperative pain, and better cosmetic results.[1,2] However, LC has its challenges, including postoperative pain and discomfort due to the use of pneumoperitoneum, which insufflates carbon dioxide into the peritoneal cavity to create a working space for laparoscopic surgery. This creates increased intra-abdominal pressure, which can lead to complications during and after the procedure.[3] Standard pressure pneumoperitoneum typically maintains an intra-abdominal pressure of 12--15 mmHg, but concerns have been raised about the potential adverse effects of high pressures, including decreased venous return, compromised cardiac output, impaired respiratory function, and increased postoperative pain.[4] To mitigate these risks, low-pressure pneumoperitoneum techniques have been proposed, reducing intra-abdominal pressure to levels closer to physiological norms. Some studies suggest that low-pressure pneumoperitoneum may alleviate postoperative pain, shoulder tip discomfort, and overall morbidity, while others argue it could impair surgical exposure, prolong operative times, and increase intraoperative complications like hemorrhage and bile duct injuries.[5,6]

The literature lacks consensus on the effectiveness and safety of low-pressure versus standard-pressure pneumoperitoneum in laparoscopic cholecystectomy due to contradictory evidence.[7] Pneumoperitoneum is crucial in laparoscopic cholecystectomy, lifting the abdominal wall and facilitating instrument manipulation.[8] However, it can cause physiological changes, such as increased intra-abdominal pressure, which can affect patient outcomes and surgical feasibility. Standard-pressure pneumoperitoneum, typically maintained between 12 to 15 mmHg, is commonly used, but concerns have been raised about potential adverse effects, such as decreased venous return, impaired cardiac function, compromised respiratory mechanics, and increased postoperative pain.[9] Alternative strategies using low-pressure pneumoperitoneum are being proposed.[10]

Low-pressure pneumoperitoneum techniques aim to reduce intra-abdominal pressures to levels closer to physiological norms, typically around 8 to 10 mmHg. Advocates argue that these techniques may mitigate adverse effects of standard-pressure pneumoperitoneum, such as postoperative pain, shoulder tip discomfort, and hemodynamic instability. They also suggest that low-pressure pneumoperitoneum may improve patient outcomes and enhance the safety profile of laparoscopic cholecystectomy.[11] The traditional approach to pneumoperitoneum involves maintaining standard intra-abdominal pressures, typically 12 to 15 mmHg. However, concerns about potential adverse effects have led to the exploration of alternative techniques like low-pressure pneumoperitoneum.[12] These techniques aim to reduce postoperative pain, shoulder tip discomfort, and overall morbidity, enhancing patient comfort and satisfaction.[13] An emerging concept is the use of humidified and heated CO2 gas for insufflation during laparoscopic cholecystectomy. Traditional methods involve dry and cold CO2 gas, which can lead to desiccation of peritoneal tissues, hypothermia, and postoperative discomfort. Humidified and heated CO2 gas has been proposed to mitigate these effects and improve patient outcomes by preserving tissue integrity, minimizing heat loss, and reducing postoperative pain.[14-16] Future research directions may involve large-scale prospective studies comparing the effectiveness and safety of different pneumoperitoneum

techniques, exploring adjunctive therapies and interventions, and leveraging technological advancements in insufflation devices and imaging modalities to revolutionize minimally invasive surgery and expand the repertoire of available techniques for pneumoperitoneum management.

Aim of this study is to compares low-pressure and standard-pressure pneumoperitoneum in laparoscopic cholecystectomy cases at Santosh Medical College and Hospital, Ghaziabad. The primary outcome is shoulder tip pain evaluation using visual analogue score. Secondary outcomes include operative time, intraoperative difficulties, complications, bradycardia incidence, post-operative complications, conversion rate from laparoscopic to open surgery, and number of patients achieving critical view of safety.

METHODS

The comparative observational study was conducted at Santosh Medical College and Hospital's Department of General Surgery, Ghaziabad over a period of one year. Sample size –total 126 (63 in each group A and group B) patients included in the study.

The study included patients aged 18-65 with uncomplicated symptomatic cholelithiasis, those aged <18 or >65 with gallbladder malignancy, acute cholecystitis, cholelithiasis associated with choledocholithiasis, patients unfit for general anaesthesia surgery, and pregnant women.

All patients will assess before and after surgery using various parameters such as laboratory, intra-operative, and post-operative parameters. The study will use various tools such as history, clinical examination, laboratory tests, radiological tests, type of surgery (laparoscopic cholecystectomy), gross pathology, and histological changes. Data management and statistical analysis will be done using SPSS 24th version , with categorical variables as frequency and continuous parameters as mean ± standard deviation. Non-parametric variables will be presented as median, and the Mann- Whitney test will be used for comparisons. Categorical variables will be compared between groups using the Chi-square test, and a two-tailed p-value of <0.05 will be considered statistically significant.

RESULTS:

Total 126 adult patients aged 18 to 65 years, who were admitted due to upper abdominal pain. The patients were divided into two groups: Group A-63 (low pressure group) and Group B-63 (standard pressure pneumoperitoneum group), with a gender distribution of 68.25% and 31.75% respectively. Both groups were sex-matched, and there was no significant difference in gender distribution. The age distribution of patients was uniform across the age groups, with no significant difference in the age distribution between male and female patients. The comparison of operational time between groups A and B showed that the percentages of patients with operative times ranging from 1-50 to 126-150 minutes were 31.75% in Group A and 28.57% in Group B. The average operative time in Group A was 66±10.5 minutes, while in Group B it was 62±9.4 minutes. Both groups were comparable based on operative time. The study highlights the importance of understanding the distribution of patients and their operative time in managing upper abdominal pain. (Table 1)

Table 1: Distribution of patients according to Demographic profile and different Operation time in group A and group B

Gender	Group A (LPLC) (n=63)		Group B (SPLC) (n=63)		Chi. Sq.	p-value
	n	%	n	%	0.00	1.00
Female	43	68.25	43	68.25		
Male	20	31.75	20	31.75		
Age (in Years)						
18-28 years	12	19.05	12	19.05	0.00	1.00
29-38 years	12	19.05	12	19.05		
39-48 years	13	20.63	13	20.63		
49-58 years	13	20.63	13	20.63		
59-65 years	13	20.63	13	20.63		
Operative Time (in min)						
1-50	20	31.75	18	28.57	2.83	0.587
51-75	22	34.92	20	31.75		
76-100	17	26.98	18	28.57		
101-125	3	4.76	7	11.11		
126-150	1	1.59	0	0.00		
mean±SD	66±10.5		62±9.4			

The study compared the average changes in blood pressure between two groups, group A and group B. In group A, the average changes were 0.70±0.10, 1.64±0.18, and 0.82±0.11, respectively. In group B, the average changes were 0.98±0.21, 2.66±0.42, and 1.72±0.20, respectively. The average increase in blood pressure was significantly higher in group B compared to group A. The mean hospital stay was significantly lower in group A (low pressure) compared to group B (standard pressure pneumoperitoneum). The average pain score was higher in group B at 6 hours, 12 hours, and 24 hours, with group B having a higher mean pain score after 6 hours. However, no significant difference was observed between group A and group B at 12 hours and 24 hours. (Table 2)

Table 2: Comparison of mean Blood Pressure changes, postoperative hospital stay and pain score in between group A and group B

	Group A (LPLC) (n=63)	Group B (SPLC) (n=63)	t	p-Value
BP change	Mean±SD	Mean±SD		
Systolic BP (change in mm Hg)	0.70±0.10	0.98±0.21	9.56	<0.001*
Diastolic BP (change in mm Hg)	1.64±0.18	2.66±0.42	17.72	<0.001*
Pulse Change (per min.)	0.82±0.11	1.72±0.20	31.30	<0.001*
Hospital stay (days)	2.01±0.45	2.55±0.59	-0.08	0.934
Pain score				
6 hrs	3.45±0.94	3.78±0.90	2.01	0.003
12 hrs	2.51±0.62	2.64±0.64	1.16	0.249
24 hrs	2.24±0.55	2.30±0.58	0.59	0.552

*-significant

The study compared the frequency of various outcome factors between two groups of patients. In Group A, 3.17% of patients required conversion to open cholecystectomy, while 4.76% in Group B did not. The majority of patients in both groups did not require conversion, with 96.83% in Group A and 95.24% in Group B. There was no statistically significant difference between the groups regarding conversion to open cholecystectomy. In Group A, 4.76% of patients experienced bile spillage, while 1.59% in Group B did not experience it. The majority of patients in both groups did not experience bile spillage, with 95.24% in Group A and 98.41% in Group B. No visceral injury occurred in either group, indicating no statistical comparison. Postoperative shoulder tip pain was more prevalent in Group B compared to Group A. Nausea or vomiting was more common in Group A, but not in Group B. The need for additional analgesia was also found to be similar between the two groups. There were no cases of mortality in either Group A (LPLC) or Group B (SPLC), with all 63 patients in both groups surviving, resulting in a 100% survival rate in each group. No statistical comparison could be made as there were no mortality events in either group.(Table 3)

Table 3: Comparison of frequencies of Conversion to open cholecystectomy, Bile spillage, Visceral injury, Postoperative shoulder tip pain, Nausea/ vomiting, Need for additional analgesia, and mortality in between group A and group B

Items		Group A (LPLC) (n=63)		Group B (SPLC) (n=63)		P value
		n	%	n	%	
Conversion to open cholecystectomy	Yes	2	3.17	3	4.76	1.00
	No	61	96.83	60	95.24	
Bile Spillage	Yes	3	4.76	1	1.59	0.619
	No	60	95.24	62	98.41	
Visceral injury	Yes	0	0.00	0	0.00	1.00
	No	63	100	63	100	
Postoperative Shoulder tip pain	Yes	4	6.35	15	23.81	0.011
	No	59	93.65	48	76.19	

Nausea/vomiting	Yes	8	12.70	11	17.46	0.620
	No	55	87.30	52	82.54	
Need for additional analgesia	Yes	3	4.76	4	6.35	1.00
	No	60	95.24	59	93.65	
Mortality	Yes	0	0.00	0	0.00	-
	No	63	100	63	100	

*significant

DISCUSSION

Laparoscopic cholecystectomy requires sufficient abdominal space for optimal visibility and results. Standard methods include pneumoperitoneum and procedures like laparolifts and laparotensors. However, studies show side effects during standard pressure pneumoperitoneum with carbon dioxide gas.[17-19] A study by Helmy et al.[19] found that 24 hours after laparoscopic cholecystectomy, patients experienced an increase in transaminase levels, negatively affecting liver function. To address these limitations, carbon dioxide aspiration is a low-pressure technique developed. Studies show that low-pressure pneumoperitoneum laparoscopic cholecystectomy results in better postoperative recovery, improved quality of life, and lower surgical pain intensity compared to standard pressure pneumoperitoneum.[19-23]

The study found that shoulder tip pain scores were significantly higher in low pressure and standard pressure pneumoperitoneum groups after 6 hours, 12 hours, and 24 hours. Group B had significantly higher mean pain scores after 6 hours than group A. However, at 12 and 24 hours, no significant difference was found between the two groups. Research has shown that low-pressure pneumoperitoneum can significantly decrease postoperative pain and shoulder tip discomfort after laparoscopic cholecystectomy.[24] However, a recent study by Chang et al. showed no significant difference in postoperative discomfort when operating with different pneumoperitoneum pressures, including low and extremely low pressures.[25] The study contradicted previous findings, as it found that the low pressure group had lower median pain scores at four specific time points. Hua et al. found that the use of low-pressure pneumoperitoneum was associated with a significantly lower incidence of shoulder pain, determined using the Mantel-Haenszel method and the fixed-effects model.[26] In contrast, Sandhu et al. found no statistically significant difference in the incidence of shoulder pain after surgery between the low-pressure and standard-pressure groups.[27] Further research is needed to confirm these findings and improve the management of postoperative pain.

In our study, the mean change in systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg) and pulse rate (per min) at low pressure were 0.70±0.10, 1.64±0.18 and 0.82±0.11, respectively. The mean changes in systolic blood pressure, diastolic blood pressure and pulse rate (per min) in the standard pressure pneumoperitoneum group were 0.98±0.21, 2.66±0.42 and 1.72±0.20, respectively. The study found that low-pressure laparoscopic cholecystectomy results in smaller changes in hemodynamics, such as heart rate, cardiac output, and blood pressure, compared to standard-pressure laparoscopic cholecystectomy. However, hemodynamic changes are comparable in both groups, possibly due to the 6 mmHg difference in intraperitoneal pressure between the two groups. One possible reason for this lack of statistical significance may be that the low-pressure pneumoperitoneum group maintained an intraperitoneal pressure of 8 mmHg, which is the definition of standard pressure used by several investigators.[25,28]

Several studies suggest that the decrease in cardiac output was similar in both groups, although the group undergoing laparoscopic cholecystectomy with low-pressure pneumoperitoneum experienced a faster recovery. Previous studies have observed that both low-pressure laparoscopic cholecystectomy and standard pressure cholecystectomy resulted in a decrease in mean arterial blood pressure and heart rate, but these changes were not found to be statistically significant.[29-32]

A notable discrepancy in surgical outcomes was observed at the 10-minute mark, as well as a significant deviation in both systolic and diastolic blood pressure at the 30-minute mark. However, no significant differences in systolic or diastolic blood pressure were found in a study conducted by Kanwer et al.[33]

The study found that the mean hospital stay for laparoscopic surgery was 2.01 days in group A and 2.55 days in group B, with a significantly lower mean stay in group A (low pressure) compared to group B (standard pressure pneumoperitoneum). The average length of hospital stay for the LPLC group was 1.56 days, while the SPLC group had an average stay of 1.63 days. No significant intra- or postoperative problems were observed in either group. The distension of the abdominal cavity with gas may increase the risk of postoperative nausea and vomiting.[24]

The study found that the rates of conversion to open cholecystectomy, bile leakage, visceral damage, postoperative shoulder tip discomfort, nausea/vomiting, mortality, need for additional analgesics, and death were significantly higher in the standard pressure pneumoperitoneum group compared to the low-pressure group. The standard pressure pneumoperitoneum group had a significantly higher proportion of postoperative shoulder tip discomfort compared to the low-pressure group. Other factors showed comparable characteristics in both groups. Previous studies have found no significant differences in the incidence of vomiting and nausea after surgery between standard pressure and low pressure laparoscopy.[34,35] Low-pressure pneumoperitoneum was performed by experienced surgeons without significant increase in surgical complexity, conversion rate, or postoperative complication rate. The functional visual field was not affected.[26] Mahajan et al. proposed the standardization of low-pressure laparoscopic cholecystectomy in outpatient surgery, showing no significant differences compared to standard pressure pneumoperitoneum.[36] There were no notable differences in the adequacy of the surgical field, contact between the parietal peritoneum and the underlying viscera during insertion of the secondary port, duration of the procedure, complication rates, or surgical difficulty.

The study found that the majority of patients were aged 39 or older, with 43 out of 63 being female. This suggests that gallstone disease is more common in women. Similar studies have shown similar age and gender distributions. Abdallah et al (2024) found that a significant proportion of patients were between 40 and 50 years old. Of the 80 cases, 71 were female, indicating a higher proportion of females.[24,37]

CONCLUSION

The study concluded that low-pressure pneumoperitoneum reduces postoperative shoulder discomfort but has no beneficial effect on intraoperative hemodynamics, operational time, intraoperative injuries, or mortality.

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