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Postoperative Outcomes of Low Pressure versus Standard Pressure Pneumoperitoneum in Laparoscopic Cholecystectomy

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ABSTRACT

Objective: To compare outcomes in laparoscopic cholecystectomy performed with either low-pressure pneumoperitoneum (LPP <12 mm Hg) or standard-pressure pneumoperitoneum (SPP >12 mm Hg).

Methodology: This randomized trial was conducted over six months, from September 2020 to March 2021, with data prospectively collected from patients. Patients aged 20-60 years with symptomatic gallstones were divided between Group A or Group B randomly, with 31 patients in each group. Group A underwent surgery with low-pressure pneumoperitoneum (LPP), whereas Group B underwent surgery with standard-pressure pneumoperitoneum (SPP). Postoperative ileus was assessed at six hours, while shoulder tip pain was evaluated at 24 hours post-surgery, and comparisons were made between both groups.

Results: There were 16 males and 15 females in group A and 14 males and 17 females in group B. Mean age in Group A was 40.35±7.27 years and in Group B 42.28±6.95 years. Group A had an average hospital stay of 1.06 ± 0.21 days and Group B had 1.09 ± 0.37 days. 10 patients (32.3%) experienced right shoulder tip pain in the LPP group as compared to 19 patients (61.3%) in the SPP group (p=0.021). Paralytic ileus was noticed in 6 patients (19.4%) in Group A and 16 patients (51.6%) in Group B (p<0.007).

Conclusion: LLP is a possible and safe option that significantly reduces postoperative shoulder tip pain and paralytic ileus, facilitating earlier bowel recovery compared to standard-pressure pneumoperitoneum.

Keywords: Laparoscopic cholecystectomy, postoperative shoulder tip pain, postoperative ileus, standard pressure pneumoperitoneum, low-pressure pneumoperitoneum.

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Introduction

The most commonly performed procedure for gallstone disease is laparoscopic cholecystectomy around the world and is considered the gold standard treatment.[1] Right upper quadrant pain is the frequent presentation with fever, vomiting, an abdominal mass, and sometimes perforation.[2] Lower postoperative pain, ileus, wound infection, hospital stay and recovery period has been documented with laparoscopic as compared to open cholecystectomy.[3]

Creating an optimal working field in the abdominal cavity is crucial for safe and effective laparoscopic surgery.[4] This is typically achieved using either pneumoperitoneum or abdominal wall lifting devices.[5] During laparoscopic cholecystectomy, CO2 is insufflated into the peritoneal cavity, usually through the umbilical port, to establish and maintain pneumoperitoneum at a pre-set pressure throughout the procedure.[6] Standard-pressure pneumoperitoneum (SPP) typically ranges between 12-14 mmHg. Adverse effects like reduced pulmonary compliance, impaired circulatory function,

and venous pressure abnormalities are reported with standard pressure.[7, 8]

An emerging trend in laparoscopic surgery is the use of lower insufflation pressures (7-10 mmHg) to minimize the physiological impact of pneumoperitoneum while maintaining sufficient surgical exposure.[9,10] Despite its advantages, CO2 insufflation carries risks such as increased pCO2 levels, ventilation-perfusion disturbances, pneumothorax, pneumopericardium, surgical emphysema, and even CO2 embolism.[11] Residual gas post-surgery and hypercarbia can trigger sympathetic stimulation, leading to postoperative shoulder pain.[12] Additionally, opioid-based analgesia used to manage postoperative pain can exacerbate gastrointestinal motility issues, increasing the risk of nausea, vomiting, and delayed discharge.[13] Paralytic ileus, a well-documented complication of pneumoperitoneum, may result from factors such as transient bowel ischemia due to elevated intra-abdominal pressure or CO2 absorption.[14]

Although several studies have compared low-pressure and standard-pressure pneumoperitoneum, limitations such as small sample sizes, single-center settings, and lack of randomization necessitate further research on this topic.[15] The challenge remains in balancing adequate surgical exposure with minimizing postoperative complications. While higher pneumoperitoneum pressures offer improved visibility, they can also prolong recovery times. Conversely, lower pressures may reduce adverse effects but could hinder the surgical workspace and may lead to increased intraoperative adverse events.

Given the lack of consensus on the optimal pneumoperitoneum pressure, this study aims to assess the outcomes of laparoscopic cholecystectomy with LPP versus SPP. Our findings seek to contribute to refining best practices in laparoscopic surgery and improving patient care.

Methodology

This randomized controlled trial was conducted in the General Surgery Unit of the Pakistan Institute of Medical Sciences, Islamabad, from September 2020 to March 2021. A total of 62 patients were enrolled, with 31 patients randomly assigned to each of the two study groups. The sample size was calculated using WHO software, based on a significance level of 5% and a statistical power of 80%, referencing a prior study that reported shoulder tip pain prevalence rates of 7.5% in the low-pressure pneumoperitoneum (LPP) group and 23.8% in the standard-pressure pneumoperitoneum (SPP) group. Simple random sampling was employed for participant selection.

Inclusion criteria comprised patients of either gender, aged between 20 and 60 years, with an American Society of Anesthesiologists (ASA) physical status classification of grade II or lower, who were scheduled for laparoscopic cholecystectomy. Exclusion criteria included lack of informed consent, pre-existing shoulder pain conditions (such as rheumatoid arthritis, adhesive capsulitis, or subacromial bursitis), active hepatitis B or C, HIV infection, thyroid disorders, prior abdominal surgeries, recent episodes of pancreatitis, or endoscopic retrograde cholangiopancreatography (ERCP) with stenting within the past six months.

Ethical approval was obtained prior to initiating the study. Patients were enrolled following the acquisition of informed consent, which was administered in Urdu. Demographic data, including age, gender, body mass index (BMI), and place of residence, were collected along with relevant medical history, such as the presence of diabetes mellitus, hypertension, and smoking status. Participants were randomly allocated into either Group A (LPP, intra-abdominal pressure <12 mmHg) or Group B (SPP, intra-abdominal pressure >12 mmHg) using sealed opaque envelopes. All procedures were performed by a consistent team of three experienced laparoscopic surgeons.

Postoperative shoulder tip pain was assessed using the Visual Analog Scale (VAS) 24 hours after surgery, with a score of ≥6 considered clinically significant. Additionally, the presence of postoperative ileus was evaluated through clinical parameters, including auscultation of bowel sounds, passage of flatus and stool, and tolerance to oral intake within six hours postoperatively. Quantitative variables such as age, height, weight, BMI, and duration of hospital stay were recorded, along with categorical variables like gender, residential status, comorbidities (diabetes, hypertension), obesity, smoking status, and postoperative outcomes.

Data analysis was performed using SPSS Version 20. Means and standard deviations were calculated for continuous variables, while frequencies and percentages were used for categorical data. The chi-square test was applied to compare postoperative outcomes between groups, with a p-value of ≤0.05 considered statistically significant.

Results

A total data for 62 patients were collected. The mean age was 41.32 years, with a standard deviation of ±10.06. Mean age for group A was 40.35 years ± 7.27, and for Group B, it was 42.28 years ± 6.95. Group A had 16 males and 15 females, and Group B had 14 males and 17 females. Both groups were homogeneous regarding demographic details and distribution of comorbidities as evident from (Table I).

The average length of stay for all participants was approximately 1.07 days, with a standard deviation of 0.42. Lengths of stay, with averages of 1.06 and 1.09 days were similar in both of the groups respectively.

10 patients (32.3%) in Group A (LPP) and 19 patients (61.3%) in Group B (SPP) developed post-operative shoulder tip pain. In Group A 21 patients (67.7%) and in group B 12 patients (38.7%) had no pain (p = .021). Regarding postoperative paralytic ileus, 6 patients (19.4%) in Group A and 16 patients (51.6%) in Group B developed this complication (p=.007), and no ileus was observed in rest of the patients. (Table II).

Discussion

Pneumoperitoneum is a fundamental requirement for laparoscopic surgeries; however, the debate over the optimal intra-abdominal pressure (IAP) remains unresolved. While lower pressures may provide benefits such as reduced postoperative pain and fewer cardiopulmonary complications, they may also compromise the surgical field. Conversely, higher pressures ensure better visibility but are associated with more profound physiological and hemodynamic changes. It also leads to increased postoperative discomfort and longer recovery period. Our study aimed to compare the LPP with SPP on postoperative outcomes in laparoscopic cholecystectomy, especially for pain and ileus.

The results of our study align with several national and international studies. Our findings showed a lower incidence of postoperative shoulder tip pain in the LPP group (32.3%) as compared to the SPP group (61.3%), with a statistically significant p-value of 0.021. Abdallah et al,. reported similar results with significantly less postoperative shoulder pain in the LPP group.[16] Similarly, a significant reduction in postoperative abdominal and shoulder pain in the LPP group is reported with a total of 84 patients in another study.[17] Statistically significant reductions in postoperative pain and analgesic consumption in patients undergoing laparoscopic cholecystectomy with LPP were reported in a meta-analysis of 44 randomized controlled trials (RCTs), further contributing to the body of evidence.[18] Although our study did not assess intraoperative hemodynamics or operative time, the literature found no differences which are of statistical significance in these parameters, aligning with the conclusions drawn by Abdallah et al.[16]

Regarding postoperative ileus, our study found a statistically significant reduction in paralytic ileus in the LPP group (19.4%) as opposed to the SPP group (51.6%) (p-value <0.007). It is consistent with a recent randomized controlled trial involving 84 patients; which

Table I: Demographics, BMI, Length of Hospital Stay and Comorbidities in both Groups.

	Overall	Group A	Group B	p-value
Age	41.32 ± 10.06	40.35 ± 7.27	42.28 ± 6.95	.281
Male	30	16	14	.611
Female	32	15	17	
Urban	38	20	18	.602
Rural	24	11	13	
Length of stay (Days)	1.07 ± 0.42	1.06 ± 0.21	1.09 ± 0.37	.693
Diabetes	21	09	12	.422
Hypertension	18	06	12	.091
Smoking	12	04	08	.191
Obesity BMI>28 kg/m^2	12	06	06	1.001

Table II: Comparison of post-operative shoulder pain and paralytic Ileus in both groups.

Parameter		Low Pressure Pneumoperitoneum (Group A, LPP)	Standard Pressure Pneumoperitoneum (SPP, Group B)	p-value
Post Op Shoulder Tip Pain at twenty-four hours	Yes	10 (32.3%)	19 (61.3%)	.021
	No	21 (67.7%)	12 (38.7%)	
Post Op Paralytic Ileus at Six hours	Yes	06 (19.4%)	16 (51.6%)	.007
	No	25 (80.6%)	15 (48.4%)	

demonstrated a reduction in postoperative ileus in the LPP group, reinforcing our findings.[17] The pathophysiology of postoperative ileus is multifactorial, involving inhibitory neuronal reflexes, inflammation, and pharmacological effects.[19] Evidence from colorectal surgery trials suggests that laparoscopic surgery is associated with reduced postoperative ileus due to minimal bowel handling and lower inflammatory response.[20,21] However, compared to shoulder and abdominal pain, postoperative ileus remains less frequently reported in studies evaluating LPP outcomes in laparoscopic cholecystectomy, highlighting the need for further research.

In Our study LPP group had observed a reduced length of hospital stay (1.06 ± 0.21 days) compared to the SPP group (1.09 ± 0.37 days), but the difference was not statistically significant. This finding aligns with the systematic review of 44 RCTs, which also reported a shorter hospital stay in the LPP group, but without statistical significance.[18] The shorter hospital stay observed in LPP patients may be attributed to reduced postoperative pain and faster recovery, though further large-scale studies are needed to establish conclusive evidence.

While our findings support the benefits of LPP in reducing postoperative pain and ileus, certain inconsistencies with other studies warrant further research. Unlike our study, which did not record and report intraoperative outcomes, Abdallah et al. found no positive impact of LPP on intraoperative hemodynamics, operative time, intraoperative injuries, or mortality.[16] Moreover, surgeon experience and comfort with lower-pressure settings could influence outcomes, which our study did not assess.

Our study has several limitations. Patients in either group who were converted to open surgery were not recorded and were excluded. Additionally, intraoperative complications such as bleeding, visceral or vascular injuries, and bile spillage were not documented. Furthermore, we did not evaluate the surgeon's perception of ergonomics while operating under LPP and SPP. More studies are required to address these issues to better understand the impact of pneumoperitoneum pressure on surgical outcomes.

Despite these limitations, our study has notable strengths. With a total of 62 patients meeting the inclusion criteria, our sample size provides meaningful data on the effects of LPP and SPP on postoperative outcomes. Randomized patient selection helped mitigate selection bias, and the homogeneity of both groups regarding demographic details and comorbidities enhances the validity of our comparisons.

Conclusion

In conclusion, our study supports the growing body of evidence favoring LPP in laparoscopic cholecystectomy, particularly in reducing postoperative pain and ileus. Given the ongoing debate regarding optimal IAP levels, future multicenter trials with good and reasonable sample sizes and better protocols are required to establish definitive guidelines for pneumoperitoneum pressure in laparoscopic surgery. Our findings contribute to this evolving discussion and highlight the potential benefits of adopting LPP as a standard approach for improving patient outcomes.

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