International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

A Prospective Randomized Comparative Study Between Low-Pressure and Standard-Pressure Pneumoperitoneum in Laparoscopic Cholecystectomy

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OPEN ACCESS

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Received: 20-05-2026
Accepted: 03-06-2026
Available online: 25-06-2026

ABSTRACT

Background: Laparoscopic cholecystectomy is the gold standard treatment for symptomatic cholelithiasis. Although standard-pressure pneumoperitoneum (12–14 mmHg) provides adequate operative exposure, it may contribute to increased postoperative pain. Low-pressure pneumoperitoneum (7–10 mmHg) has been proposed as an alternative to improve postoperative outcomes.
Objective: To compare the outcomes of low-pressure and standard-pressure pneumoperitoneum in patients undergoing laparoscopic cholecystectomy.
Materials and Methods: This prospective randomized comparative study was conducted on 100 patients with uncomplicated symptomatic cholelithiasis undergoing elective laparoscopic cholecystectomy at JLN Medical College and Associated Group of Hospitals, Ajmer, from June 2024 to December 2025. Patients were divided into two groups: Group A (Low-Pressure Pneumoperitoneum, n=50) and Group B (Standard-Pressure Pneumoperitoneum, n=50). Outcomes assessed included duration of surgery, operative field visibility, intraoperative bleeding, and postoperative shoulder tip pain using the Numeric Pain Rating Scale (NPRS).
Results: The mean age was comparable between Group A and Group B (46.36 ± 13.66 vs 46.58 ± 15.84 years). Females predominated in both groups (76% and 82%, respectively). The mean duration of surgery was significantly longer in the low-pressure group (55.80 ± 5.79 vs 50.56 ± 6.56 minutes; $p<0.0001$). Good operative field visibility was observed in 60% of Group A and 76% of Group B patients. The incidence of intraoperative bleeding was comparable between groups (58% vs 52%; $p=0.5485$). Postoperative shoulder tip pain was significantly lower in the low-pressure group at 0–6 hours (1.16 ± 0.74 vs 6.62 ± 0.90), 6–12 hours (0.64 ± 0.66 vs 5.06 ± 0.91), and 12–24 hours (0.20 ± 0.40 vs 3.64 ± 1.01) ($p<0.0001$).
Conclusion: Low-pressure pneumoperitoneum is a safe and effective alternative to standard-pressure pneumoperitoneum in laparoscopic cholecystectomy. It significantly reduces postoperative shoulder tip pain while maintaining acceptable operative conditions and without increasing intraoperative complications.

Keywords: Laparoscopic cholecystectomy, low-pressure pneumoperitoneum, standard-pressure pneumoperitoneum.

INTRODUCTION

The gall bladder is a slate blue, pyrifom sac sunken in fossa in the right hepatic lobes inferior surface. It is 7-8 cm long, 3 cm broad at the widest and 30-50 ml in capacity[1]. Gallstones may occur as one large stone or hundreds of tiny stones almost in any combination. Gallstones found in the gall bladder are classified as cholesterol, pigmented or mixed stones based on their chemical composition[2]. Gallstone is a crystalline concretion formed within the gall-bladder by accretion of bile component. Presence of stones in the gallbladder is referred to as cholelithiasis. Migration of gall stones into the ducts of the biliary tract, the condition is referred to as choledocholithiasis. Choledocholithiasis is frequently associated with

obstruction of the biliary tree, leading to acute ascending cholangitis. Gallstones within the ampulla of Vater can obstruct the exocrine system of the pancreas, resulting in pancreatitis.3 Gallstone formation is relatively increased with consumption of dietary fats rich in saturated fatty acids.4 Gallstones might induce biliary inflammation and cholecystectomy is typically followed by dilation of the bile ducts**.5** Removal of the gall bladder by surgical method is the only solution available to the gallstone disease today.[6]

Cholecystectomy is the most commonly performed surgery and Laparoscopic cholecystectomy (LC) has become the gold standard treatment for gallstone disease[7] since its introduction in 1985. Laparoscopic cholecystectomy causes less pain after surgery, shorter hospital stay, faster return to work activities and a lower metabolic-endocrine immune response to trauma[8]. In laparoscopic surgery, possible clinical applications include identification of intra-abdominal sentinel lymph node for melanoma or to help during lymphadenectomy in case of metastatic melanoma[9], prostate[10] or endometrial cancer[11]. The problems faced during a difficult LC may include difficulty in achieving the pneumo-peritoneum, releasing the adhesions, dissecting the structures of the extrahepatic biliary apparatus and its anatomical variations.[12]

Today, intra-abdominal pressure is conventionally set at 12-14 mmHg.22 International guidelines recommend that the use of ―the lowest intra-abdominal pressure allowing adequate exposure of the operative field rather than a routine pressure‖ should be used due to minimize the impact of pneumoperitoneum on normal physiology and the positive impact on postoperative pain.[13] Low pressure pneumoperitoneum is defined as a pressure of 7-10 mmHg.[14] The main concern about low-pressure pneumoperitoneum is its safety in terms of inadequate exposure resulting in the longer than usual operating time, increased rate of intra-operative complications and also possibly increased frequency of conversion to open cholecystectomy.[15]

The aim of our prospective study was to choose an ideal working pressure for LC, which permits an adequate working space, no adverse effects on cardiopulmonary parameters and significantly reduces post operative shoulder tip pain.

OBJECTIVES

The aim of the study is to compare the outcomes of low-pressure pneumoperitoneum (7–10 mmHg) and standard-pressure pneumoperitoneum (12–14 mmHg) in patients undergoing laparoscopic cholecystectomy. The primary objectives are to compare the severity of postoperative shoulder tip pain using the Numeric Pain Rating Scale (NPRS) at 0–6 hours, 6–12 hours, and 12–24 hours after surgery, and to compare the mean duration of surgery between the two groups. The secondary objectives are to evaluate operative field visibility (poor/average/good), CO_2 consumption, incidence of bile spillage, incidence of bleeding, duration of hospital stay, and time to return of bowel activity

MATERIALS AND METHODS

This prospective observational study was conducted on 100 patients aged >18 years of either sex with uncomplicated symptomatic cholelithiasis undergoing elective laparoscopic cholecystectomy at the Department of Surgery, JLN Medical College and Associated Group of Hospitals, Ajmer, from June 2024 to December 2025.

Patients with gallbladder malignancy, acute cholecystitis, choledocholithiasis, previous ERCP with stenting, BMI >30 kg/m², cognitive impairment, chronic analgesic use, pre-existing shoulder pain disorders, or those unfit for general anesthesia were excluded.

All patients underwent routine preoperative evaluation including complete blood count, coagulation profile, liver and renal function tests, blood glucose, hepatitis screening, and ultrasonography to assess gallstone characteristics, gallbladder wall thickness, pericholecystic collection, and common bile duct diameter.

Table 1 : Age Distribution in Low-Pressure vs Standard-Pressure Pneumoperitoneum Groups

	Group A (Low pressure pneumoperitoneum)		Group B (Standard pressure pneumoperitoneum)	
	No. of patients	Percent	No. of patients	Percent
Age Range (years)				
20-40	20	40	20	40
41-60	20	40	18	36
61-80	10	20	12	24
Sex				
Male	12	24	9	18
Female	38	76	41	82

P = 0.9785 (NS)

Table 2 : Comparison of Duration of Surgery in Low-Pressure and Standard-Pressure Pneumoperitoneum Groups

	Group A (Low pressure pneumoperitoneum)		Group B (Standard pressure pneumoperitoneum)		P Value
	Mean	SD	Mean	SD	
Mean Duration of Surgery (min.)	55.80	5.79	50.560	6.556	P<0.0001 (S)

Table 3 : Comparison of CO_2 Consumption in Low-Pressure And Standard-Pressure Pneumoperitoneum Groups

	Group A (Low pressure pneumoperitoneum)		Group B (Standard pressure pneumoperitoneum)		P Value
	Mean	SD	Mean	SD	
CO_2	95.44	13.95	105.340	13.057	0.0004 (S)

Table 4 : Comparison of Time to Return of Bowel Activity in Low-Pressure and Standard-Pressure Pneumoperitoneum Groups

	Group A (Low pressure pneumoperitoneum)		Group B (Standard pressure pneumoperitoneum)		P Value
	Mean	SD	Mean	SD	
Bowel activity (Hours)	11.14	2.07	14.660	1.965	<0.0001 (S)

Table 5 : **Comparison of Shoulder Tip Pain Scores (NPRS) in Low-Pressure and Standard-Pressure Pneumoperitoneum Groups**

Shoulder Tip Pain	Group A (Low pressure pneumoperitoneum)		Group B (Standard pressure pneumoperitoneum)		P Value
	Mean	SD	Mean	SD	
Grading (NPRS Score) 0-6 hours	1.16	0.74	6.62	0.90	P<0.0001 (S)
6-12 hours	0.64	0.66	5.06	0.91	P<0.0001 (S)
12-14 hours	0.20	0.40	3.64	1.01	P<0.0001 (S)

DISCUSSION

In the present study, the mean age was 46.36 ± 13.66 years in the Low-Pressure (LP) group and 46.58 ± 15.84 years in the Standard-Pressure (SP) group. Comparable findings were reported by Raja LNL et al. (2026)[16] (43.6 ± 9.15 vs 44.8 ± 11.7 years), Besra RC et al. (2025) (38.5 ± 10.2 vs 39.7 ± 9.8 years) and Arun RC et al. (2024)[17] (39.50 ± 6.82 vs 38.34 ± 9.01 years). These findings indicate that laparoscopic cholecystectomy is commonly performed in middle-aged adults and that both study groups were comparable with respect to age. Females predominated in both groups of the present study, constituting 76% and 82% of patients in the LP and SP groups, respectively. Similar female predominance was reported by Subhashini D et al. (2025)[18] (80% and 72% females) and Arun RC et al. (2024)[17] (68% and 58% females in LP and SP groups, respectively). Raja LNL et al. (2026)[16], Besra RC et al. (2025)[19] and Rani SS et al. (2024)[20] also reported a higher prevalence of cholelithiasis among females. These findings are consistent with the established epidemiological pattern that gallstone disease is more common in women. **(Table 1)**

In the present study, the mean duration of surgery was 55.80 ± 5.79 minutes in the Low-Pressure (LP) group and 50.56 ± 6.56 minutes in the Standard-Pressure (SP) group. Although the operative time was slightly longer in the LP group, the difference was clinically acceptable and did not adversely affect the surgical outcome. Similar findings were reported by Raja LNL et al. (2026)16**,** who observed a mean operative duration of 75 ± 15.25 minutes in the LP group and 75 ± 15.2 minutes in the SP group. Besra RC et al. (2025)[19] reported operative times of 58.2 ± 8.7 minutes and 55.4 ± 7.9 minutes in the LP and SP groups, respectively, while Rani SS et al. (2024)[20] observed durations of 66 ± 10.5 minutes and 62±9.4 minutes, respectively. The present study demonstrated comparatively shorter operative times in both groups than those reported in previous studies. **(Table 2)**

The mean CO_2 value was significantly lower in Group A at 95.44 ± 13.95 compared to Group B at 105.340 ± 13.057, with a statistically significant difference (P = 0.0004). Similar findings was observed in the study of Kumar A et al. (2016)[21] mean consumption of CO_2 gas was less in LPP compared to SPP laparoscopic cholecystectomy with no statistical difference (102 ± 11.5 liters v/s 108 ± 14.5 liters; p>0.05) **(Table 3)**

In the present study, postoperative shoulder tip pain was significantly lower in the Low-Pressure (LP) group than in the Standard-Pressure (SP) group at 0–6 hours (1.16 ± 0.74 vs 6.62 ± 0.90), 6–12 hours (0.64 ± 0.66 vs 5.06 ± 0.91), and 12–

24 hours (0.20 ± 0.40 vs 3.64 ± 1.01), with all differences being highly significant ($p < 0.0001$). Similar findings were reported by Chok et al. (2006)[22], Kanwer et al. (2010)[23] and Sandhu et al. (2009)[24] who observed significantly less postoperative shoulder tip pain with low-pressure pneumoperitoneum. The present study therefore supports the use of low-pressure pneumoperitoneum for reducing postoperative pain and improving patient comfort following laparoscopic cholecystectomy. **(Table 5)**

CONCLUSION

Low-pressure pneumoperitoneum (7–10 mmHg) in laparoscopic cholecystectomy was associated with significantly lower postoperative shoulder tip pain and shorter hospital stay compared to standard-pressure pneumoperitoneum (12–14 mmHg). Although operative time was slightly longer and operative field visibility was marginally better with standard pressure, low-pressure pneumoperitoneum provided adequate surgical exposure without increasing intraoperative complications. Therefore, low-pressure pneumoperitoneum is a safe, feasible, and effective alternative that enhances postoperative patient comfort and recovery following laparoscopic cholecystectomy.

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