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Original Research Article

A Study of Operative Outcomes and Surgeons' Comfort in Low and Standard Pressure Pneumoperitoneum in Laparoscopic Cholecystectomy

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Abstract:
Background: Laparoscopic cholecystectomy requires pneumoperitoneum to provide adequate working space and visualization. Although standard-pressure pneumoperitoneum facilitates surgical exposure, it may increase postoperative pain and produce transient physiological alterations. Low-pressure pneumoperitoneum may reduce these effects, but concerns remain regarding operative time and surgeon comfort.
Aim: To compare operative outcomes, postoperative liver and kidney function, pain, complications, hospital stay, and surgeon comfort between low-pressure and standard-pressure pneumoperitoneum during laparoscopic cholecystectomy.
Materials and Methods: This prospective study was conducted over two years at Narayana Medical College and Hospital, Nellore, among 100 patients with symptomatic cholelithiasis undergoing laparoscopic cholecystectomy. Fifty patients underwent low-pressure laparoscopic cholecystectomy (LPLC) and 50 underwent standard-pressure laparoscopic cholecystectomy (SPLC). Low-pressure pneumoperitoneum was maintained at approximately 9 mmHg, while standard pressure was approximately 13 mmHg. Operative parameters, surgeon comfort, postoperative pain, liver and kidney function tests, complications, conversion rates, and duration of hospital stay were assessed. Statistical analysis was performed using appropriate parametric and categorical tests, with $p<0.05$ considered statistically significant.
Results: The mean insufflation pressure was 9.12 ± 0.87 mmHg in LPLC and 13.08 ± 0.80 mmHg in SPLC ($p<0.0001$). Operative time was significantly longer with LPLC (52.56 ± 10.48 vs. 42.86 ± 10.61 minutes; $p<0.0001$), while surgeon comfort significantly favoured SPLC ($p=0.0073$). Postoperative pain was significantly lower with LPLC at 6 hours (VAS 3.30 ± 1.46 vs. 5.14 ± 1.43; $p<0.0001$) and 24 hours (2.36 ± 1.22 vs. 3.14 ± 1.37; $p=0.0034$). Postoperative bilirubin, AST and ALT levels were significantly lower in the LPLC group at both 6 and 24 hours. Blood urea was also significantly lower at 6 hours ($p=0.0102$), while serum creatinine showed no significant difference. Hospital stay was shorter with LPLC (2.02 ± 0.68 vs. 2.44 ± 0.79 days; $p=0.0054$). Conversion to open surgery and most postoperative complications were comparable between groups.
Conclusion: Low-pressure pneumoperitoneum during laparoscopic cholecystectomy provides significant patient-centred advantages, including reduced postoperative pain, less transient hepatic biochemical disturbance, and shorter hospital stay. Standard-pressure pneumoperitoneum provides greater surgeon comfort and shorter operative duration. A flexible, pressure-tailored approach, beginning with low pressure and increasing it when required for adequate exposure and safe dissection, may provide an appropriate balance between patient benefit and operative safety.
Keywords: Low-pressure pneumoperitoneum; Laparoscopic cholecystectomy; Postoperative pain; Surgeon comfort.
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Introduction

Laparoscopic cholecystectomy (LC) is the conventional procedure for symptomatic gallbladder disease, and the establishment of a CO_2 Pneumoperitoneum is crucial for achieving sufficient working space and visualisation. Traditionally, "standard" intra-abdominal pressures (about 12–14 mmHg) are employed to enhance visibility and for safe dissection. Nonetheless, elevated pneumoperitoneum pressures are correlated with physiological consequences (cardiovascular, pulmonary, and splanchnic) and are consistently associated with increased postoperative pain—especially shoulder-tip pain—presumably due to diaphragmatic irritation and peritoneal distension. These concerns are significant as laparoscopic cholecystectomy is frequently conducted as a short-stay or day-care treatment, where effective pain management, prompt ambulation, and expedited release are critical outcomes. Evidence syntheses and randomised studies have consistently indicated that using low-pressure pneumoperitoneum (generally 8–10/11 mmHg) helps alleviate postoperative discomfort following laparoscopic cholecystectomy (LC).[1]

Notwithstanding these prospective advantages for patients, a significant worry is if diminishing insufflation pressure undermines the surgical field—resulting in inadequate exposure, prolonged operating duration, an increased necessity for elevated pressure "rescue," or conversion—thereby impacting safety and the surgeon's experience. Numerous studies indicate that surgical environments at reduced pressure may be suboptimal unless enhanced by measures such as suitable patient posture, strategic port placement, and, in many procedures, sufficient neuromuscular blockade. Studies assessing surgical space conditions and the impact of deep neuromuscular blockade suggest that "comfort" and field quality are critical factors influencing the feasibility of low pressure laparoscopic cholecystectomy in standard practice.[2–4]

A focused study is required to compare operative outcomes (operative time, bile/vascular injury, bleeding, need for increased pressure, conversion, postoperative pain/analgesic requirements, hospital stay, complications) with surgeons' comfort and operating conditions to produce pragmatic, real-world evidence. This is particularly pertinent since current literature frequently prioritises patient-centered pain outcomes, but surgeon-reported field quality and comfort may get relatively less focus—despite their significant impact on the adoption of low-pressure techniques and overall safety. Recent randomised trials and meta-analyses are further refining the evidence base, encompassing feasibility in high-risk populations and standardised evaluation of operational circumstances.

Aim of the Study: To compare the effect of low and standard pressure pneumoperitoneum in patients undergoing Low Pressure Laparoscopic Cholecystectomy and Standard Pressure Laproscopic Cholecystectomy.

Primary Objective: To compare the differences in postoperative liver function tests (LFTs) and (KFTs) under low and standard pressure pneumoperitoneum in patients undergoing LPLC and SPLC.

Secondary Objective: To compare the surgeon's comfort under low and standard pressure pneumoperitoneum as per surgeon's comfort score in patients undergoing LPLC and SPLC. To compare the difference in operative time, conversion difference in complications and postoperative pain and outcome at discharge in LPLC and SPLC. iv. To assess.

Materials and Methods

This was a prospective study done for 2 years in Narayana Medical College and Hospital in Nellore in 100 patients diagnosed with symptomatic cholelithiasis who were slated for laparoscopic cholecystectomy at the study center.

Inclusion Criteria: Patients between 18 to 60 years, with symptomatic cholelithiasis appointed for laparoscopic cholecystectomy.

Exclusion Criteria: Severe obesity (BMI >30 kg/m^2), History of several prior abdominal operations, pregnant patients, with complex gallstone pathology, encompassing gallstone-induced pancreatitis and with confirmed common bile duct calculi and Patients with impaired hepatic, renal, pulmonary, or cardiac functioning.

Statistical Analysis: The acquired data were input into Microsoft Excel and later analysed using the Statistical Package for the Social Sciences (SPSS) software. Continuous data were represented as mean ± standard deviation (SD), whilst categorical variables were represented as frequencies and percentages. Comparisons between the low-pressure pneumoperitoneum group and the standard-pressure pneumoperitoneum group were conducted utilising the Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as applicable. The comfort levels of surgeons and postoperative pain scores were compared between the two groups utilising suitable parametric or non-parametric techniques according to the data distribution. A p-value below 0.05 was deemed statistically significant. All statistical tests were conducted as two-tailed.

Ethical Considerations: Ethical approval was secured from the Institutional Ethical Committee of Narayana Medical College, Nellore, before the initiation of the investigation. Informed written permission was acquired from all subjects before to participation.

Results

Table 1: Distribution of Patients According To Age and Gender Group in LPLC and SPLC Groups

Category	LPLC (n=50)	SPLC (n=50)	Total (N=100)
18-30	4	9	13
31-40	20	22	42
41-50	20	14	34
51-60	6	5	11
Chi-square test; $\chi^2 = 3.168$; $p = 0.3664$			
Male	20	15	35
Female	30	35	65
Chi-square test; $\chi^2 = 0.7033$; $p = 0.4017$			

Table 2: Distribution of Patients According To BMI and ASI Grade

BMI	LPLC (n=50)	SPLC (n=50)	Total (N=100)
Under Weight	2	0	2
Normal	9	13	22
Over Weight	8	11	19
Obese 1	31	26	57
Chi-square test; $\chi^2 = 3.36396$; $p = 0.3031$			
ASA I	31	31	62
ASA II	19	19	38
Chi-square test; $\chi^2 = 0$; $p = 1$			

Table 3: Distribution of Comorbidities in LPLC and SPLC Groups

Comorbidity	LPLC Yes	LPLC No	SPLC Yes	SPLC No	χ^2 / p-value
Diabetes Mellitus	10	40	5	45	1.2549 / 0.2626
Hypertension	9	41	14	36	0.9034 / 0.3419
Chi-square test; Diabetes Mellitus: $p = 0.2626$; Hypertension: $p = 0.3419$					

Table 4: Distribution of stone number in LPLC and SPLC Groups

Category	LPLC (n=50)	SPLC (n=50)	Total (N=100)
Single	27	23	50
Multiple	23	27	50
Chi-square test; $\chi^2 = 0.36$; $p = 0.5485$			

Table 5: Distribution of USG Findings in LPLC and SPLC Groups

USG Parameter	LPLC(n=50) Mean ± SD	SPLC(n=50) Mean ± SD	t-value	USG Parameter	LPLC (n=50) Mean ± SD
GB Wall Thickness (mm)	3.67 ± 0.92	3.43 ± 0.9	1.3452	GB Wall Thickness (mm)	3.67 ± 0.92
Largest Stone Size (mm)	12.05 ± 5.1	13.01 ± 4.78	-0.967	Largest Stone Size (mm)	12.05 ± 5.1
Independent t-test; GB Wall Thickness (mm): $p = 0.1817$; Largest Stone Size (mm): $p= 0.3359$					

Table 6: Comparison of Baseline Demographic and Haematological Parameters

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Age (Years)	40.3 ± 8.8	38.76 ± 9.17	0.8571	0.3935
BMI (kg/m²)	24.81 ± 2.85	24.63 ± 2.59	0.3343	0.7389
Symptom Duration (Months)	4.98 ± 2.74	4.92 ± 2.68	0.1106	0.9121
Haemoglobin (g/dL)	12.19 ± 1.44	12.1 ± 1.37	0.3137	0.7545
TLC (/cumm)	8105.94 ± 2283.6	8219.88 ± 1834.2	-0.2751	0.7838

Table 7: Comparison of Preoperative Liver Function Tests

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Total Bilirubin (mg/dL)	0.81 ± 0.19	0.77 ± 0.19	0.9673	0.3358
Direct Bilirubin (mg/dL)	0.21 ± 0.09	0.21 ± 0.06	0.207	0.8364
AST (U/L)	28.96 ± 7.58	27.98 ± 6.66	0.687	0.4937
ALT (U/L)	26.4 ± 7.61	27.7 ± 6.94	-0.8925	0.3743
ALP (U/L)	76.22 ± 21.71	76.98 ± 17.82	-0.1913	0.8487

Table 8: Comparison of Preoperative Kidney Function Tests

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Blood Urea (mg/dL)	26.06 ± 5.95	26.13 ± 6.34	-0.0602	0.9521
Serum Creatinine (mg/dL)	0.94 ± 0.16	0.91 ± 0.13	1.3008	0.1964

Table 9: Comparison of Insufflation Pressure

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value
Insufflation Pressure (mmHg)	9.12 ± 0.87	13.08 ± 0.8	-23.6037
Independent t-test; Insufflation Pressure (mmHg): p = <0.0001			
Operative Time (min)	52.56 ± 10.48	42.86 ± 10.61	4.5974
Independent t-test; Operative Time (min): p = <0.0001			

Table 10: Distribution of Surgeon Comfort Score in LPLC and SPLC Groups

Category	LPLC (n=50)	SPLC (n=50)	Total (N=100)
Very Difficult	2	0	2
Difficult	2	5	7
Average	16	11	27
Comfortable	23	13	36
Very Comfortable	7	21	28
Mean ± SD	3.62 ± 0.92	± 1.03	
Chi-square test; $\chi^2 = 13.9894$; p = 0.0073			

Table 11: Distribution of Intraoperative Complications

Complication Type	LPLC (n=50)	SPLC (n=50)	Total (N=100)
None	38	48	86
Bleeding	2	0	2
GB Perforation	3	1	4
Bile Spillage	7	1	8

Table 12: Distribution of Conversion Rates in LPLC and SPLC Groups

Conversion Type	Yes	No	Total
LPLC to SPLC (LPLC group, n=50)	4	46	50
Lap to Open (LPLC group, n=50)	1	49	50
Lap to Open (SPLC group, n=50)	3	47	50
Chi-square test for Lap to Open conversion between groups; $\chi^2 = 0.2604$; p = 0.6098			

Table 13: Comparison of Postoperative 6-Hour Liver Function Tests

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Total Bilirubin (mg/dL)	0.96 ± 0.23	1.11 ± 0.25	-3.2062	0.0018
Direct Bilirubin (mg/dL)	0.27 ± 0.09	0.32 ± 0.08	-3.3197	0.0013
AST (U/L)	37.42 ± 7.86	44.54 ± 9.24	-4.1491	0.0001
ALT (U/L)	33.02 ± 8.67	43.18 ± 9.99	-5.4316	0.0001
ALP (U/L)	84.2 ± 23.65	95.64 ± 19.28	-2.6509	0.0094

Table 14: Comparison of Postoperative 6-Hour Kidney Function Tests

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Blood Urea (mg/dL)	27.95 ± 6.11	31.21 ± 6.36	-2.6198	0.0102
Serum Creatinine (mg/dL)	± 0.17	1.04 ± 0.16	-1.3947	0.1663

Table 15: Comparison of Postoperative 24-Hour Liver Function Tests

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Total Bilirubin (mg/dL)	0.88 ± 0.21	0.97 ± 0.19	-2.1226	0.0363
Direct Bilirubin (mg/dL)	0.25 ± 0.09	0.29 ± 0.08	-2.2284	0.0281
AST (U/L)	32.74 ± 8.37	38.36 ± 8.53	-3.3255	0.0012
ALT (U/L)	29.38 ± 8.34	35.82 ± 8.07	-3.924	0.0002
ALP (U/L)	81.36 ± 22.63	88.26 ± 18.41	-1.6725	0.0976

Table 16: Comparison of Postoperative 24-Hour Kidney Function

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
Blood Urea (mg/dL)	27.22 ± 6.06	28.92 ± 6.44	-1.3592	0.1772
Serum Creatinine (mg/dL)	0.98 ± 0.17	0.98 ± 0.15	-0.1459	0.8843

Table 17: Comparison of Postoperative Vas Pain Scores

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value	t-value
VAS Pain Score at 6 hours	3.3 ± 1.46	5.14 ± 1.43	-6.3684	<0.0001
VAS Pain Score at 24 hours	2.36 ± 1.22	3.14 ± 1.37	-3.0007	0.0034

Table 18: Distribution of Post Op Symptoms

SHOULDER TIP PAIN	LPLC (n=50)	SPLC (n=50)	Total (N=100)
No	39	29	68
Yes	11	21	32
Chi-square test; $\chi^2 = 3.7224$; $p = 0.0537$			
Nausea and Vomiting			
No	39	38	77
Yes	11	12	23
Chi-square test; $\chi^2 = 0$; $p = 1$			
Wound Infection			
No	44	45	89
Yes	6	5	11
Chi-square test; $\chi^2 = 0$; $p = 1$			
Bile Leak	2	2	4
Port Site Hernia	1	1	2
Chi-square test; $\chi^2 = 0$; $p = 1$			

Table 19: Distribution of Outcome at Discharge

Parameter	LPLC (n=50) Mean ± SD	SPLC (n=50) Mean ± SD	t-value
Hospital Stay (Days)	2.02 ± 0.68	2.44 ± 0.79	-2.8475
Independent t-test; Hospital Stay (Days): p = 0.0054			
Satisfactory	44	45	89
Complications Managed	6	5	11

Discussion:

The present study evaluated operative outcomes and surgeon comfort between low-pressure laparoscopic cholecystectomy (LPLC) and standard-pressure laparoscopic cholecystectomy (SPLC). Both groups were comparable with respect to age, sex, BMI, ASA grade, comorbidities, ultrasonographic findings, baseline haematological parameters, and preoperative liver and renal function. This baseline comparability strengthens the internal validity of the study and suggests that differences in postoperative outcomes were predominantly related to pneumoperitoneum pressure rather than demographic or clinical differences. The mean insufflation pressure was 9.12 ± 0.87 mmHg in the LPLC group and 13.08 ± 0.80 mmHg in the SPLC group, providing adequate differentiation between the two techniques. The principal findings demonstrated that low-pressure pneumoperitoneum was associated with reduced postoperative pain, less postoperative hepatic biochemical disturbance, lower blood urea at 6 hours, fewer physiological stresses, and shorter hospital stay. In contrast, standard pressure resulted in shorter operative duration and greater surgeon comfort. Conversion to open surgery, postoperative nausea and vomiting, wound infection, other postoperative complications, and discharge outcomes were comparable between groups. These findings are consistent with the existing literature. Systematic reviews and randomised trials have generally demonstrated improved postoperative pain outcomes with low-pressure pneumoperitoneum, although this may be accompanied by reduced operative exposure and increased technical difficulty. The 2014 Cochrane review by Gurusamy et al. reported reduced pain intensity, shoulder-tip pain, and analgesic requirements with low-pressure pneumoperitoneum, while operative time was generally comparable. The 2022 comprehensive review and meta-analysis by Ortenzi et al. also supported therapeutic benefits of low-pressure pneumoperitoneum in laparoscopic cholecystectomy.[5,6]

Baseline Characteristics:

Most patients were aged 31–40 and 41–50 years, with female predominance, consistent with the established epidemiology of gallstone disease. A substantial proportion were overweight or obese-I, reflecting common risk factors for symptomatic cholelithiasis. There were no significant differences between groups in age, sex, BMI, ASA grade, diabetes, hypertension, gallstone characteristics, gallbladder wall thickness, or laboratory parameters. Similar baseline comparability has been reported by Barczyński et al., Joshipura et al., and Neogi et al. in randomised studies comparing low- and standard-pressure pneumoperitoneum.[7,8]

Operative Time: The mean operating time was significantly longer in the LPLC group (52.56 ± 10.48 minutes) than in the SPLC group (42.86 ± 10.61 minutes). Low pressure reduces the available intra-abdominal working space and may restrict visualisation of Calot's triangle, requiring more meticulous dissection and tissue manipulation. These factors can increase operative duration.

Neogi et al. reported greater surgeon comfort with normal pressure, with some low-pressure cases requiring escalation because of technical difficulties. Joshipura et al. similarly noted increased technical difficulty with low pressure, although operative duration was not significantly different. Barczyński et al. reported comparable operative times between groups, while the Cochrane review found generally similar operating times, with a marginal advantage for standard pressure.[1,6,7]

The greater difference observed in our study may reflect the learning curve, case complexity, obesity, inflammation, or the need for greater caution while maintaining low pressure. Thus, although LPLC is feasible, it may require additional operative time to obtain adequate exposure and ensure safe dissection.

Surgeon Comfort and Technical Ease: Surgeon comfort was significantly better with SPLC. A greater proportion of procedures were rated as "very comfortable," and the mean comfort score also favoured standard pressure. Surgeon comfort is clinically important because it influences exposure, dissection, clipping, operative speed, and the decision to increase pressure or convert the procedure.

These findings correspond with Neogi et al., who found significantly greater surgeon comfort with normal pressure, and with Joshipura et al., who reported increased technical difficulty at low pressure. Bhattacharjee et al. identified inadequate exposure and reduced working space as important barriers to widespread adoption of low-pressure cholecystectomy.[7,8,9]

However, recent evidence suggests that technical disadvantages may depend on surgical expertise, patient selection, neuromuscular blockade, and the degree of pressure reduction. A 2024 multicentre randomised trial in patients with cardiopulmonary comorbidities found no significant differences in surgeon comfort, operative time, bile leakage, blood loss, or conversion when 10 mmHg was compared with 14 mmHg.[10] Thus, low pressure is technically achievable, although it may be less comfortable in routine practice.

Intraoperative Complications and Conversion: Intraoperative complications occurred more frequently in the LPLC group, with 12 patients affected compared with two in the SPLC group. Bile spillage was the most common event, followed by gallbladder perforation and haemorrhage. Reduced working space and more difficult traction-countertraction may contribute to these complications.

This finding differs from several previous studies. Joshipura et al. and Barczyński et al. found no significant differences in intraoperative or postoperative complications between pressure groups. The Cochrane review likewise reported no significant difference in morbidity or conversion to open surgery, although study quality limited the strength of evidence.[1,6,7]

Four patients in the LPLC group required escalation from low to standard pressure. One patient in LPLC and three in SPLC required conversion to open surgery, with no significant difference between groups. Similar findings have been reported by Neogi et al., Joshipura et al., and Chok et al., where some low-pressure cases required pressure escalation because of inadequate exposure. The Cochrane review suggested that laparoscopic cholecystectomy can be successfully completed at low pressure in approximately 90% of patients.[7,8,11]

Therefore, low pressure should be regarded as a flexible strategy rather than a rigid requirement. Pressure should be increased whenever visualisation, dissection, or safety becomes inadequate.

Postoperative Liver Function: A major finding was the significantly lower postoperative hepatic biochemical disturbance with LPLC. At 6 hours, total bilirubin, direct bilirubin, AST, ALT, and ALP were significantly higher in the SPLC group. At 24 hours, total bilirubin, direct bilirubin, AST, and ALT remained significantly higher, while the difference in ALP was no longer significant.

These findings agree with Hasukić, who demonstrated greater postoperative AST and ALT elevation at 14 mmHg compared with 7 mmHg. Neogi et al. similarly reported greater hepatic enzyme alterations with normal-pressure pneumoperitoneum and suggested low pressure for patients with impaired hepatic function. Gupta et al. reported less physiological disturbance with pressures in the 8–10 mmHg range.[8,12,13] The mechanism is likely related to increased intra-abdominal pressure reducing portal venous flow and temporarily affecting hepatic microcirculation. Morino et al. demonstrated that postoperative AST and ALT elevation is related to the magnitude and duration of pneumoperitoneum, while Giraudo et al. reported fewer biochemical abnormalities with gasless or lower-pressure laparoscopy compared with 14 mmHg.[14,15]

The predominance of these changes at 6 hours, with partial resolution by 24 hours, suggests transient physiological stress rather than permanent hepatic injury. Low pressure may therefore be particularly useful in patients with reduced hepatic reserve or prolonged and technically difficult procedures.

Postoperative Renal Function: Blood urea at 6 hours was significantly lower in LPLC, whereas serum creatinine did not differ significantly. By 24 hours, neither urea nor creatinine differed between groups. These findings indicate that the renal effects of pneumoperitoneum were mild and transient in this relatively low-risk population.

Increased intra-abdominal pressure can temporarily reduce renal perfusion and urine output. Gupta et al. described subclinical hepatorenal physiological changes with standard-pressure pneumoperitoneum and suggested that low pressure may reduce these effects.[6,13] The absence of persistent creatinine changes suggests that routine uncomplicated procedures in patients with normal renal function are unlikely to result in clinically important renal morbidity. Nevertheless, lower initial pressure may be advantageous in elderly patients or those with pre-existing renal dysfunction.

Postoperative Pain and Shoulder-Tip Pain: Postoperative pain was significantly lower following LPLC. Mean VAS scores at 6 hours were 3.30 ± 1.46 versus 5.14 ± 1.43, and at 24 hours were 2.36 ± 1.22 versus 3.14 ± 1.37 in LPLC and SPLC, respectively. This represents one of the most clinically important advantages of low-pressure pneumoperitoneum.

Barczyński et al. reported reduced postoperative and shoulder-tip pain and improved early quality of life with low pressure. Joshipura et al. similarly demonstrated reduced pain and analgesic requirements. The Cochrane review confirmed reduced discomfort with low-pressure pneumoperitoneum, while the 2024 randomised study by Srikanth et al. demonstrated significantly lower pain at 6 and 24 hours.[1,7,9]

The likely mechanisms include reduced peritoneal distension, decreased diaphragmatic irritation, less residual CO_2-related inflammation, and attenuation of the postoperative stress response.

Shoulder-tip pain occurred in 11 LPLC patients compared with 21 SPLC patients. Although the difference did not reach conventional statistical significance, the clinically relevant trend is consistent with previous evidence. Barczyński et al. reported substantially less shoulder-tip pain with low pressure, while the Cochrane review found a pooled relative risk of 0.53. Sandhu et al. also observed a higher frequency of shoulder pain with standard pressure without statistical significance.[1,16]

Postoperative Morbidity and Hospital Stay: Postoperative nausea and vomiting, wound infection, bile leak, port-site hernia, and other postoperative complications were comparable between groups. These findings are consistent with Joshipura et al., Barczyński et al., and the Cochrane review, which found that low pressure does not consistently reduce overall postoperative morbidity.[1,28]. Hospital stay was significantly shorter following LPLC, with a mean duration of 2.02 ± 0.68 days compared with 2.44 ± 0.79 days in SPLC. This may be related to reduced pain and less postoperative physiological disturbance. Joshipura et al. also reported shorter hospitalisation with low-pressure pneumoperitoneum, while Barczyński et al. demonstrated improved early quality of life.[1,7]. A shorter hospital stay may improve patient satisfaction, facilitate earlier mobilisation, reduce bed occupancy, and support day-care or enhanced-recovery pathways.

Clinical Implications: The major finding of this study is the balance between patient benefit and surgeon convenience. LPLC provided better postoperative pain control, reduced hepatic biochemical disturbance, lower early blood urea, and shorter hospitalisation, whereas SPLC offered shorter operative duration and greater surgeon comfort. This trade-off is consistent with findings from Neogi et al. and Joshipura et al.

Therefore, no single pneumoperitoneum pressure should be considered universally optimal. Low pressure appears particularly attractive in uncomplicated elective cholecystectomy and in patients where reduction of physiological stress is desirable. Standard pressure may be preferable when exposure is difficult, inflammation is severe, or technical safety is compromised. A practical approach is to begin with low pressure and increase it when necessary to obtain adequate visualisation and safe dissection.[36–40]

Low-pressure pneumoperitoneum may also be beneficial in patients with cardiopulmonary impairment because increased intra-abdominal pressure can affect venous return, pulmonary compliance, airway pressures, splanchnic circulation, and renal perfusion. However, technical safety must remain the primary consideration.

The findings also emphasise that successful LPLC requires appropriate patient selection, experienced surgeons, meticulous tissue handling, effective camera manipulation, and good teamwork. Difficult dissection of Calot's triangle, adhesions, thick gallbladder walls, obesity, or a prominent fatty liver may necessitate pressure escalation. Persisting with low pressure despite inadequate exposure would be inappropriate.

Conclusion: The present study demonstrates that low-pressure laparoscopic cholecystectomy provides important patient-centred benefits, particularly reduced postoperative pain, less transient hepatic and renal physiological disturbance, and shorter hospital stay. Standard-pressure pneumoperitoneum, however, provides better surgeon comfort and shorter operative duration. Intraoperative conversion and most postoperative complications were comparable. Thus, low-pressure pneumoperitoneum should not be viewed as a rigid replacement for standard pressure but as a useful initial strategy that can be individualised according to patient characteristics and intraoperative requirements. The optimal approach is a flexible, pressure-tailored technique in which the physiological advantages of low pressure are utilised without compromising exposure, surgeon comfort, or the safety of dissection.

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