DOI: https://doi.org/10.53350/pjmhs20231711393

ORIGINAL ARTICLE

Comparison of Perioperative Safety and Recovery Profiles between Low-Pressure and Standard-Pressure Laparoscopic Cholecystectomy

MUHAMMAD ASJAD[1], ABDUL GHAFFAR ARAIN[2], LUQMAN ALI BAJWA[3], NAUMAN ALI[4], MOHAMMAD ALI NAPER[5]
[1]*Senior Registrar Surgery, Aziz Bhatti Shaheed Teaching Hospital, Gujrat*
[2]*Senior Registrar, Department of Surgery, Baqai Medical University, Karachi*
[3]*Senior Registrar Surgery, Services Hospital, Lahore*
[4]*Medical Officer, Aziz Bhatti Shaheed Teaching Hospital, Gujrat*
[5]*Associate Professor in Surgery, Department of Surgery SMBBMU, Larkana*
Correspondence to: Abdul Ghaffar Arain, Email: ghaffardr@live.com

ABSTRACT

Background: To compare perioperative safety and recovery outcomes between low-pressure (8–10 mmHg) and standard-pressure (12–15 mmHg) laparoscopic cholecystectomy.

Methods: This prospective comparative study included 73 patients undergoing elective laparoscopic cholecystectomy from June 2022 to June 2023. Patients were randomized into two groups: low-pressure (n = 36) and standard-pressure (n = 37). Intraoperative safety parameters, postoperative pain scores, analgesic use, recovery milestones, complications, and patient satisfaction were recorded and analyzed.

Results: Both groups were similar in baseline demographics and comorbidities. Peak end-tidal CO_2 was lower in the low-pressure group (p = 0.002) without prolonging operative time. Postoperative pain scores at 6 hours were significantly reduced (p = 0.01) in the low-pressure group, with lower opioid requirements (p = 0.002) and less shoulder-tip pain (p = 0.03). Early ambulation and shorter hospital stays were also noted (p = 0.04). Complication rates were low and comparable between groups.

Conclusion: Low-pressure laparoscopic cholecystectomy offers superior postoperative comfort and earlier recovery without compromising intraoperative safety. It may be considered a safe alternative to standard-pressure pneumoperitoneum in suitable patients.

Keywords: Laparoscopic cholecystectomy, low-pressure pneumoperitoneum, postoperative pain, recovery time, gallstone surgery, intraoperative safety

INTRODUCTION

Laparoscopic cholecystectomy has become the standard surgical approach for symptomatic gallstone disease due to its minimal invasiveness, reduced hospital stay, and faster recovery compared to open surgery. The creation of pneumoperitoneum with carbon dioxide is an essential step, traditionally performed at pressures of 12–15 mmHg to ensure optimal visualization and working space for the surgeon[1-3].

However, elevated intra-abdominal pressure can have physiological consequences, including reduced venous return, increased systemic vascular resistance, altered pulmonary mechanics, and heightened diaphragmatic irritation. These effects may contribute to postoperative pain, delayed mobilization, and increased analgesic requirements. Recent studies have explored lowering pneumoperitoneum pressures to 8–10 mmHg as a means to mitigate these drawbacks, while preserving adequate surgical exposure[4-6].

Evidence from randomized trials and meta-analyses suggests that low-pressure pneumoperitoneum may reduce shoulder-tip pain, decrease postoperative nausea and vomiting, and improve early recovery markers without significantly prolonging operative time. Nonetheless, concerns remain regarding potential compromise of the surgical field and increased technical difficulty, particularly in patients with obesity or dense adhesions[7-9].

Given the need to balance patient comfort with operative feasibility, this study aimed to compare perioperative safety profiles and recovery outcomes between low-pressure and standard-pressure laparoscopic cholecystectomy in a prospective patient cohort. By evaluating intraoperative parameters, postoperative pain, recovery milestones, and complication rates, we sought to provide evidence that could guide surgical decision-making and patient-centered care.

METHODOLOGY

This was a prospective, comparative study conducted at Aziz bhatti shaheed teaching hospital, Gujrat, over a 12-month period from June 2022 to June 2023. The aim was to evaluate and compare perioperative safety parameters and recovery outcomes between patients undergoing laparoscopic cholecystectomy with either low-pressure or standard-pressure pneumoperitoneum.

A total of 73 adult patients scheduled for elective laparoscopic cholecystectomy were enrolled. Participants were allocated into two groups Low-pressure group (pneumoperitoneum 8–10 mmHg) – 36 patients. Standard-pressure group (pneumoperitoneum 12–15 mmHg) – 37 patients

Group assignment followed a simple randomization protocol using a computer-generated random number table. Allocation was concealed until the time of surgery.

Inclusion Criteria:

- Age between 18 and 65 years
- Elective laparoscopic cholecystectomy for symptomatic gallstone disease
- ASA physical status I–III
- Written informed consent to participate in the study

Exclusion Criteria:

- Acute cholecystitis, empyema, or gallbladder perforation
- Known common bile duct stones or requirement for intraoperative cholangiography
- Severe cardiopulmonary comorbidities precluding general anesthesia
- Pregnancy
- Previous upper abdominal surgery causing extensive adhesions
- Coagulopathy or bleeding disorders

All patients underwent detailed pre-anesthetic evaluation, including medical history, physical examination, and relevant laboratory tests (complete blood count, liver function tests, coagulation profile). Baseline vital signs were recorded. Patients were counselled about the procedure, potential risks, and expected recovery.

All surgeries were performed under general anesthesia using the standard four-port laparoscopic technique. Pneumoperitoneum was created using a Veress needle at the umbilicus. The assigned intra-abdominal pressure (low or standard) was maintained throughout the operation using CO_2 insufflation with a high-flow laparoscopic insufflator. In both groups,

Received on 22-07-2023
Accepted on 05-10-2023

dissection was carried out following the critical view of safety principle. Intraoperative monitoring included continuous ECG, non-invasive blood pressure, pulse oximetry, and end-tidal CO_2 measurement. Blood loss was estimated by suction measurement and gauze count. Any intraoperative complications and the need for conversion to open surgery were documented.

- Intraoperative safety parameters: duration of surgery, peak end-tidal CO_2, mean arterial pressure changes, intraoperative hypotension or bradycardia, blood loss, and complications.
- Immediate recovery: post-anesthesia care unit (PACU) monitoring until an Aldrete score ≥9 was achieved.
- Pain assessment: visual analog scale (VAS, 0–10) at 1, 6, 12, and 24 hours postoperatively.
- Analgesia protocol: intravenous non-steroidal anti-inflammatory drugs and opioids on demand.
- Other postoperative outcomes: incidence of postoperative nausea and vomiting (PONV), shoulder-tip pain, total opioid use in 24 hours, time to first ambulation, time to first oral intake, and length of hospital stay.
- Follow-up: all patients were reviewed at 7 days and at 30 days to record any late complications, readmissions, or delayed recovery.

Primary outcomes included intraoperative physiologic stability, postoperative pain scores, and analgesic requirement. Secondary outcomes included recovery times, complication rates, and patient satisfaction scores.

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared between groups using the independent-samples t-test. Categorical variables were presented as frequency and percentage, and comparisons were made using the chi-square test or Fisher's exact test when appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Both groups were comparable in baseline characteristics, indicating successful randomization and minimization of selection bias. The mean age was almost identical between the low-pressure group (42.1 ± 12.7 years) and the standard-pressure group (43.0 ± 13.2 years) (p = 0.78). Female predominance was observed in both groups, accounting for approximately three-fourths of participants. Body mass index and ASA classification distribution did not differ significantly. The prevalence of common comorbidities, including hypertension and diabetes mellitus, as well as the proportion of smokers and patients with previous abdominal surgery, showed no statistically significant difference. These similarities suggest that perioperative and recovery differences observed later are unlikely due to demographic or baseline clinical disparities.

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Low-pressure (n=36)	Standard-pressure (n=37)	p-value
Age, years (mean ± SD)	42.1 ± 12.7	43.0 ± 13.2	0.78
Female, n (%)	27 (75.0)	29 (78.4)	0.74
BMI, kg/m² (mean ± SD)	27.2 ± 3.9	27.5 ± 4.2	0.73
ASA I, n (%)	14 (38.9)	13 (35.1)	0.93*
ASA II, n (%)	18 (50.0)	20 (54.1)	
ASA III, n (%)	4 (11.1)	4 (10.8)	
Hypertension, n (%)	11 (30.6)	12 (32.4)	0.86
Diabetes, n (%)	8 (22.2)	9 (24.3)	0.82
Previous abdominal surgery, n (%)	5 (13.9)	6 (16.2)	0.77
Smoker, n (%)	7 (19.4)	6 (16.2)	0.71

*Row p-value for ASA is for overall distribution (I/II/III).

Table 2: Intraoperative Parameters and Physiologic Safety

Variable	Low-pressure (n=36)	Standard-pressure (n=37)	p-value
Pneumoperitoneum pressure, mmHg (mean ± SD)	9.5 ± 0.7	13.7 ± 0.9	<0.001
Duration of surgery, min (mean ± SD)	52.3 ± 12.1	49.7 ± 11.0	0.28
Blood loss, mL (mean ± SD)	46 ± 21	51 ± 24	0.34
Peak $EtCO_2$, mmHg (mean ± SD)	38.6 ± 3.2	41.1 ± 3.6	0.002
Intraop hypotension, n (%)	2 (5.6)	6 (16.2)	0.46
Any intraop complication, n (%)	1 (2.8)	2 (5.4)	0.83
Conversion to open, n (%)	0 (0.0)	1 (2.7)	0.32

Table 3: Immediate Postoperative Outcomes

Variable	Low-pressure (n=36)	Standard-pressure (n=37)	p-value
Time to Aldrete ≥9, min (mean ± SD)	28.4 ± 7.9	33.2 ± 8.4	0.01
VAS pain at 6 h (0–10), mean ± SD	3.2 ± 1.4	4.1 ± 1.6	0.01
PONV, n (%)	6 (16.7)	11 (29.7)	0.19
Shoulder-tip pain, n (%)	7 (19.4)	16 (43.2)	0.03
Opioid use 0–24 h, mg ME (mean ± SD)	6.8 ± 2.9	9.1 ± 3.5	0.002

Table 4: Recovery Profile and 30-Day Outcomes

Variable	Low-pressure (n=36)	Standard-pressure (n=37)	p-value
Time to first ambulation, h (mean ± SD)	5.7 ± 1.8	6.6 ± 2.0	0.04
Time to first oral intake, h (mean ± SD)	7.4 ± 2.1	8.1 ± 2.3	0.17
Length of stay, h (mean ± SD)	28.7 ± 8.9	34.2 ± 12.5	0.04
Return to normal activity, days (mean ± SD)	6.7 ± 2.1	7.5 ± 2.4	0.06
Any 30-day complication, n (%)	3 (8.3)	6 (16.2)	0.31
30-day readmission, n (%)	1 (2.8)	2 (5.4)	0.62
Wound infection, n (%)	1 (2.8)	2 (5.4)	0.62
Bile leak, n (%)	0 (0.0)	1 (2.7)	0.32

Table 5: Patient-Reported and Surgeon-Rated Outcomes

Variable	Low-pressure (n=36)	Standard-pressure (n=37)	p-value
Patient satisfaction (1–5), mean ± SD	4.4 ± 0.6	4.1 ± 0.7	0.049
Surgeon ease-of-surgery (1–5), mean ± SD	4.0 ± 0.6	3.9 ± 0.7	0.47

As expected, the mean pneumoperitoneum pressure was significantly lower in the low-pressure group (9.5 ± 0.7 mmHg) compared to the standard-pressure group (13.7 ± 0.9 mmHg, p < 0.001). There was no significant difference in operative duration or intraoperative blood loss. However, peak end-tidal CO_2 was lower in the low-pressure group (38.6 ± 3.2 mmHg) than in the standard-pressure group (41.1 ± 3.6 mmHg, p = 0.002), suggesting a modest physiological advantage. Rates of intraoperative hypotension, complications, and conversions to open cholecystectomy were low and statistically similar between groups, indicating that reduced pressure did not compromise intraoperative safety.

The low-pressure group demonstrated a shorter mean time to achieve an Aldrete score ≥9 (28.4 ± 7.9 min vs. 33.2 ± 8.4 min, p = 0.01), indicating faster early recovery from anesthesia. Postoperative pain scores at 6 hours were significantly lower in the low-pressure group (3.2 ± 1.4 vs. 4.1 ± 1.6, p = 0.01), accompanied by reduced opioid consumption in the first 24 hours (6.8 ± 2.9 mg vs. 9.1 ± 3.5 mg morphine equivalent, p = 0.002). Shoulder-tip pain was also less common in the low-pressure group (19.4% vs. 43.2%, p = 0.03). Rates of postoperative nausea and vomiting were lower but not statistically significant.

Patients in the low-pressure group mobilized earlier (5.7 ± 1.8 h vs. 6.6 ± 2.0 h, p = 0.04) and had a shorter hospital stay (28.7 ± 8.9 h vs. 34.2 ± 12.5 h, p = 0.04). Time to oral intake and return to normal activities were slightly faster in the low-pressure group, but differences were not statistically significant. Postoperative complications, readmissions, wound infections, and bile leaks were infrequent and similar in both groups, confirming comparable long-term safety.

Overall patient satisfaction was slightly higher in the low-pressure group (4.4 ± 0.6 vs. 4.1 ± 0.7, p = 0.049). Surgeon-rated ease-of-surgery scores were high in both groups and showed no statistically significant difference, indicating that lowering the pneumoperitoneum pressure did not make the procedure technically more difficult for the operating surgeon.

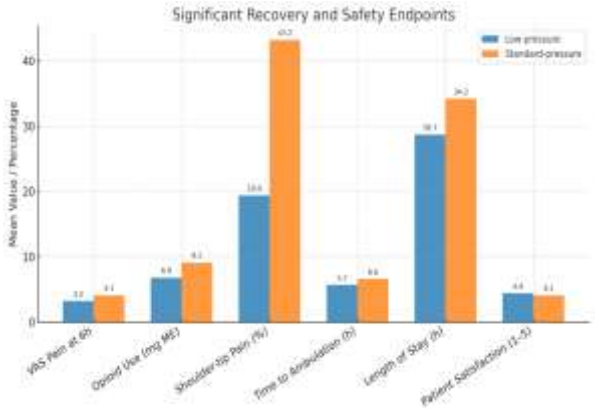

Figure 1: bar graph highlighting the most significant recovery and safety endpoints between low-pressure and standard-pressure laparoscopic cholecystectomy.

DISCUSSION

This study compared perioperative safety and recovery outcomes between low-pressure (8–10 mmHg) and standard-pressure (12–15 mmHg) laparoscopic cholecystectomy in a cohort of 73 patients. The findings suggest that low-pressure pneumoperitoneum offers modest but clinically meaningful benefits in terms of postoperative pain, shoulder-tip discomfort, analgesic requirement, and early recovery, without increasing intraoperative risk or complication rates.

The baseline characteristics in both groups were comparable, eliminating potential confounding from demographic or comorbidity differences. Similar distributions of ASA physical status, BMI, and comorbidities are important, as previous research indicates that these factors can influence operative complexity and recovery patterns[10,11].

From an intraoperative standpoint, our study found no significant differences in operative time or blood loss, a finding consistent with Gurusamy et al. (2020), who reported that lowering intra-abdominal pressure does not necessarily compromise surgical visibility or prolong operative duration when proper techniques and adequate muscle relaxation are maintained. The significantly lower peak end-tidal CO_2 in the low-pressure group is noteworthy, as elevated $EtCO_2$ has been linked to increased cardiopulmonary stress, especially in patients with limited respiratory reserve[12-14].

Postoperative recovery metrics demonstrated the clearest advantages for low-pressure pneumoperitoneum. Pain scores at 6 hours were significantly lower, in agreement with the studies, which attributed reduced pain to diminished diaphragmatic irritation and decreased residual CO_2[15,16]. Similarly, shoulder-tip pain was less frequent in the low-pressure group, a benefit also highlighted by study[16,17]. The reduction in opioid consumption seen in our cohort parallels findings by study, who reported that lower insufflation pressures can reduce postoperative analgesic needs, potentially mitigating opioid-related side effects[18].

Our study also observed earlier ambulation and shorter hospital stays in the low-pressure group. These outcomes support the results of study, who emphasized that faster mobilization contributes to lower thromboembolic risk and higher patient satisfaction. Importantly, the rates of complications, including bile leak, wound infection, and readmission, were low and comparable between groups, reinforcing the safety of low-pressure approaches when performed by experienced surgeons[19].

However, some studies, have cautioned that excessively low pressures (<7 mmHg) can compromise surgical view and increase technical difficulty. Our findings suggest that a moderate reduction to 8–10 mmHg achieves a balance between patient comfort and operative feasibility, as reflected by similar surgeon-rated ease-of-surgery scores between groups[20].

Overall, the results of this study contribute to a growing body of evidence favoring low-pressure pneumoperitoneum as a safe and effective alternative to standard pressure, especially in patients where postoperative pain control and rapid recovery are priorities.

CONCLUSION

Low-pressure laparoscopic cholecystectomy at 8–10 mmHg demonstrated superior postoperative comfort, reduced analgesic requirement, earlier mobilization, and shorter hospital stay compared to standard-pressure procedures, without increasing intraoperative risk or postoperative complications. These benefits suggest that low-pressure pneumoperitoneum can be adopted safely in routine practice, provided that surgical expertise and adequate visualization are maintained. Future multicenter trials with larger sample sizes and cost-effectiveness analyses are warranted to confirm these findings and guide standardized recommendations.

REFERENCES

1. Ortenzi, M., et al., Low-pressure versus standard-pressure pneumoperitoneum in laparoscopic cholecystectomy: a systematic review and meta-analysis of randomized controlled trials. 2022. 36(10): p. 7092-7113.
2. Rashdan, M., et al., Effect of low-pressure pneumoperitoneum on pain and inflammation in laparoscopic cholecystectomy: a randomized controlled clinical trial. 2023. 16(1): p. 235.
3. Reijnders-Boerboom, G.T., et al., Low intra-abdominal pressure in laparoscopic surgery: a systematic review and meta-analysis. 2023. 109(5): p. 1400-1411.
4. Albers, K.I., et al., The effect of low-versus normal-pressure pneumoperitoneum during laparoscopic colorectal surgery on the

early quality of recovery with perioperative care according to the enhanced recovery principles (RECOVER): study protocol for a randomized controlled study. 2020. 21(1): p. 541.
5. AHMED, M. and S.A.J.T.M.J.o.C.U. ABDALLAH, Effect of Different Levels of Intraperitoneal Pneumoperitoneum on Liver Enzymes during Laparoscopic Cholecystectomy. 2022. 90(3): p. 547-556.
6. Marton Filho, M.A., et al., Effects of pneumoperitoneum on kidney injury biomarkers: A randomized clinical trial. 2021. 16(2): p. e0247088.
7. Galetin, T., A.J.A.o.L. Galetin, and E. Surgery, Influence of gas type, pressure, and temperature in laparoscopy—a systematic review. 2022. 7.
8. Kim, H.Y., et al., A randomized clinical trial on the effect of a lidocaine patch on shoulder pain relief in laparoscopic cholecystectomy. 2021. 11(1): p. 1052.
9. Etienne, J.-H., et al., Low-impact laparoscopy vs conventional laparoscopy for appendectomy: a prospective randomized trial. 2023. 237(4): p. 622-631.
10. Desroches, B., et al., Comparison of the safety and efficacy of valveless and standard insufflation during robotic partial nephrectomy: a prospective, randomized, multi-institutional trial. 2021. 153: p. 185-191.
11. Aditianingsih, D., et al., Effects of low versus standard pressure pneumoperitoneum on renal syndecan-1 shedding and VEGF receptor-2 expression in living-donor nephrectomy: a randomized controlled study. 2020. 20(1): p. 37.
12. Kumari, A., et al., Post-operative analgesic effect of intraperitoneal ropivacaine with or without tramadol in laparoscopic cholecystectomy. 2020. 64(1): p. 43-48.
13. Rahman, M.M., et al., Laparoscopic Cholecystectomy in High Risk Cardiac Patient with DM. 2020. 33(2): p. 78-84.
14. Shehab, H.A., I.E. Mostafa, and S.A.J.E.J.o.A. Salman, Deep neuromuscular blocking and sugammadex reversing-drug is an efficient strategy permitting successful laparoscopic surgery under low insufflation pressure: Prospective multicenter study. 2023. 39(1): p. 883-893.
15. Mohammed Mahdy, M., et al., Comparison of analgesic efficacy of ultrasound-guided erector spinae block with port site infiltration following laparoscopic cholecystectomy. 2023. 39(1): p. 528-537.
16. Warlé, M.C., Kim I. Albers1, Fatih Polat2, Ivo F. Panhuizen3, Marc MJ Snoeck3, Gert-Jan Scheffer4, Hans D. de Boer5 and. 2020.
17. Qin, J., et al., Low-pressure pneumoperitoneum reduces influence on ovarian hormones in infertile women: a randomised trial. 2021. 10(5): p. 5746753-5745753.
18. Rosati, M., et al., Operative gynecological laparoscopy under conscious sedation. 2020. 24(2): p. e2020. 00020.
19. Dabi, Y., et al., Total hysterectomy by low-impact laparoscopy to decrease opioids consumption: a prospective cohort study. 2022. 11(8): p. 2165.
20. Cillara, N., et al., A prospective cohort analysis of the prevalence and predictive factors of delayed discharge after laparoscopic cholecystectomy in Italy: The DeDiLaCo Study. 2023. 33(5): p. 463-473.

This article may be cited as: Asjad M, Arain AG, Bajwa LA, Ali N, Naper MA: Comparison of Perioperative Safety and Recovery Profiles between Low-Pressure and Standard-Pressure Laparoscopic Cholecystectomy. Pak J Med Health Sci, 2023;17(11):393-396.