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Original Research Article

Evaluation of Post-Operative Shoulder Tip Pain in Low-Pressure vs. Standard-Pressure Pneumoperitoneum in Laparoscopic Cholecystectomy: A Prospective Comparative Study

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Conflict of interest: Nil

Abstract

Background: Shoulder tip pain (STP) is a common complaint after laparoscopic cholecystectomy (LC), attributed to diaphragmatic irritation from CO2 pneumoperitoneum. Lower insufflation pressures may reduce STP but could affect operative conditions.

Objective: To compare incidence and severity of postoperative STP between low-pressure (10 mmHg) and standard-pressure (14 mmHg) CO2 pneumoperitoneum in LC.

Methods: Prospective, randomized, single-blind study of 100 adult patients undergoing elective LC randomized 1:1 to low-pressure (n=50) or standard-pressure (n=50). Primary outcome: incidence of STP at 24 hours. Secondary outcomes: STP severity (numeric rating scale, NRS 0–10) at 6, 12, 24, 48 hours; analgesic consumption (morphine-equivalent) in 48 hours; operative time; intraoperative complications; conversion to open surgery; surgeon-rated operative field (Likert scale).

Results: 100 patients randomized equally. Baseline demographics comparable. Incidence of STP at 24 h: low-pressure 28% (14/50) vs standard-pressure 56% (28/50), p=0.003. Mean NRS at 24 h: low 1.2±1.6 vs standard 2.8±2.1, mean difference −1.6 (95% CI −2.4 to −0.8), p<0.001. Median 48-h morphine-equivalent: low 6 mg (IQR 4–10) vs standard 10 mg (IQR 6–16), p=0.01. Operative time: low 52±12 min vs standard 45±10 min, p=0.001. Conversion rate: low 2% vs standard 0%, p=0.31. Surgeon-rated operative field: satisfactory in 92% standard vs 80% low, p=0.08. No significant differences in intraoperative complications or length of stay.

Conclusion: Low-pressure (10 mmHg) CO2 pneumoperitoneum reduced incidence and severity of postoperative shoulder tip pain but was associated with modestly longer operative time; operative field remained acceptable in most cases. Low-pressure insufflation may be considered to reduce postoperative STP when surgical conditions permit.

Keywords: Low-pressure, Laparoscopic Cholecystectomy, Pneumoperitoneum, Randomized study, Shoulder tip pain.

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Introduction

Laparoscopic cholecystectomy (LC) is the standard for symptomatic gallstones [1]. Pneumoperitoneum is created by insufflation of CO2 in peritoneal cavity & maintaining the pressure, till the end of surgery. Pneumoperitoneum usually is maintained at the pressure ranging from 12 to 16mm of Hg [2,3,4]. Creation of pneumoperitoneum is associated with various physiological effects like, compromised circulatory system, diminished pulmonary compliance, and disrupted blood gas values, raised liver enzymes, raised venous return, kidney impairment & shoulder tip pain [5-12]. Postoperative shoulder tip pain (STP) is a frequent complaint, related to diaphragmatic irritation and phrenic nerve referred pain from CO2 insufflation, peritoneal stretch, residual gas, and chemical

irritation. Strategies to reduce STP include low-pressure pneumoperitoneum, warmed/humidified CO2, careful desufflation, intraperitoneal local anaesthetic or saline, and postoperative analgesia. As an alternative, low insufflation pressure has been suggested, which is typically described as intra-abdominal pressure between 06 to 10mm of Hg [6-9, 11]. Low insufflation pressure may reduce diaphragmatic stretch and peritoneal irritation but might worsen exposure and prolong surgery [6-8]. We conducted a prospective randomized study of 100 patients comparing low-pressure (10 mmHg) vs standard-pressure (14 mmHg) CO2 pneumoperitoneum for LC, with primary outcome of STP incidence at 24 hours.

Material & Methods

A multi-centre, prospective, randomized, single-blind (patients blinded) controlled trial was conducted over a period of 1 year. Patients of age 18–75 years, with ASA I–III, having symptomatic cholelithiasis, which were scheduled for elective Laparoscopic Cholecystectomy (LC) were included. Patient having history of acute cholecystitis within 4 weeks, or with BMI >40 kg/m2 or prior upper abdominal surgery causing dense adhesions, or pregnancy, or coagulopathy, or not giving consent, or having allergy to study analgesics were excluded. Patients were then randomized 1:1 to low-pressure (10 mmHg) or standard-pressure (14 mmHg) using computer-generated blocks of 10 sealed envelopes. Patients blinded to group & surgeons were not blinded.

Interventions

Standard general anesthesia; standard four-port LC technique was used. Insufflation was done with CO2, using automated insufflator set to assigned pressure (10 or 14 mmHg) from trocar insertion until desufflation. Other variables were standardized i.e. flow rate 6–8 L/min for insufflation, routine intraoperative irrigation and suctioning, removal of residual gas by gentle abdominal compression and passive desufflation with open ports was done at end of procedure. Analgesia protocol: intraoperative paracetamol 1 g IV, ketorolac 30 mg IV unless contraindicated; postoperative rescue: IV morphine titrated, then oral opioids and NSAIDs as needed. All analgesic use recorded and converted to morphine-equivalents.

Outcomes Primary outcome

Incidence of shoulder tip pain (STP) was noted at 24 hours post-op, defined as patient-reported referred pain in ipsilateral or bilateral shoulder (yes/no).

Secondary outcomes

STP severity by Numeric Rating Scale (NRS) from 0–10 at 6, 12, 24, 48 hours. Total analgesic consumption in first 48 hours (morphine-equivalent mg). Operative time (skin incision to closure). Surgeon-rated operative field (5-point Likert: 1=very poor to 5=excellent). Conversion to open, intraoperative complications, length of stay, post-operative nausea/vomiting (PONV) incidence.

Sample size

Based on expected reduction in STP incidence from 55% to 30% with low pressure, alpha 0.05, power 80%, two-sided test: required 46 per group; inflated to 50 per group for dropouts — total 100 patients were included in this study.

Statistical analysis

Various statistical tools like Intention-to-treat analysis, Categorical variables: chi-square or Fisher's exact, Continuous variables: t-test or Mann–Whitney U as appropriate, Repeated measures NRS compared using mixed-effects ANOVA, Significance $p<0.05$ were used in this study.

Results

100 patients were included in the study as per inclusion criteria & were randomized equally (n=50 per group). Mean Age in low pressure was found to be 46±12 yrs & in standard pressure was found to be 45±13 yrs with female sex of 72% both groups, Mean BMI was found to be 28±4 vs 27.5±4.2; with ASA I–II of 86% in low pressure vs 88% in standard pressure — no significant differences.

Table 1: Baseline Patient Characteristics

Characteristic	Low Pressure	Standard Pressure	Significance
Age (yrs)	46 ± 12	45 ± 13	NS*
BMI (kg/m²)	28 ± 4	27.5 ± 4.2	NS
Female (%)	72%	72%	NS
ASA I–II (%)	86%	88%	NS

***NS = Not Statistically Significant (p > 0.05)**

Primary outcome: STP incidence at 24 h: low pressure group 14/50 (28%) vs standard pressure group 28/50 (56%); chi-square p=0.003; relative risk 0.5 (95% CI 0.31–0.80).

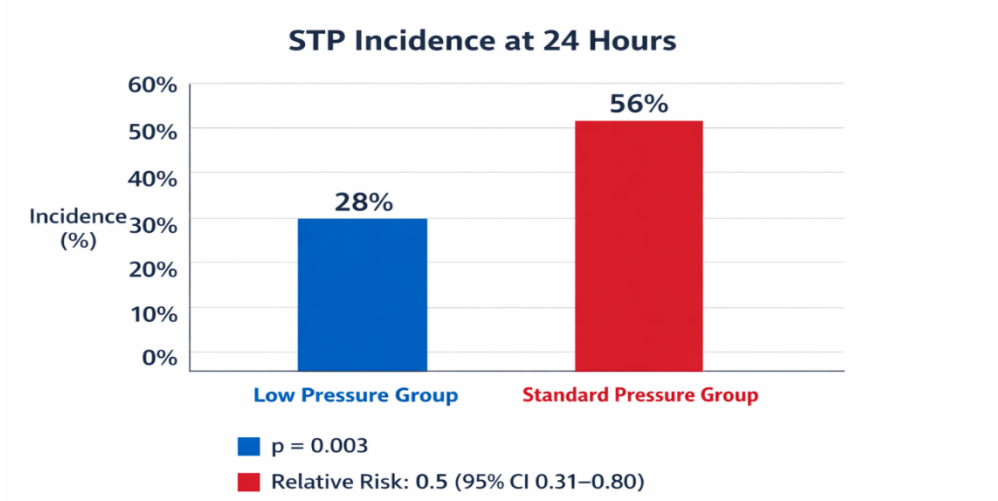

Figure 1:

Secondary outcomes: Mean NRS (mean±SD) at 6 h in low pressure group was found to be 2.1±1.9 vs 3.6±2.2 in standard pressure with p<0.001. At 12 h, Mean NRS (mean±SD) in low pressure group was found to be 1.6±1.7 vs 3.2±2.0 in standard pressure group with p<0.001. Mean NRS (mean±SD) at 24 h in low pressure group was 1.2±1.6 vs 2.8±2.1 in standard pressure with p<0.001 & at 48 h, in low pressure was 0.6±1.0 vs 1.2±1.4 in standard pressure with p=0.02.

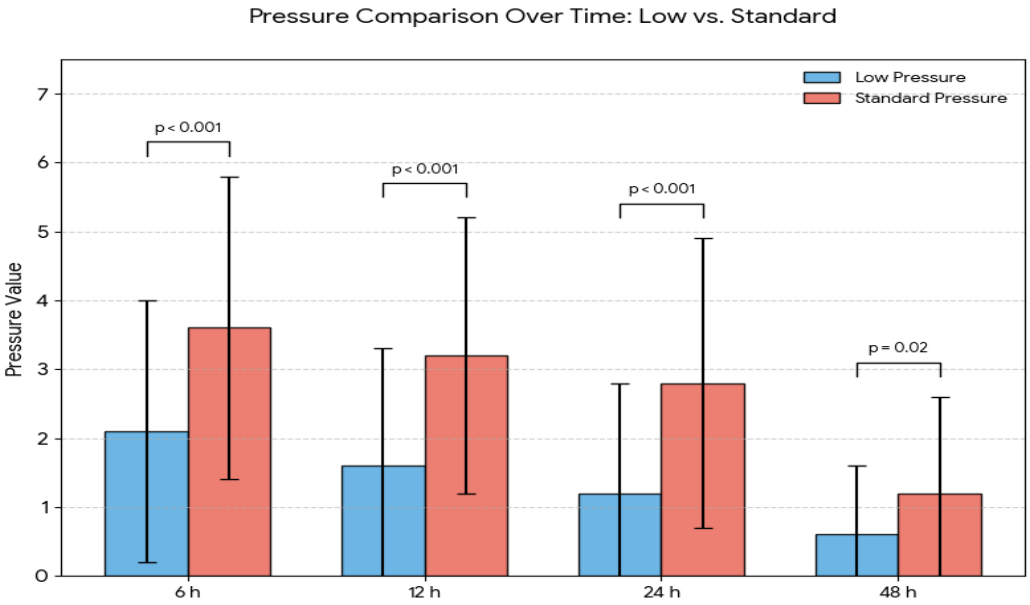

Figure 2:

Morphine-equivalent mg median (IQR) at 48 h in low pressure group was found to be 6 (4–10) vs 10 (6–16) in standard pressure group with p=0.01. Operative time in low pressure group was 52±12 min vs 45±10 min in standard pressure group, mean difference of 7 minutes with p=0.001.

Surgeon-rated operative field satisfactory (Likert ≥4) in low pressure group was found to be 80% vs 92% in standard pressure group with p=0.08. Conversion from Lap to open was seen in low pressure group in 01 case (2%) & 0 in standard pressure group with p=0.31. Intraoperative complications like bile leak was found negligible & there was no significant difference. PONV in low pressure group was found to be 18% vs 22% in standard pressure group with p=0.58. Median length of stay was, 01 day in both groups. There were no adverse events, no mortality. One patient in low-pressure group converted to open for dense adhesions. No major cardio-respiratory events related to pressure.

Discussion

In this randomized study, low-pressure pneumoperitoneum (10 mmHg) significantly reduced incidence and severity of postoperative STP and decreased analgesic requirements. The trade-off was a modestly longer operative time and slightly lower (not statistically significant) surgeon satisfaction with operative field & conversion and complication rates were similar. Findings align with prior literature suggesting lower insufflation pressures decrease peritoneal stretch and diaphragmatic irritation, reducing referred shoulder pain [13-15]. Clinical implications were, where exposure allows, using 10 mmHg may reduce postoperative discomfort and opioid needs without increasing complications [16-18]. Limitations of this study was, surgeon not blinded.

Conclusion

Low-pressure (10 mmHg) CO2 pneumoperitoneum in LC, compared with standard 14 mmHg, reduced postoperative shoulder tip pain and analgesic consumption in this 100-patient randomized study, with acceptable operative conditions in most cases. Consider low-pressure insufflation where feasible [17-20].

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