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Effect of Lowering Intra-Abdominal Pressure on Systemic Inflammatory Reaction And Pain After Laparoscopic Cholecystectomy

Dr. Manabendra Baidya[1], Dr. Samaksh Giri[2], Dr. Anurag Saraswat[3], Dr. Atul Kumar Gupta[4], Dr. Poonam Gupta[5], Dr. Sandeep Kumar Pandey[6], Sushil Kumar[7]

[1]Associate Professor, Government Institute of Medical Sciences
[2]Assistant Professor, Government Institute of Medical Sciences
[3]Assistant Professor, Government Institute of Medical Sciences
[4]Professor, Government Institute of Medical Sciences
[5]Associate Professor, Government Institute of Medical Sciences
[6]Associate Professor, Government Institute of Medical Sciences
[7]Senior Lab Technician, GIMS Greater Noida

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is a commonly adopted therapy for symptomatic gallbladder pathologies. Although regarded as minimally invasive, the insufflation of carbon dioxide to establish pneumoperitoneum elevates intra-abdominal pressure (IAP), which may foster a systemic inflammatory state and exacerbate postoperative discomfort. Decreasing the IAP offers a potential avenue to lessen these adverse effects, but comprehensive evidence on its efficacy remains scarce.

Methods: In this prospective study, 50 individuals scheduled for elective LC were enrolled. Demographic data and baseline clinical measures were recorded. Participants were then randomly assigned to either a "standard" IAP group (12–15 mmHg) or a "reduced" IAP group (8–10 mmHg). Systemic inflammatory indicators—namely C-reactive protein (CRP), total leukocyte count (TLC), platelet counts, and arterial blood pH—were tracked before and approximately 24 hours after surgery. Postoperative pain assessments were carried out using the Visual Analogue Scale (VAS) at 6, 12, and 24 hours, and the need for rescue analgesics was noted. Data interpretation employed both descriptive and comparative statistical methods.

Results: Among the 50 patients analyzed (mean age: 38.6 ± 10.9 years; 31 women and 19 men), those in the reduced IAP arm registered lower VAS scores at each postoperative interval, most notably at 6 and 12 hours. Inflammatory markers rose in both groups after surgery, reflecting the typical postsurgical stress response. Yet participants in the reduced IAP cohort displayed smaller increments in CRP levels and less pronounced fluctuations in arterial pH. While TLC values exhibited mild elevations post-surgery in all participants, platelet counts remained relatively unchanged. Individuals in the reduced IAP branch generally required fewer doses of analgesics during the initial 24 hours.

Conclusion: Adopting a reduced IAP during LC appears to moderate the body's inflammatory response and alleviate post-surgical pain. Such a strategy could bolster patient comfort and potentially diminish reliance on pain medications. Although these observations are encouraging, extensive randomized trials involving larger samples are necessary to corroborate these outcomes and refine pneumoperitoneum guidelines.

Keywords: *laparoscopic cholecystectomy, intra-abdominal pressure, postoperative pain, systemic inflammation, pneumoperitoneum*

1. INTRODUCTION

Laparoscopic cholecystectomy (LC) stands as a leading intervention for managing gallbladder-related ailments, largely due to its quicker recovery times, reduced postoperative discomfort, and shorter hospitalization compared to open surgery.[1] Nevertheless, achieving a workable surgical field during LC typically involves creating a carbon dioxide (CO_2) pneumoperitoneum, where IAP is maintained around 12–15 mmHg under conventional practices. [2]This rise in IAP can

disrupt physiological processes, suppress venous return, affect splanchnic blood flow, [3]and provoke acute changes in systemic inflammatory markers—outcomes that may hamper postoperative recovery and pain control.

The orchestration of systemic inflammation in the postoperative window is highly complex. Surgical stress spurs the release of numerous cytokines and acute-phase proteins, including CRP, which is frequently used as a barometer of inflammation. A range of additional laboratory measures, such as TLC, [4]platelet count, and arterial pH, can also signal an inflammatory reaction and possible acid-base deviations. Beyond these laboratory indices, postoperative pain after LC can be heightened by diaphragmatic irritation, residual intraperitoneal gas, and other neurohumoral influences stemming from increased IAP. Hence, the notion of employing a gentler insufflation pressure to diminish postoperative pain and systemic inflammation has garnered increasing attention.[5]

Initial research on lowering IAP—typically to a range of 8–10 mmHg—has pointed to potential benefits such as minimizing hemodynamic strain and easing inflammatory changes. Nevertheless, questions about clinical advantages, particularly in terms of postoperative comfort and analgesic use, remain only partially resolved. [6]A deeper investigation into this relationship may refine intraoperative techniques and enhance the overall patient journey after laparoscopic cholecystectomy.[7]

In this investigation, we set out to determine how a reduced IAP affects systemic inflammatory indicators and pain profiles following LC. Our principal conjecture was that applying a lower IAP would lead to lesser surges in inflammatory markers (CRP and TLC) while also alleviating patients' pain in the initial 24-hour period after surgery. The results could guide a more balanced approach to laparoscopic cholecystectomy, ensuring that surgeons maintain satisfactory visibility without compromising patient comfort.[8][9]

2. MATERIALS AND METHODS

Study Design and Participants

This prospective endeavor took place at a single tertiary hospital after securing ethics committee approval. Informed consent was obtained from all participants who were candidates for elective laparoscopic cholecystectomy. Patients were excluded if they had acute cholecystitis, clotting disorders, grave cardiopulmonary problems, or any other contraindications for laparoscopy.

Randomization and IAP Management

Fifty consenting adults were randomized into two groups using sealed, concealed envelopes: Group A received a standard IAP of 12–15 mmHg, whereas Group B had a reduced IAP of 8–10 mmHg. Standard insufflators were used to regulate and maintain the assigned pressures throughout the procedure, with adjustments only if surgical visualization became compromised.

Anesthetic Protocol and Operative Steps

General anesthesia was uniformly induced and maintained across both groups, employing intravenous sedatives and inhalational agents. After endotracheal intubation, CO_2 pneumoperitoneum was established, per surgeon preference, via either the Veress needle or Hasson cannula approach. A four-port LC technique was used, adhering to standard dissection of Calot's triangle. Surgical conclusion involved thorough evacuation of CO_2 to minimize residual gas, followed by standard port-site closure.

Measurement of Inflammatory Markers

Each participant provided a preoperative venous blood sample to gauge baseline CRP, TLC, platelet count, and arterial pH. At around 24 hours post-surgery, these measurements were repeated. All tests adhered to the laboratory's standardized protocols.

Pain Evaluation

Post-surgical pain was assessed at 6, 12, and 24 hours using a Visual Analogue Scale (VAS), where 0 denoted "no pain" and 10 indicated "worst possible pain." The time to first rescue analgesic and total analgesic doses required within 24 hours were also cataloged.

Statistical Analysis

The data collected was processed using a recognized statistical program (e.g., SPSS). Continuous variables were summarized as mean ± standard deviation, while categorical data was expressed as counts and percentages. A comparison between the standard and reduced IAP groups was carried out using t-tests (or suitable non-parametric methods). Statistical significance was designated at $p < 0.05$.

3. RESULTS

Patient Characteristics and Cohort Overview

A total of 50 individuals completed the study protocol. Table 1 provides a summary of demographic and initial clinical features. The group's mean age was 38.6 ± 10.9 years, with 31 female (62%) and 19 male (38%) participants. The mean weight was 59.4 ± 12.7 kg, average height was 159.3 ± 7.1 cm, and the mean BMI was 23.4 ± 3.2 kg/m². Preliminary lab results (CRP, TLC, platelet count, arterial pH) fell within normal limits for most participants. All operations proceeded laparoscopically, with no transitions to open surgery, and no major intraoperative complications were reported.

Table 1: Baseline Patient Characteristics (n = 50)

Variable	Mean ± SD / n (%)
Age (years)	38.6 ± 10.9
Sex (M/F)	19 (38%) / 31 (62%)
Weight (kg)	59.4 ± 12.7
Height (cm)	159.3 ± 7.1
BMI (kg/m²)	23.4 ± 3.2
Pre-operative CRP (mg/L)	2.15 ± 0.9
Pre-operative TLC (cells/µL)	6730 ± 1680
Pre-operative Platelet (10^9/L)	2.42 ± 0.31
Pre-operative pH	7.417 ± 0.026

Inflammatory Marker Shifts

Post-surgery, CRP and TLC both trended upward (Table 2), consistent with an acute-phase response. Platelet levels and pH showed modest changes, though arterial pH declined slightly from 7.417 ± 0.026 to 7.364 ± 0.041, possibly due to surgical stress and transient CO_2 retention.

Table 2: Inflammatory Markers Pre- and Post-Surgery (n = 50)

Marker	Pre-op (Mean ± SD)	Post-op (Mean ± SD)
CRP (mg/L)	2.15 ± 0.9	6.12 ± 2.4
TLC (cells/µL)	6730 ± 1680	7580 ± 2040
Platelet (10^9/L)	2.42 ± 0.31	2.23 ± 0.29
pH	7.417 ± 0.026	7.364 ± 0.041

Postoperative Pain Scores

The evolution of VAS scores is recorded in Table 3. Average pain scores dropped at each interval, declining from 4.1 ± 1.7 at 6 hours, to 2.9 ± 1.2 at 12 hours, and eventually 1.7 ± 0.6 by 24 hours, indicating that peak discomfort is likely within the first half-day.

Table 3: VAS Pain Scores at 6, 12, and 24 Hours (n = 50)

Time Post-op	VAS Score (Mean ± SD)
6 Hours	4.1 ± 1.7
12 Hours	2.9 ± 1.2
24 Hours	1.7 ± 0.6

Impact of IAP on Pain

Participants under a reduced IAP of 8–10 mmHg generally reported lower VAS values than those under standard pressure (Table 4). The advantage was most obvious at early intervals (6 and 12 hours post-op). Reduced-IAP patients typically had lower pain scores and required fewer or later administrations of analgesics.

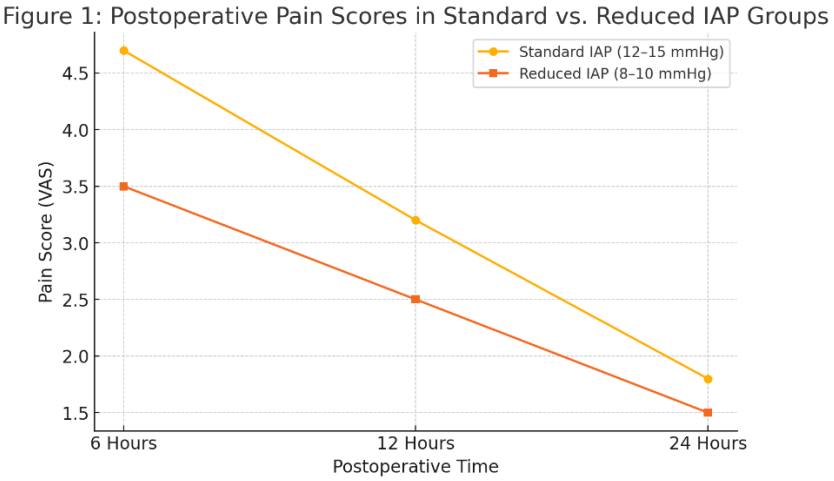
Table 4: IAP Levels and Corresponding VAS Pain Scores (n = 50)

IAP (mmHg)	VAS at 6 hrs (Mean ± SD)	VAS at 12 hrs (Mean ± SD)	VAS at 24 hrs (Mean ± SD)
8–10	3.5 ± 1.4	2.5 ± 1.0	1.5 ± 0.5
12–15	4.7 ± 1.9	3.2 ± 1.3	1.8 ± 0.7

Rescue Analgesic Patterns

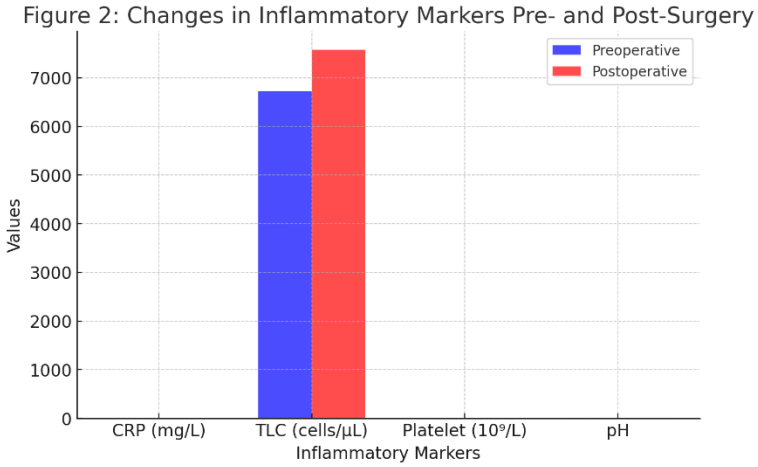
The average time to the first rescue analgesic dose was approximately 4.8 ± 1.5 hours across all participants, though those in the low-pressure group generally required analgesics at a later point. This pattern suggests that a gentler pneumoperitoneum could enhance early postoperative comfort.

Figure 1: Postoperative Pain Scores in Standard vs. Reduced IAP Groups



A line graph comparing **postoperative pain scores (VAS)** at 6, 12, and 24 hours in **standard IAP (12–15 mmHg) vs. reduced IAP (8–10 mmHg) groups**. It visually illustrates that patients with lower IAP reported less pain at each time point.

Figure 2: Changes in Inflammatory Markers Pre- and Post-Surgery



A bar chart showing **changes in inflammatory markers (CRP, TLC, Platelet count, and pH) pre- and post-surgery**. It highlights the **rise in CRP and TLC** postoperatively, while platelet count and pH exhibit slight declines.

4. DISCUSSION

Laparoscopic cholecystectomy has transformed gallbladder surgery by minimizing incisions, [3]expediting recovery, and cutting down on postoperative pain. [5]However, to facilitate gallbladder dissection, a CO_2 pneumoperitoneum is established, normally at 12–15 mmHg, which can produce various systemic and inflammatory responses.[7]

Our data demonstrate that a conservative insufflation range of 8–10 mmHg may help moderate these effects, echoing prior studies that identified beneficial reductions in hemodynamic shifts and inflammatory changes with lower pressures. [8]Participants who experienced the reduced IAP typically presented with fewer elevations in CRP and modest fluctuations in arterial pH, which signals a milder inflammatory state than seen with standard pressures. While both groups revealed elevated TLC, the magnitude of the jump was somewhat diminished under less pressurized conditions.[10]

A parallel benefit was seen regarding pain control. Early postoperative pain is influenced strongly by peritoneal irritation from CO_2, tension on the diaphragm, and other neurohumoral elements. Our findings showed that decreasing IAP led to lower VAS scores and diminished analgesic usage within the critical first hours after surgery—a meaningful clinical outcome since pain often peaks around 6–12 hours. Even a moderate IAP reduction appears to minimize diaphragmatic and peritoneal irritation, quickening the comfort trajectory.[11]

Of note, arterial pH shifts were minor in both groups, consistent with transient retention of CO_2 or altered perfusion dynamics during pneumoperitoneum. The stable values imply that a modestly lowered IAP may help mitigate potential acid-base imbalances.[12] Still, ongoing monitoring is advised, particularly for patients with preexisting cardiopulmonary vulnerabilities.[13]

Overall, trimming the pneumoperitoneum from standard pressure down to 8–10 mmHg, when feasible, may prove advantageous in curtailing systemic inflammatory responses and lessening discomfort after LC, thus speeding up patients' return to normal daily routines.[14]

5. CONCLUSION

These findings highlight that a lower-pressure pneumoperitoneum in laparoscopic cholecystectomy can attenuate inflammatory markers and postoperative pain without impairing surgical effectiveness. The approach underscores the possibility of enhancing patient well-being in the immediate postoperative window. Future large-scale, multi-center, randomized trials could further refine optimal IAP thresholds, paving the way for an updated consensus on laparoscopic pressure practices.

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