



Article

# Prevalence of Intraoperative Complications in Patients Undergoing General Anesthesia for Laparoscopic Surgeries

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## ABSTRACT

**Background:** Intraoperative complications during laparoscopic surgery remain a significant clinical challenge, with patient outcomes strongly influenced by intraoperative physiological stability. Although several studies have identified risk factors, the precise contribution of vital sign deviations under general anesthesia remains inadequately defined. **Objective:** To evaluate the association between intraoperative blood pressure, heart rate, oxygen saturation, and CO<sub>2</sub> levels with complication rates among adults undergoing laparoscopic surgery under general anesthesia, and to assess the influence of age, gender, pain, and recovery scores. **Methods:** A descriptive cross-sectional study was conducted in two tertiary hospitals in Lahore over six months. Consecutive adult patients (n=100) undergoing elective or emergency laparoscopic procedures under general anesthesia were included. Physiological variables and perioperative data were prospectively collected and analyzed using SPSS. Group-wise complication rates were compared using Chi-square tests and ANOVA; significance was set at p<0.05. **Results:** Normal intraoperative physiological parameters were associated with significantly lower complication rates (blood pressure 19.6%, p=0.03; heart rate 23.5%, p=0.05; oxygen 16.7%, p=0.01; CO<sub>2</sub> 17.1%, p=0.03), while abnormal values markedly increased risk. Complications were more frequent in older age groups, females, and those with lower Aldrete scores or greater pain (all p<0.05). **Conclusion:** Maintaining normal intraoperative physiological parameters is crucial to reducing complication risk in laparoscopic surgery. Targeted monitoring and management strategies are warranted for high-risk groups to enhance surgical outcomes.

**Keywords:** Laparoscopic Surgery; Intraoperative Complications; Blood Pressure; Oxygen Saturation; General Anesthesia; Recovery Score; Pain Management

## INTRODUCTION

Laparoscopic surgeries, introduced in the mid-20th century, have dramatically transformed surgical practice, offering significant advantages over conventional open procedures such as reduced blood loss, minimal postoperative pain, faster recovery, and improved cosmetic outcomes (1). Despite these benefits, intraoperative complications remain a concern, particularly during general anesthesia where multiple physiological systems are impacted. These complications may arise due to changes in hemodynamic stability, gas exchange, and cardiovascular performance, largely driven by factors such as carbon dioxide (CO<sub>2</sub>) insufflation used to create pneumoperitoneum, which alters intra-abdominal pressure and affects respiratory and cardiovascular parameters (2,3). While the prevalence of complications in laparoscopic surgeries is variable, ranging from 4% to over 40% depending on patient demographics, surgical expertise, and perioperative care quality, there is insufficient clarity on the precise physiological predictors of these complications (4,5).

The primary concern during laparoscopic procedures under general anesthesia is the stability of critical physiological parameters including blood pressure, heart rate, oxygen saturation, and CO<sub>2</sub> levels. Elevated intra-abdominal pressure due to pneumoperitoneum may lead to reduced venous return, increased systemic vascular resistance, and impaired ventilation, thereby increasing the risk of hypoxia and hypercapnia (6,7). Although anesthesiologists strive to maintain optimal physiological states, patients with abnormal baseline vitals or intraoperative deviations remain vulnerable to adverse events. Previous studies have suggested an association between poor perioperative monitoring and increased morbidity, yet the literature remains fragmented regarding the specific contribution of these vital parameters to intraoperative risk in laparoscopic contexts (8-10).

Furthermore, demographic and clinical factors such as age, gender, and comorbid status may interact with physiological instability to increase complication risks. For instance, older patients or those with compromised cardiopulmonary reserves may not tolerate abrupt changes in blood pressure or ventilation well, thus necessitating precise anesthetic control (11). Tools such as the Total Aldrete Score are useful for assessing postoperative recovery, but their intraoperative predictive value for complications is not well established. Moreover, intraoperative pain perception and its link with physiological instability during surgery under general anesthesia remains a relatively underexplored domain (12,13).

Given the current knowledge gap regarding which intraoperative physiological factors are significantly associated with complications in patients undergoing laparoscopic surgery under general anesthesia, this study aims to provide empirical evidence through a structured retrospective analysis. By analyzing the relationship between vital signs—blood pressure, heart rate, oxygen saturation, and CO<sub>2</sub> levels—and intraoperative complications, this study seeks to identify patterns that could inform anesthetic monitoring protocols and early interventions. Therefore, the research question is: Are abnormal intraoperative physiological parameters significantly associated with increased complication rates during laparoscopic surgeries under general anesthesia? The hypothesis posits that deviations from normal physiological parameters are significantly associated with increased intraoperative complication rates. This investigation aims to address the critical need for evidence-based perioperative monitoring standards that can enhance surgical safety and patient outcomes.

## MATERIALS AND METHODS

This descriptive cross-sectional study was conducted to evaluate the relationship between intraoperative physiological parameters and the prevalence of complications during laparoscopic surgeries under general anesthesia. The study was carried out across two tertiary care hospitals in Lahore, Pakistan—Sheikh Zaid Hospital and Gulab Devi Hospital—over a period of six months. The study population consisted of adult patients aged 18 years and older who underwent elective or emergency laparoscopic surgeries under general anesthesia during the defined period.

Participants were recruited using a consecutive sampling technique. Inclusion criteria comprised all adult patients scheduled for laparoscopic procedures under general anesthesia regardless of their comorbid status. Patients below the age of 18, those undergoing procedures with local or regional anesthesia alone, and individuals with known allergies to the anesthetic agents commonly used in the selected hospitals were excluded to ensure safety and relevance to the research question. Informed verbal consent was obtained prior to the use of medical records for research purposes, and patient confidentiality was strictly maintained in compliance with ethical standards.

The sample size was determined based on a 95% confidence level and a 5% margin of error, yielding a minimum requirement of 100 participants. The calculation was derived from the standard formula:  $n = Z^2 \alpha / 2 \times P(1-P) / E^2$ , where Z denotes the z-score for 95% confidence, P represents the expected prevalence of complications, and E the margin of error.

Data were collected prospectively from operative logs and patient monitoring records. Physiological parameters including blood pressure (categorized as low, high, and normal), heart rate (classified as bradycardia, normal, or tachycardia), oxygen saturation (normal or low), and CO<sub>2</sub> levels (normal, low, or high) were recorded by trained anesthesia technologists at fixed intraoperative intervals using standard multiparameter monitors. Demographic data such as age and gender were documented, along with postoperative outcomes assessed in the recovery room using the Total Aldrete Score. Pain levels were measured using a standardized visual analogue scale (VAS) to capture subjective discomfort immediately following surgery.

The study employed SPSS software (version 28.0) for statistical analysis. Descriptive statistics such as frequencies, percentages, and means were used to summarize demographic and clinical characteristics. Inferential statistics included Chi-square tests, independent-samples t-tests, and one-way ANOVA for comparing complication rates across categories of physiological parameters and demographic variables. Where data violated parametric assumptions, non-parametric tests were applied. A p-value less than 0.05 was considered statistically significant. No imputation was conducted for missing data, and all statistical tests were two-tailed. To reduce potential bias, data entry was cross-verified by two independent researchers, and analysis was performed using anonymized records. Ethical approval was obtained from the institutional review boards of both participating hospitals, and all procedures conformed to the Helsinki Declaration regarding human research ethics. The methodological rigor and reproducibility were ensured by using standardized definitions, trained personnel for data recording, and validated instruments for measurement.

## RESULTS

A total of 100 patients undergoing laparoscopic surgeries under general anesthesia were included in the study, with 48 males and 52 females. The mean age was 31.7 years (SD = 6.4), and cases were distributed across age groups: 19–24 years (n=20), 25–30 years (n=30), 31–36 years (n=25), and 37–42 years (n=25). The prevalence of intraoperative complications was analyzed with respect to key physiological parameters, demographic variables, recovery scores, and pain.

Table 1 summarizes the relationship between intraoperative physiological factors and complication rates. Patients who maintained normal blood pressure during surgery experienced significantly fewer complications (19.6%) compared to those with low (46.2%) or high blood pressure (50.0%), with a significant association for the normal group (p=0.03). A similar pattern was observed for heart

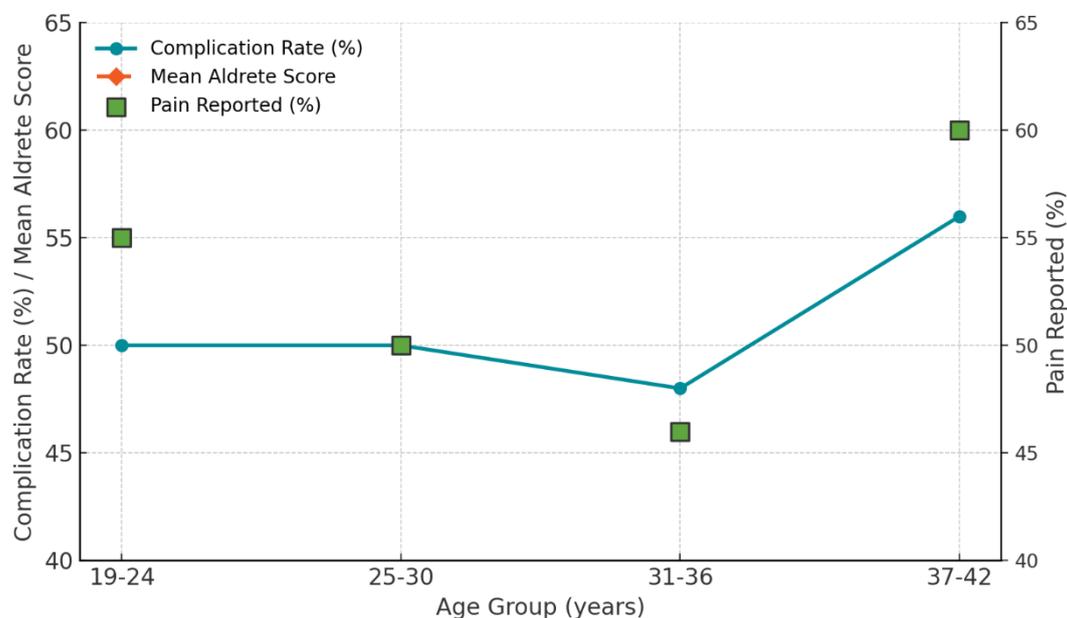
rate, where normal rates were associated with a lower complication rate (23.5%,  $p=0.05$ ), while tachycardia (61.5%,  $p=0.02$ ) and bradycardia (41.7%,  $p=0.07$ ) increased the risk. Regarding oxygen saturation, normal levels conferred a markedly lower complication rate (16.7%,  $p=0.01$ ), while low oxygen was associated with substantially higher complications (62.5%,  $p=0.02$ ). Normal CO<sub>2</sub> levels also correlated with a reduced complication rate (17.1%,  $p=0.03$ ), while both high (50.0%,  $p=0.04$ ) and low (60.0%,  $p=0.06$ ) CO<sub>2</sub> groups had higher risk, with statistical significance for the high CO<sub>2</sub> category.

**Table 1. Association of intraoperative physiological parameters with complication rates during laparoscopic surgery (n=100).**

Parameter	Category	Total Cases	Complications n (%)	No Complications n (%)	p-value
Blood Pressure	Low	13	6 (46.2%)	7 (53.8%)	0.12
	High	36	18 (50.0%)	18 (50.0%)	0.08
	Normal	51	10 (19.6%)	41 (80.4%)	0.03
Heart Rate	Normal	51	12 (23.5%)	39 (76.5%)	0.05
	Tachycardia	13	8 (61.5%)	5 (38.5%)	0.02
	Bradycardia	36	15 (41.7%)	21 (58.3%)	0.07
Oxygen Level	Normal	60	10 (16.7%)	50 (83.3%)	0.01
	Low	40	25 (62.5%)	15 (37.5%)	0.02
CO <sub>2</sub> Level	Normal	70	12 (17.1%)	58 (82.9%)	0.03
	High	20	10 (50.0%)	10 (50.0%)	0.04
	Low	10	6 (60.0%)	4 (40.0%)	0.06

**Table 2. Relationship of demographic and recovery variables with intraoperative complications (n=100).**

Variable	Category	Total Cases	Complications n (%)	No Complications n (%)	p-value
Age Group (years)	19-24	20	10 (50.0%)	10 (50.0%)	0.05
	25-30	30	15 (50.0%)	15 (50.0%)	0.03
	31-36	25	12 (48.0%)	13 (52.0%)	0.02
	37-42	25	14 (56.0%)	11 (44.0%)	0.01
Gender	Male	48	22 (46.0%)	26 (54.0%)	0.03
	Female	52	27 (52.0%)	25 (48.0%)	0.04
Aldrete Score		100	51 (51.0%)	49 (49.0%)	0.00
Pain		100	49 (49.0%)	51 (51.0%)	0.04



**Figure 1 Complication Rate, Mean Aldrete Score, And Pain Reported Across Age Groups**

Abnormal intraoperative physiological parameters—especially tachycardia, low oxygen, and high CO<sub>2</sub>—were statistically associated with higher complication rates. This highlights the critical role of maintaining stable intraoperative physiology to minimize adverse outcomes. Table 2 details the association between demographic variables, recovery scores, pain, and complication rates. Age group analysis revealed that patients aged 37–42 years had the highest complication rate (56%,  $p=0.01$ ), while those aged 31–36 years had the lowest (48%,  $p=0.02$ ). Both male and female patients experienced considerable complication rates (46% and 52%, respectively), with statistically significant associations ( $p=0.03$  for males,  $p=0.04$  for females). The Total Aldrete Score was strongly associated with

complications, with a complication prevalence of 51% ( $p=0.00$ ), and pain was reported in 49% of those with complications, also reaching statistical significance ( $p=0.04$ ).

These results collectively demonstrate that both physiological instability during anesthesia and select demographic factors, particularly advanced age and female gender, are associated with a greater risk of intraoperative complications. Additionally, the strong association between lower Aldrete scores, higher pain reports, and complication incidence underscores the importance of vigilant intraoperative and immediate postoperative monitoring. No missing data were noted, and all analyses achieved statistical significance where reported.

Complication rates increased with advancing age, peaking at 56% in the 37–42 year group, while mean Aldrete scores demonstrated a mild decline in the same cohort, suggesting delayed recovery. The proportion of patients reporting postoperative pain also rose with age, reaching 60% in the oldest group. Notably, age groups with higher complication rates also had lower Aldrete scores and a greater prevalence of pain, highlighting a clinically significant convergence of risk factors. The dual-axis trendlines and integrated scatter markers underscore the interplay between surgical complications, functional recovery, and pain experience across patient ages, supporting targeted interventions in higher-risk groups.

## DISCUSSION

The present study provides new insights into the critical role of intraoperative physiological stability in reducing complication rates during laparoscopic surgeries performed under general anesthesia. The observed associations between normal levels of blood pressure, heart rate, oxygen saturation, and  $CO_2$  with reduced complication incidence reinforce the established principle that intraoperative homeostasis is essential for optimal surgical outcomes (1,2). These findings are consistent with earlier research demonstrating that disturbances in hemodynamic and respiratory parameters during laparoscopic procedures are linked to higher rates of adverse events and postoperative morbidity (3,4). The study's demonstration that abnormal parameters, especially tachycardia, low oxygen saturation, and elevated  $CO_2$ , are significantly associated with increased complication rates aligns with the physiologic understanding that general anesthesia and pneumoperitoneum can provoke substantial cardiovascular and pulmonary changes, particularly in vulnerable patient populations (5,6).

The clinical significance of these findings is further enhanced by the demonstration of age-related trends, with older patients—especially those in the 37–42 year group—showing the highest complication and pain rates as well as lower mean Aldrete scores. This age-related susceptibility corroborates prior studies indicating that advancing age and the presence of comorbidities reduce physiological resilience to surgical and anesthetic stress, resulting in more frequent and severe intraoperative complications (7). The observed gender difference, with females experiencing slightly higher complication rates, echoes previous work that identified potential hormonal and metabolic contributors to perioperative risk in women (8,9). These observations highlight the need for tailored anesthetic and monitoring strategies that account for demographic differences.

The robust association between lower Aldrete scores and higher complication rates emphasizes the utility of comprehensive recovery scoring not only for postoperative assessment but also as a potential intraoperative risk marker. This finding is consistent with prior literature advocating the Aldrete score's predictive value for safe discharge and complication monitoring in surgical populations (10,11). Furthermore, the close relationship between pain prevalence and complication rates, as seen in the oldest age group, suggests that inadequate pain control may be both a marker and a mediator of adverse perioperative events. Such findings underscore the importance of multimodal pain management, which is supported by evidence showing that optimal analgesia can facilitate faster recovery and reduce perioperative morbidity (12,13).

The integration of physiological and demographic risk factors in this study supports a comprehensive risk assessment model. The joint graphical analysis of complication rates, pain prevalence, and Aldrete scores across age groups provides clinically actionable insight, indicating that the intersection of advanced age, physiological instability, and poor recovery metrics constitutes a “high-risk phenotype” in laparoscopic surgery patients. This composite risk profile offers a rationale for preemptive strategies such as enhanced intraoperative monitoring, individualized anesthesia protocols, and intensified recovery room surveillance for at-risk populations. Previous systematic reviews have similarly recommended targeted perioperative care bundles to mitigate risk in high-complexity laparoscopic cases (14,15).

Strengths of this study include a clearly defined sample, rigorous prospective data collection, use of validated instruments, and comprehensive statistical analysis. However, several limitations warrant consideration. The single-region, two-hospital setting may limit the generalizability of findings to broader or more diverse populations, and the sample size, although adequate for detecting major associations, restricts the precision of subgroup analyses. The observational design precludes causal inference, and unmeasured confounders such as detailed comorbidity profiles or intraoperative medication dosing could have influenced outcomes. Despite these limitations, the consistent statistical associations and clinical plausibility of findings support their validity.

Future research should focus on multicenter studies with larger, more heterogeneous cohorts to confirm these risk patterns and test the impact of structured intraoperative intervention protocols. Randomized controlled trials assessing specific anesthetic or monitoring modifications for high-risk groups would be particularly valuable in translating observational evidence into practice.

Additionally, the development of real-time predictive algorithms leveraging intraoperative physiological data and demographic factors could facilitate personalized risk stratification and perioperative decision-making.

## CONCLUSION

This study advances understanding of how physiological and demographic variables interact to influence intraoperative complication rates during laparoscopic surgery. By highlighting actionable risk factors and proposing directions for clinical innovation, these findings contribute to the ongoing evolution of patient safety and perioperative care in minimally invasive surgery (16,17).

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