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Assessment of Laparoscopic Surgical Procedures and Anaesthesia Outcomes

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ABSTRACT

Background: *Laparoscopic surgery is a minimally invasive approach for procedures like cholecystectomy and hysterectomy, offering less pain, faster recovery, and fewer complications. Anaesthetic challenges from CO_2 pneumoperitoneum exist, but studies show both general and regional anaesthesia are safe, with regional techniques often improving outcomes. This study assessed anaesthetic results and the effect of pneumoperitoneum duration on recovery and complications.* ***Methods & Materials:*** *This observational study involved 110 adults classified as ASA I–III who were scheduled for elective surgical laparoscopy. Intraoperative monitoring along with CO_2 pneumoperitoneum was employed, and patients were categorized based on the duration of pneumoperitoneum (<120 min vs. ≥120 min). Postoperative results encompassed extubation, PACU/hospital duration, pain levels, and complications. Data analysis was conducted with SPSS-27 ($p < 0.05$). The research received IRB approval and obtained informed consent.* ***Results:*** *In a study of 110 patients (average age 48 years; 80% male), Intraoperative complications were primarily temporary, including hypotension (20%) and hypercapnia (11%). Postoperative recovery was swift (extubation 10.8 min, PACU 69.4 min, hospital 3.6 days), pain reduced from VAS 3.4 to 2.2, and PONV happened in 20.9%. Pneumoperitoneum lasting ≥120 min led to greater hypercapnia, lower blood pressure, longer recovery times, and increased early pain.* ***Conclusion:*** *This study involves ASA I–III patients undergoing laparoscopy, demonstrating that the procedure is safe with mostly temporary complications; however, extended pneumoperitoneum raises risks, necessitating diligent monitoring.*

Keywords: *Anaesthesia Outcomes, Surgical Laparoscopic Procedures, VAS, PONV*

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INTRODUCTION

Laparoscopic surgery was first introduced in the early 1900s by Ott, Kelling, and Jacobeus for diagnostic purposes and subsequently evolved rapidly in Europe and the United States [1]. Over time, it has become a standard minimally invasive surgical approach, replacing large incisions with multiple small ports and providing magnified visualization that enhances surgical precision [2,3]. Globally, an estimated 313 million surgical procedures are performed annually, with a growing proportion conducted laparoscopically [4].

Laparoscopic surgery accelerates recovery by minimizing bowel handling, discomfort, and incision-related issues. Reduced incisions decrease infection risk, with these advantages being especially significant for high-risk individuals, like the obese, enhancing results compared to open surgery [5,6,7].

Laparoscopic surgery is a less invasive method utilized in various specialties. Typical procedures consist of cholecystectomy, appendectomy, fundoplication, adrenalectomy, nephrectomy, hysterectomy, ovarian cyst removal, and endometriosis therapy. In contrast to open surgery, laparoscopy decreases postoperative discomfort, length of hospital stays, and duration of recovery while lowering the risk of complications [7,8].

Despite benefits, laparoscopic surgery introduces unique anaesthetic challenges, primarily related to carbon dioxide (CO_2) pneumoperitoneum and patient positioning. Increased intra-abdominal pressure and CO_2 absorption can lead to significant physiological alterations, including elevated systemic vascular resistance, reduced venous return, hypercapnia, respiratory acidosis, and haemodynamic instability [9-10]. Prolonged pneumoperitoneum may increase postoperative pain and delay recovery [11]. These changes may increase the risk of intraoperative hypotension, tachycardia, hypercapnia, and delayed recovery, particularly during prolonged procedures.

Global research demonstrates that anaesthesia results reveal that both general and regional methods are safe, with regional anaesthesia frequently offering less pain, less nausea, and quicker mobilization. These results endorse laparoscopic surgery as a secure, efficient, and patient-centered method globally [12]. Research conducted at Bangabandhu Sheikh Mujib Medical University indicated that regional anaesthesia in laparoscopic gynecological procedures led to reduced 8-hour postoperative pain, decreased hospital stay duration, and fewer complications in comparison to general anaesthesia[13].

A prospective study on elective laparoscopic cholecystectomy found spinal anaesthesia led to lower postoperative pain, earlier ambulation and feeding, and less nausea**,** supporting it as a safe alternative to general anaesthesia[14].

Given these considerations, the present study aimed to assess the intraoperative and postoperative anaesthetic outcomes of

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patients undergoing laparoscopic procedures and to evaluate the association between pneumoperitoneum duration and perioperative complications and recovery parameters.

METHODS & MATERIALS

Study Design and Setting

This study was a prospective observational study conducted in the Department of Anaesthesiology in collaboration with the Department of Surgery at Diabetic Association Medical College Hospital. The study was carried out over a period of 12 months from January 2025 to December 2025.

Study Population and Sample Size

A total of 110 patients undergoing elective surgical laparoscopic procedures under general anaesthesia were included in the study. The sample size was determined based on feasibility, case load, and study duration.

Inclusion Criteria

Patients were included if they met the following criteria:

- Age ≥18 years
- Scheduled for elective surgical laparoscopic surgery
- ASA physical status I–III
- Provided written informed consent

Exclusion Criteria

Patients were excluded if they:

- Required emergency surgery
- Had ASA physical status IV or V
- Had known severe cardiopulmonary instability
- Underwent conversion to open surgery at induction
- Refused to provide informed consent

Preoperative Assessment

All patients underwent thorough preoperative evaluation including:

- Detailed medical history and physical examination
- Assessment of comorbidities (hypertension, diabetes mellitus, asthma/COPD, CKD, CLD, ischemic heart disease)
- Routine laboratory investigations
- ASA physical status classification

Anaesthetic Technique

All patients received general anaesthesia with endotracheal intubation. Standard monitoring was applied in all cases, including:

- Electrocardiography (ECG)
- Non-invasive blood pressure (NIBP)
- Pulse oximetry
- Capnography ($EtCO_2$)

Anaesthesia was induced using standard intravenous agents and maintained with inhalational anaesthetics, opioids, muscle relaxants, and controlled mechanical ventilation. Ventilatory parameters were adjusted to maintain $EtCO_2$ within normal physiological range.

Intraoperative Management and Data Collection

Pneumoperitoneum was established using carbon dioxide (CO_2). Intraoperative data collected included:

- Duration of surgery
- Duration of anaesthesia
- Duration of pneumoperitoneum
- Mean arterial pressure (MAP)
- Heart rate
- $EtCO_2$ levels

Intraoperative complications such as hypotension, tachycardia, bradycardia, hypercapnia, oxygen desaturation, and need for conversion to open surgery were recorded.

For analysis, patients were categorized into two groups based on pneumoperitoneum duration:

- Group A: <120 minutes
- Group B: ≥120 minutes

Postoperative Assessment

Postoperative outcomes were assessed in the post-anaesthesia care unit (PACU) and included:

- Time to extubation
- Duration of PACU stay
- Postoperative pain using Visual Analogue Scale (VAS) at 6 and 24 hours
- Anaesthesia-related complications such as postoperative nausea and vomiting (PONV), sore throat, shoulder tip pain, shivering, and delayed recovery

Length of hospital stay and perioperative mortality were also recorded.

Statistical Analysis

All data were entered and analyzed using the Statistical Package for Social Sciences (SPSS-27) software. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequency and percentage. The independent sample t-test was used to compare continuous variables between groups, and the Chi-square test was applied for comparison of categorical variables. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Institutional Review Board (IRB) of the study institution. Written informed consent was obtained from all participants prior to enrolment. Patient confidentiality was maintained throughout the study, and participants were allowed to withdraw at any stage without any effect on their treatment.

RESULTS

A total of 110 patients undergoing elective surgical laparoscopic procedures were included in this study.

Baseline Characteristics of the Study Participants

Table I shows the baseline characteristics of the study participants. The mean age of the patients was 47.9 ± 12.8 years, with the majority (47.3%) belonging to the 41–60 years age group. Patients aged ≤40 years constituted 29.1%, while 23.6% were older than 60 years. Most of the participants were male (80.0%), resulting in a male-to-female ratio of approximately 4:1. Regarding physical status classification, nearly half of the patients (47.3%) were classified as ASA II, followed by ASA I (36.4%) and ASA III (16.3%).

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Table I: Baseline Characteristics of Study Participants (*n* = 110)

Variables	Frequency (n)	Percentage (%)
Age (years)		
≤40	32	29.1
41–60	52	47.3
>60	26	23.6
Mean ± SD	47.9 ± 12.8	
Sex		
Male	88	80.0
Female	22	20.0
ASA Classification		
ASA I	40	36.4
ASA II	52	47.3
ASA III	18	16.3

Distribution of Comorbidities

As shown in *Table II*, hypertension was the most common comorbidity (32.7%), followed by diabetes mellitus (26.4%). Respiratory diseases, including asthma and COPD, were present in 10.9% of patients. Chronic kidney disease and chronic liver disease were observed in 8.2% and 5.5% of patients, respectively. Ischemic heart disease was reported in 7.3% of cases. However, 38.2% of patients had no documented comorbid conditions.

Table II: Distribution of Comorbidities (*n* = 110)

Comorbidities	Frequency (n)	Percentage (%)
Hypertension	36	32.7
Diabetes Mellitus	29	26.4
Asthma/COPD	12	10.9
Chronic Kidney Disease (CKD)	9	8.2
Chronic Liver Disease (CLD)	6	5.5
Ischemic Heart Disease	8	7.3
No Comorbidity	42	38.2

Types and Duration of Laparoscopic Procedures

Table III illustrates Laparoscopic Cholecystectomy was the most common (84; 76.37%), followed by Laparoscopic Appendicectomy (14; 12.73%) and Laparoscopic Burst Appendix (6; 5.46%). Laparoscopic Hernioplasty and Cystectomy were rare (3 each; 2.72%). This indicates that gallbladder surgeries predominated in the laparoscopic series. The mean duration of surgery was 128.6 ± 36.4 minutes, and the mean duration of anaesthesia was 152.3 ± 39.8 minutes.

Table III: Types of Laparoscopic Procedures (*n* = 110)

Procedure Type	Frequency (n)	Percentage (%)
Laparoscopic Cholecystectomy	84	76.37
Laparoscopic Appendicectomy	14	12.73
Laparoscopic Burst appendix	6	5.46
Laparoscopic Hernioplasty	3	2.72
Laparoscopic cystectomy	3	2.72

Intraoperative Anaesthetic Parameters

Table IV presents intraoperative anaesthetic parameters. The mean intraoperative MAP was 84.9 ± 8.7 mmHg, heart rate was 79.1 ± 10.6 bpm, and $EtCO_2$ level was 39.2 ± 3.8 mmHg. Transient hypotension was the most common intraoperative complication, occurring in 20.0% of patients. Tachycardia and bradycardia were observed in 13.6% and 6.4% of patients, respectively. Hypercapnia occurred in 10.9% of cases, while oxygen desaturation and conversion to open surgery were noted in 4.5% of patients each. All complications were managed successfully without major cardiopulmonary instability.

Table IV: Intraoperative Anaesthetic Parameters

Variables	Mean ± SD / n (%)
Mean Arterial Pressure (mmHg)	84.9 ± 8.7
Heart Rate (bpm)	79.1 ± 10.6
$EtCO_2$ (mmHg)	39.2 ± 3.8
Hypotension	22 (20.0)
Hypercapnia	12 (10.9)
Oxygen Desaturation	5 (4.5)

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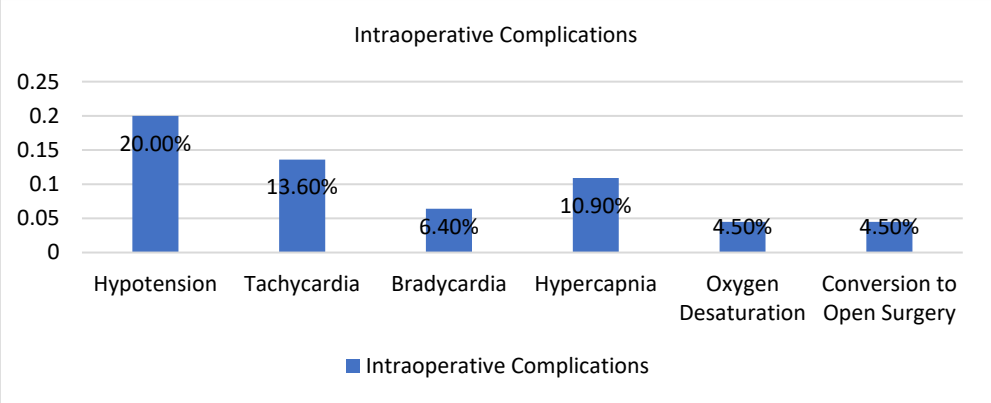

Figure 1: Intraoperative Complications (*n* = 110)

Intraoperative Complications

Figure 1 presents intraoperative complications observed during the procedures. The distribution of intraoperative complications showed that hypotension was the most frequently observed event, occurring in 20.0% of patients. Tachycardia was the second most common complication (13.6%), followed by hypercapnia (10.9%). Bradycardia was comparatively less common, observed in 6.4% of cases. Oxygen desaturation and conversion to open surgery were relatively rare, each occurring in 4.5% of patients. Overall, most complications were transient and manageable, with no major life-threatening cardiopulmonary instability reported.

Postoperative Anaesthetic Outcomes

Table V presents the mean extubation time was 10.8 ± 3.9 minutes, and the mean PACU stay was 69.4 ± 16.8 minutes. The average hospital stay was 3.6 ± 1.4 days. The mean VAS pain score was 3.4 ± 1.2 at 6 hours and decreased to 2.2 ± 0.8 at 24 hours postoperatively. Postoperative nausea and vomiting (PONV) were the most frequent complication (20.9%), followed by sore throat (17.3%), shoulder tip pain (15.5%), shivering (13.6%), and delayed recovery (9.1%). No perioperative mortality or re-intubation was recorded.

Table V: Postoperative Outcomes (*n* = 110)

Variables	Mean ± SD / n (%)
Extubation Time (minutes)	10.8 ± 3.9
PACU Stay (minutes)	69.4 ± 16.8
Hospital Stay (days)	3.6 ± 1.4
VAS Score (6 hours)	3.4 ± 1.2
VAS Score (24 hours)	2.2 ± 0.8
PONV	23 (20.9)
Sore Throat	19 (17.3)
Shoulder Tip Pain	17 (15.5)
Shivering	15 (13.6)
Delayed Recovery	10 (9.1%)

Association Between Duration of Pneumoperitoneum and Outcomes

Table VI compares anaesthetic outcomes according to the duration of pneumoperitoneum. Patients with pneumoperitoneum duration ≥120 minutes had significantly higher rates of hypercapnia (16.7% vs. 6.5%, p=0.027) and intraoperative hypotension (29.2% vs. 12.9%, p=0.024) compared to those with duration <120 minutes. Although tachycardia was more frequent in the ≥120 minutes group (18.8% vs. 9.7%), the difference was not statistically significant (p=0.156). In addition, prolonged pneumoperitoneum was associated with significantly longer extubation time (12.4 ± 4.2 vs. 9.6 ± 3.1 minutes, p=0.001) and longer PACU stay (75.6 ± 18.5 vs. 64.8 ± 14.2 minutes, p=0.001). Pain scores at 6 hours were also significantly higher in patients with pneumoperitoneum ≥120 minutes (3.8 ± 1.3 vs. 3.1 ± 1.0, p=0.002).

Table VI: Comparison of Anaesthetic Outcomes According to Duration of Pneumoperitoneum (*n* = 110)

Variables	<120 min (n=62), n(%)	≥120 min (n=48), n (%)	Test Value	p-value
Hypercapnia, n (%)	4 (6.5)	8 (16.7)	$\chi^2 = 4.89$	0.027*
Intraoperative Hypotension, n (%)	8 (12.9)	14 (29.2)	$\chi^2 = 5.12$	0.024*
Tachycardia, n (%)	6 (9.7)	9 (18.8)	$\chi^2 = 2.01$	0.156
Extubation Time (min), Mean ± SD	9.6 ± 3.1	12.4 ± 4.2	t = 3.87	0.001*
PACU Stay (min), Mean ± SD	64.8 ± 14.2	75.6 ± 18.5	t = 3.52	0.001*
VAS at 6 hours, Mean ± SD	3.1 ± 1.0	3.8 ± 1.3	t = 3.15	0.002*

**Statistically significant at $p < 0.05$*
Chi-square test applied for categorical variables; Independent sample t-test applied for continuous variables.

DISCUSSION

The average age was 47.9 ± 12.8 years, indicating a dominance of middle-aged patients and corresponding with worldwide trends of rising laparoscopic surgery in this demographic [15]. Males constituted 80%, indicating institutional and regional differences in laparoscopic case mix even though females dominate in certain procedures [16]. The majority of patients were categorized as ASA II which reflects mild systemic diseases common in elective laparoscopic procedures; elevated ASA classification is associated with greater perioperative risks and complications [17].

Hypertension and diabetes were the most prevalent comorbid conditions in this study undergoing laparoscopy. In agreement with Matin et al. (2003), comorbid conditions raise perioperative risk, whereas patients free of comorbidities experience improved outcomes. Respiratory, renal, hepatic, and cardiac issues, while not as common, still necessitate thorough preoperative optimization [18].

In this study, the most prevalent procedures were laparoscopic, aligning with other studies that emphasize renal, abdominal and reconstructive surgeries as common laparoscopic surgical interventions [7,8,19]. The average operative and anesthesia durations align with published studies, indicating a somewhat longer surgery time than open procedures while offering advantages in recovery and morbidity [20].

In this study group, average intraoperative arterial pressure, heart rate, and $EtCO_2$ indicate standard physiological alterations due to pneumoperitoneum and CO_2 insufflation during laparoscopic surgery [21]. Transient hypotension was the most prevalent intraoperative occurrence, while other cardiopulmonary variations were seen less often. According to Srisawat et al. (2018) these intraoperative variations can influence postoperative results such as acute kidney injury, emphasizing the importance of thorough monitoring and timely intervention [22].

Intraoperative hypotension was the most frequently occurring event, succeeded by tachycardia, hypercapnia, and bradycardia, while oxygen desaturation and switching to open surgery were uncommon. In agreement with Montes et al. (2015), these complications are typically temporary and can be controlled with careful oversight during laparoscopic procedures [23].

Postoperative recovery following laparoscopic surgery was positive, marked by brief extubation, PACU, and hospital durations, showcasing the advantages of minimally invasive techniques. Pain levels were mild, aligning with efficient analgesic management [12]. PONV was the most frequent complication (20.9%), succeeded by sore throat, shoulder tip discomfort, and shivering, all temporary and manageable. There were no instances of perioperative mortality or re-intubation, indicating the safety of laparoscopic surgeries [24].

Pneumoperitoneum lasting ≥120 min raised hypercapnia, hypotension, extubation/PACU durations, and initial pain levels. Reducing these risks can be achieved with brief insufflation and meticulous intraoperative management [25].

In general, laparoscopy is both safe and efficient, leading to quick recovery and mostly temporary complications, although extended pneumoperitoneum heightens physiological strain and lengthens recovery duration.

CONCLUSION

This study concludes that laparoscopic procedures under general anaesthesia are generally safe and well tolerated in ASA I–III patients. Intraoperative complications were mostly transient, with hypotension being the most common event. Postoperative outcomes were satisfactory, and no perioperative mortality was observed. However, prolonged pneumoperitoneum (≥120 minutes) was significantly associated with increased hypercapnia, hypotension, delayed extubation, and longer PACU stay. Careful monitoring and optimized anaesthetic management are essential, particularly in prolonged procedures.

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