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Frequency of Intraoperative Complications in Patients Undergoing Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy is the standard treatment for gallstone disease, offering advantages such as reduced postoperative pain, shorter hospital stays, and faster recovery. Despite being considered safe, intraoperative complications such as liver bed injury, bleeding from Calot's triangle, trocar site bleeding, and bile leakage can occur and may influence surgical outcomes. Limited regional data exist regarding the frequency and risk factors of these complications in Peshawar. **Objective:** To find out the frequency of intra operative complication in patients undergoing laparoscopic cholecystectomy. **Study Design:** Descriptive observational study. **Duration and Place of Study:** The study was conducted in the Department of General Surgery, Lady Reading Hospital, Peshawar, from December 2024 to May 2025. **Methodology:** A total of 236 patients aged 18–65 years undergoing laparoscopic cholecystectomy were included through consecutive non-probability sampling. Patients with obstructive jaundice, gallbladder malignancy, or pregnancy were excluded. Complications were documented intraoperatively as liver bed injury, bleeding from Calot's triangle, trocar site bleeding, or bile leakage. **Results:** Among 236 patients (mean age 41.18±13.86 years, 66.5% female), the frequencies of complications were: liver bed injury 8.1%, bleeding from Calot's triangle 4.7%, trocar site bleeding 8.1%, and bile leakage 7.2%. Significant associations were found between liver bed injury and age ≤45 years (p=0.030), bile leakage and female gender (p=0.049), bleeding complications and BMI >25 kg/m^2 (p=0.008, p=0.006), and higher rates of liver bed injury and Calot's bleeding in rural patients (p=0.015, p=0.026). **Conclusion:** Intraoperative complications during laparoscopic cholecystectomy occur with acceptable frequencies but are significantly influenced by age, gender, BMI, and place of residence, emphasizing the importance of careful preoperative assessment and surgical precision.

INTRODUCTION

Laparoscopic cholecystectomy has progressed to become by far the most frequently performed surgical intervention for cholelithiasis and other gallbladder diseases.[1] The reason for it is that small incisions in the belly are enough for insertion of trocars such that minimal tissue injury results along with less postoperative nociception, less time inpatient, and speedier convalescence.[2] At this procedure, instruments through which vision is conducted by an endoscopic camera are passed through peritoneal cavity trocars by which visualization and removal of gallbladder are achieved.[2] Advanced instruments and advanced operative techniques have converted this operation to one that is largely safe. Yet it is not absolutely without intraoperative risks. During intervention, some complications do develop which at times make conversion to open cholecystectomy essential or postoperative recuperative phase longer.[3]

Of these intraoperative complications, hepatic bed injury and bleeding from Calot's area are of clinical significance.[4] Hepatic bed injury is most commonly noticed in dissection from gallbladder and leads to intraoperative bleeding along with postoperative hemoperitoneum or serous collection.[4] Minor bleeding will result in successful hemostasis by electrocauterization or by direct compression, while major bleeding from torn vessels would necessitate suturing or by application of topical hemostatic agent.[5] Similarly, bleeding from Calot's area from cystic artery or from one of its subsidiary branches is one among the larger surgical challenges.[6] This one is encountered more frequently among patients with acute cholecystitis in whom inflammatory changes obscure the difference in anatomy.[6] Under such circumstances, bleeding prolongs operative time and increases likelihood of wrongful identification of anatomical landmarks and hence escalates iatrogenic bile duct injury.[7]

Other serious clinical complications include bleeding from the insertion site for the trocar and leakage from the

gallbladder.[8] During trocar insertion, laceration by abdominal wall vessels such as the inferior epigastric artery may hematoma the rectus sheath or necessitate open surgical conversion.[8] Correspondingly, leakage from bile most commonly follows iatrogenic injury to gallbladder wall from traction or dissection.[9] The resultant spill over contaminates the surgical site and clouds vision through the laparoscope by obscurations from chemical pericarditis or by encouraging postoperative or intra-abdominal collection of abscess.[9] Preventive measures in form of prudent laparoscopic dissection and use of endoscopic bag for removal will reduce such complications, but these intraoperative situations serve to underscore importance in terms of proper surgical precision and operative skill in cholecystectomy by laparoscopy.[10]

According to the study by Agarwal and Joshi, the reported frequencies of intraoperative complications in patients undergoing laparoscopic cholecystectomy were hepatic bed injury (7%), hemorrhage from Calot's region (4%), trocar site bleeding (7%), and bile leakage from the gallbladder (6%).[11]

Gallstone disease is a common surgical condition in Peshawar, for which laparoscopic cholecystectomy is currently the standard surgical intervention. However, intraoperative complications such as hepatic bed injury, bleeding from Calot's zone, trocar site bleeding, and bile leakage are nonetheless clinically relevant and have the ability to lead to morbidity along with open surgery conversion. Though fairly common in occurrence, minimal regional evidence from Peshawar is available regarding documentation of the pattern and burden of these intraoperative complications. That such a study is performed is essential in terms of providing evidence specific to regional surgical practice, maximizing operative safety, and informing measures for preventive mitigation for optimal patient outcomes.

METHODOLOGY

The study was conducted in the General Surgery Department of Lady Reading Hospital, Peshawar, over a six-month period from December 2024 to May 2025. A descriptive design was employed to evaluate the frequency of complications occurring during laparoscopic cholecystectomy, which is defined as the surgical removal of the gallbladder through small abdominal incisions using a camera and specialized instruments, providing a minimally invasive approach. Ethical approval was obtained from the hospital's ethical review committee as well as the Research Department of the College of Physicians and Surgeons Pakistan, Karachi, ensuring compliance with established ethical standards. A total of 236 patients were included, calculated using the WHO sample size calculator based on a predicted frequency of intraoperative complications—specifically bleeding from Calot's triangle—of 4%,[11] with an absolute precision of 2.5% and a confidence level of 95%. Patients were recruited using consecutive non-probability sampling to include all eligible candidates undergoing laparoscopic cholecystectomy during the study period.

Participants comprised men and women aged 18 to 65 years scheduled for laparoscopic cholecystectomy. Patients were excluded if they had obstructive jaundice, gallbladder malignancy, or were pregnant. Informed consent was obtained from all participants after explaining the purpose, procedures, and minimal risks of the study. Demographic details were collected. A detailed history and physical examination were performed for each patient. All surgical procedures and assessments of complications were supervised by a consultant with at least five years of post-fellowship experience.

Complications during surgery were documented based on direct observation. Liver bed injury was recorded if lacerations or bleeding were observed in the liver during gallbladder dissection. Bleeding from Calot's triangle was identified when active hemorrhage was seen from vessels in this anatomical region. Trocar site bleeding was noted if hemorrhage occurred at the site of trocar insertion. Bile leakage was recorded when visible escape of bile occurred from the gallbladder or bile ducts during manipulation. The presence of any of these findings indicated that an intraoperative complication had occurred. Data analysis was performed using SPSS version 25. Categorical variables were presented as frequencies and percentages. Continuous variables were assessed for normality using the Shapiro-Wilk test and reported as mean ± standard deviation or median with interquartile range as appropriate. Confounding factors were controlled through stratification. Post-stratification, the Chi-square or Fisher's exact test was applied to assess associations, with a p-value of ≤0.05 considered statistically significant.

RESULTS

The study analyzed 236 patients undergoing laparoscopic cholecystectomy with a mean age of 41.18±13.86 years and mean BMI of 25.66±2.58 kg/m^2, with surgery duration averaging 46.28±8.65 minutes. The cohort comprised 79 males (33.5%) and 157 females (66.5%), with 128 patients (54.2%) from urban areas and 108 (45.8%) from rural areas. Histopathological examination revealed acute cholecystitis in 79 patients (33.5%) and chronic cholecystitis in 157 patients (66.5%) (as shown in Table 1).

Table 1

Patient Demographics

Demographics		Mean ± SD
Age (Years)		41.18±13.86
BMI (kg/m^2)		25.66±2.58
Duration of Surgery (min)		46.28±8.65
Gender	Male n (%)	79 (33.5%)
	Female n (%)	157 (66.5%)
Place of Living	Urban n (%)	128 (54.2%)
	Rural n (%)	108 (45.8%)
Histopathology	Acute n (%)	79 (33.5%)
	Chronic n (%)	157 (66.5%)

Regarding intraoperative complications, liver bed injury occurred in 19 patients (8.10%) while 217 patients (91.90%) had no liver bed injury, bleeding from Calot's triangle occurred in 11 patients (4.70%) while 225 patients (95.30%) had no bleeding from Calot's triangle, trocar site bleeding occurred in 19 patients (8.10%) while 217 patients (91.90%) had no trocar site bleeding, and bile leakage occurred in 17 patients (7.20%) while 219

patients (92.80%) had no bile leakage (as shown in Table 2).

Table 2

Frequency of Intraoperative Complications in Patients Undergoing Laparoscopic Cholecystectomy

Intraoperative Complications		Frequency	% age
Liver Bed Injury	Yes	19	8.10%
	No	217	91.90%
Bleeding from Calots	Yes	11	4.70%
	No	225	95.30%
Trocar Site Bleeding	Yes	19	8.10%
	No	217	91.90%
Bile Leakage	Yes	17	7.20%
	No	219	92.80%

Statistical analysis of patient factors revealed significant associations between age groups and complications. For patients ≤45 years versus >45 years, liver bed injury occurred in 14 patients (12.3%) versus 5 patients (4.1%) respectively (p=0.030), bleeding from Calot's triangle occurred in 2 patients (1.8%) versus 9 patients (7.4%) respectively (p=0.061), trocar site bleeding occurred in 6 patients (5.3%) versus 13 patients (10.7%) respectively (p=0.128), and bile leakage occurred in 7 patients (6.1%) versus 10 patients (8.2%) respectively (p=0.541). Gender analysis showed that in males versus females, liver bed injury occurred in 4 patients (5.1%) versus 15 patients (9.6%) respectively (p=0.313), bleeding from Calot's triangle occurred in 4 patients (5.1%) versus 7 patients (4.5%) respectively (p=1.000), trocar site bleeding occurred in 7 patients (8.9%) versus 12 patients (7.6%) respectively (p=0.746), and bile leakage occurred in 2 patients (2.5%) versus 15 patients (9.6%) respectively (p=0.049). BMI analysis comparing patients with BMI ≤25 kg/m^2 versus >25 kg/m^2 showed liver bed injury in 8 patients (8.5%) versus 11 patients (7.7%) respectively (p=0.833), bleeding from Calot's triangle in 0 patients (0.0%) versus 11 patients (7.7%) respectively (p=0.008), trocar site bleeding in 2 patients (2.1%) versus 17 patients (12.0%) respectively (p=0.006), and bile leakage in 10 patients (10.6%) versus 7 patients (4.9%) respectively (p=0.097). Surgery duration analysis comparing ≤40 minutes versus >40 minutes showed liver bed injury in 2 patients (3.2%) versus 17 patients (9.8%) respectively (p=0.104), bleeding from Calot's triangle in 0 patients (0.0%) versus 11 patients (6.3%) respectively (p=0.071), trocar site bleeding in 2 patients (3.2%) versus 17 patients (9.8%) respectively (p=0.171), and bile leakage in 2 patients (3.2%) versus 15 patients (8.6%) respectively (p=0.251). Place of living analysis comparing urban versus rural patients showed liver bed injury in 5 patients (3.9%) versus 14 patients (13.0%) respectively (p=0.015), bleeding from Calot's triangle in 2 patients (1.6%) versus 9 patients (8.3%) respectively (p=0.026), trocar site bleeding in 10 patients (7.8%) versus 9 patients (8.3%) respectively (p=0.884), and bile leakage in 13 patients (10.2%) versus 4 patients (3.7%) respectively (p=0.076). Histopathological analysis comparing acute versus chronic cholecystitis showed liver bed injury in 7 patients (8.9%) versus 12 patients (7.6%) respectively (p=0.746), bleeding from Calot's triangle in 4 patients (5.1%) versus 7 patients (4.5%) respectively (p=1.000), trocar site bleeding in 7 patients (8.9%) versus 12 patients (7.6%) respectively (p=0.746), and bile leakage in 2 patients (2.5%) versus 15 patients (9.6%) respectively (p=0.061) (as shown in Table 3).

Table 3

Association of Intraoperative Complications with Patient Factors

Patient Factors		Liver Bed Injury		p-value	Bleeding from Calots		p-value	Trocar Site Bleeding		p-value	Bile Leakage		p-value
		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)	
Age (years)	≤45	14 (12.3%)	100 (87.7%)	0.030*	2 (1.8%)	112 (98.2%)	0.061*	6 (5.3%)	108 (94.7%)	0.128	7 (6.1%)	107 (93.9%)	0.541
	>45	5 (4.1%)	117 (95.9%)		9 (7.4%)	113 (92.6%)		13 (10.7%)	109 (89.3%)		10 (8.2%)	112 (91.8%)	
Gender	Male	4 (5.1%)	75 (94.9%)	0.313	4 (5.1%)	75 (94.9%)	1.000	7 (8.9%)	72 (91.1%)	0.746	2 (2.5%)	77 (97.5%)	0.049*
	Female	15 (9.6%)	142 (90.4%)		7 (4.5%)	150 (95.5%)		12 (7.6%)	145 (92.4%)		15 (9.6%)	142 (90.4%)	
BMI (kg/m^2)	≤25	8 (8.5%)	86 (91.5%)	0.833	0 (0.0%)	94 (100.0%)	0.008*	2 (2.1%)	92 (97.9%)	0.006*	10 (10.6%)	84 (89.4%)	0.097
	>25	11 (7.7%)	131 (92.3%)		11 (7.7%)	131 (92.3%)		17 (12.0%)	125 (88.0%)		7 (4.9%)	135 (95.1%)	
Duration of Surgery (min)	≤40	2 (3.2%)	60 (96.8%)	0.104	0 (0.0%)	62 (100.0%)	0.071*	2 (3.2%)	60 (96.8%)	0.171	2 (3.2%)	60 (96.8%)	0.251
	>40	17 (9.8%)	157 (90.2%)		11 (6.3%)	163 (93.7%)		17 (9.8%)	157 (90.2%)		15 (8.6%)	159 (91.4%)	
Place of Living	Urban	5 (3.9%)	123 (96.1%)	0.015*	2 (1.6%)	126 (98.4%)	0.026*	10 (7.8%)	118 (92.2%)	0.884	13 (10.2%)	115 (89.8%)	0.076
	Rural	14 (13.0%)	94 (87.0%)		9 (8.3%)	99 (91.7%)		9 (8.3%)	99 (91.7%)		4 (3.7%)	104 (96.3%)	
Histopathology	Acute	7 (8.9%)	72 (91.1%)	0.746	4 (5.1%)	75 (94.9%)	1.000	7 (8.9%)	72 (91.1%)	0.746	2 (2.5%)	77 (97.5%)	0.061
	Chronic	12 (7.6%)	145 (92.4%)		7 (4.5%)	150 (95.5%)		12 (7.6%)	145 (92.4%)		15 (9.6%)	142 (90.4%)	

DISCUSSION

The present study demonstrates that intraoperative complications during laparoscopic cholecystectomy occur with varying frequencies, with liver bed injury and trocar site bleeding being the most common at 8.10% each, followed by bile leakage at 7.20% and bleeding from Calot's triangle at 4.70%. These complication rates fall within the acceptable range reported in contemporary laparoscopic surgery, indicating that the procedure maintains its safety profile when performed by experienced surgeons. The significant association between younger age (≤45 years) and increased liver bed injury (12.3% vs 4.1%, p=0.030) can be attributed to the typically more inflamed and friable gallbladder tissue in younger patients with acute inflammatory conditions, making dissection more challenging and increasing the risk of inadvertent liver capsule damage during separation of the gallbladder from its bed. The higher incidence of bile leakage in females compared to males (9.6% vs 2.5%, p=0.049) may be explained by anatomical differences, including smaller bile duct caliber and variations in the intrahepatic biliary tree architecture, which can predispose to ductal injury during dissection of Calot's triangle. The strong correlation between elevated BMI (>25 kg/m^2) and both bleeding from Calot's triangle (7.7% vs 0.0%, p=0.008) and trocar site bleeding (12.0% vs 2.1%,

p=0.006) reflects the technical challenges posed by increased visceral adiposity, which obscures anatomical landmarks, requires higher insufflation pressures, and necessitates more forceful tissue manipulation, thereby increasing vascular trauma risk. Rural patients exhibited significantly higher rates of liver bed injury (13.0% vs 3.9%, p=0.015) and bleeding from Calot's triangle (8.3% vs 1.6%, p=0.026), likely due to delayed presentation resulting in more advanced inflammatory changes, increased adhesion formation, and tissue fibrosis that complicates surgical dissection planes and increases the likelihood of inadvertent tissue damage.

The complication rates observed in our study demonstrate both concordance and variation when compared with existing literature on laparoscopic cholecystectomy outcomes. Our liver bed injury rate of 8.10% falls within the range reported by similar studies, with Bharai et al. [12] reporting 5.83%, Agarwal et al. [11] documenting 7%, and Rahman et al. [13] noting 7%, while Rooh-ul-Muqim et al. [14] reported a slightly higher rate of 11.11%. This consistency across multiple centers suggests that liver bed injury remains a predictable technical challenge during laparoscopic dissection, particularly when anatomical planes are obscured by inflammation or adhesions. Our bleeding from Calot's triangle rate of 4.70% aligns closely with Agarwal et al. [11] who reported 4%, though Rooh-ul-Muqim et al. [14] documented a considerably higher rate of 16.23%, possibly reflecting differences in surgical experience or patient selection criteria, as surgeon expertise has been shown to significantly impact complication rates with experienced surgeons demonstrating lower conversion rates.[15]

The trocar site bleeding frequency of 8.10% in our study corresponds well with Rahman et al. [13] (8%) and is comparable to Bharai et al. [12] (9.16%) and Rooh-ul-Muqim et al. [14] (9.97%), suggesting this complication occurs consistently across different populations and surgical settings. Our bile leakage rate of 7.20% is higher than most reported studies, with Agarwal et al. [11] reporting 6%, Bharai et al. [12] documenting 5%, and Rahman et al. [13] noting 5%, while Rooh-ul-Muqim et al. [14] reported 3.98%. This variation may be attributed to differences in case complexity, surgeon experience, or detection sensitivity, as bile leaks can range from minor self-limiting collections to major ductal injuries requiring surgical intervention.

Our finding of increased complications in rural patients (liver bed injury 13.0% vs 3.9% urban, bleeding from Calot's triangle 8.3% vs 1.6% urban) reflects a pattern observed in developing countries where rural populations often present with more advanced disease due to delayed healthcare access, similar to findings in studies from Pakistan [14,16,17] and India [11,12,15] where patient demographics and disease severity at presentation significantly influenced surgical outcomes. The significant association between higher BMI and increased complications (bleeding from Calot's triangle 7.7% vs 0.0% for BMI >25 vs ≤25, trocar site bleeding 12.0% vs 2.1%) is supported by technical challenges described in multiple studies, where increased adiposity creates visualization difficulties and requires higher insufflation pressures, leading to more traumatic tissue handling.

The gender-based difference in bile leakage (9.6% females vs 2.5% males) observed in our study contrasts with most literature where gender-specific complication patterns are less pronounced, though this finding may reflect anatomical variations in bile duct caliber and branching patterns that predispose females to ductal injury during dissection. Our age-related finding of higher liver bed injury in younger patients (12.3% ≤45 years vs 4.1% >45 years) differs from typical expectations where older patients generally have higher complication rates, but may be explained by the acute inflammatory nature of cholecystitis in younger patients, creating more friable tissue planes and increased technical difficulty during dissection, a pattern that aligns with studies focusing on acute cholecystitis where inflammation severity directly correlates with surgical complexity.[16,17]

The present study has several limitations that should be acknowledged. As a single-center study, the findings may not be entirely generalizable to other healthcare settings with different patient populations, surgical expertise levels, or institutional protocols. The sample size of 236 patients, while adequate for statistical analysis, may limit the power to detect less common complications or subtle associations between patient factors and outcomes. The study design did not account for surgeon-specific factors such as years of experience, training background, or individual surgical volumes, which have been demonstrated to significantly influence complication rates in laparoscopic cholecystectomy. Additionally, the lack of stratification based on case complexity, such as the degree of inflammation, presence of adhesions, or anatomical variants, may have influenced the interpretation of risk factors associated with specific complications.

CONCLUSION

Our study has concluded that intraoperative complications during laparoscopic cholecystectomy occur with acceptable frequencies, with liver bed injury and trocar site bleeding being the most common complications, followed by bile leakage and bleeding from Calot's triangle. The analysis revealed significant associations between patient-specific factors and complication rates, demonstrating that younger age is associated with increased liver bed injury, female gender predisposes to bile leakage, higher body mass index correlates with bleeding complications, and rural residence is linked to higher rates of liver bed injury and bleeding from Calot's triangle.

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