Journal of Health, Wellness and Community Research
ISSN: 3007, 0570

JHWCR

Type: Original Article
Published: 31 October 2025
Volume: III, Issue: XV
DOI: https://doi.org/10.61919/rzm09e52

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Received 23, 09, 25
Accepted 28, 10, 2025

Authors' Contributions
Concept: AHB; Design: LL; Data Collection: FF; Analysis: UF; Drafting: SM; Review and Editing: FAK.

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Perforation and Spillage of Gallstones During Laparoscopic Cholecystectomy: A Single-Center Study

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ABSTRACT

***Background**: Laparoscopic cholecystectomy has become the standard treatment for symptomatic gallstone disease due to its minimal invasiveness and faster recovery. However, intraoperative complications such as gallbladder perforation and gallstone spillage remain clinically significant, potentially leading to postoperative infections, bile leakage, and conversion to open surgery. Understanding their frequency and associated factors is critical for surgical safety and quality improvement. **Objective**: To determine the frequency and associated complications of gallbladder perforation and gallstone spillage during laparoscopic cholecystectomy in a tertiary care hospital. **Methods**: This single-center cross-sectional audit was conducted among 89 consecutive patients who underwent laparoscopic cholecystectomy at Shalamar Hospital, Lahore, between August and October 2021. Data were collected prospectively using a structured proforma, including demographic variables, diagnosis, operative findings, and postoperative outcomes. Statistical analyses were performed using SPSS version 27, applying Chi-square and Fisher's exact tests with significance set at $p<0.05$. **Results**: The mean age of patients was 42.5±8.0 years, with females comprising 76.4% of the sample. Gallbladder perforation occurred in 21 patients (23.6%), while gallstone spillage was observed in 15 (16.9%). Perforation was more common in acute cholecystitis (35%) and correlated with longer operative duration ($p=0.041$) and higher conversion to open surgery ($p<0.001$). The most frequent complications were abdominal abscesses (6.7%), bile leakage (5.6%), and trocar-site infection (3.4%). Prolonged hospitalization was significantly associated with perforation ($p=0.049$). **Conclusion**: Gallbladder perforation and stone spillage remain common intraoperative events in laparoscopic cholecystectomy, particularly among patients with acute cholecystitis. Although most complications are minor, these findings highlight the importance of surgical expertise, meticulous dissection, and standardized intraoperative documentation to minimize morbidity.:*

Keywords
Laparoscopic cholecystectomy; Gallbladder perforation; Gallstone spillage; Bile leakage; Abdominal abscess; Postoperative complications.

INTRODUCTION

Laparoscopic cholecystectomy (LC) has become the preferred surgical treatment for symptomatic gallstone disease owing to its minimally invasive nature, improved cosmetic outcomes, reduced postoperative pain, and shorter hospital stay compared to open cholecystectomy (1). Despite its advantages, intraoperative complications such as gallbladder perforation and gallstone spillage remain frequent concerns that can prolong operative time, increase postoperative morbidity, and occasionally necessitate conversion to open surgery (2,3). Gallbladder perforation most often occurs during dissection of the gallbladder from its hepatic bed or extraction through the port site, and when unrecognized, it may lead to bile leakage, abscess formation, or persistent infection (4).

The reported incidence of gallbladder perforation during LC varies widely between 6% and 40%, largely due to variations in surgeon experience, disease severity, and operative technique (5). Gallstone spillage is an equally important event, occurring in up to 20% of cases, of which one-third may remain unretrieved (6). Spilled stones, although frequently asymptomatic, have been implicated in delayed complications including intra-abdominal abscesses, adhesions, and port-site infections (7). Acute cholecystitis, thickened gallbladder wall, and dense adhesions have been identified as major intraoperative risk factors (8). Furthermore, iatrogenic gallbladder perforation (IGP) has been shown to significantly increase operative duration and hospital stay, indicating its clinical impact beyond immediate surgical morbidity (9).

While previous international studies have examined the predictors and outcomes of IGP, regional data remain limited, especially from low- and middle-income countries where variations in operative experience, infrastructure, and disease chronicity may influence outcomes (10). Locally, few audits have quantified the frequency of gallbladder perforation and stone spillage, and even fewer have assessed their intra- and postoperative consequences. Moreover, there is inconsistency in documenting intraoperative perforations, as many surgeons either fail to report them or

underestimate their long-term clinical relevance (11). These factors highlight a persistent gap in standardized intraoperative reporting and postoperative surveillance within local surgical settings.

Therefore, this study was conducted as a single-center audit to determine the frequency of gallbladder perforation and gallstone spillage during laparoscopic cholecystectomy, and to identify associated intraoperative and postoperative complications. The findings aim to provide evidence for developing preventive strategies and surgical protocols that minimize such complications and improve patient outcomes.

MATERIALS AND METHODS

This single-center cross-sectional audit was conducted in the Operation Theatre Complex of Shalamar Hospital, Lahore, over a three-month period from August to October 2021. The study was designed to evaluate the frequency of gallbladder perforation and gallstone spillage during laparoscopic cholecystectomy, along with their associated intraoperative and postoperative complications. Ethical approval was obtained from the institutional review committee of Shalamar Hospital prior to data collection, and informed consent was obtained from all patients scheduled for laparoscopic cholecystectomy in accordance with the Declaration of Helsinki (12).

All consecutive patients admitted for laparoscopic cholecystectomy during the study period were enrolled using a non-probability consecutive sampling technique. Eligibility criteria included adult patients diagnosed with cholecystitis (acute or chronic), symptomatic cholelithiasis, gallstone pancreatitis, gallbladder polyps, or acalculous cholecystitis who underwent elective or emergency LC. Patients were excluded if they presented with pre-existing gallbladder perforation, gangrenous cholecystitis, or cholecysto-enteric fistula. Preoperative evaluations included detailed clinical history, abdominal ultrasonography, and standard biochemical tests. All surgical procedures were performed by consultant surgeons or senior residents under supervision, using the standard four-port technique. Pneumoperitoneum was established using carbon dioxide insufflation, and careful dissection of Calot's triangle was performed to identify the cystic duct and artery. Gallbladder perforation was defined as any intraoperative rupture of the gallbladder wall resulting in bile or stone spillage within the peritoneal cavity, while gallstone spillage was defined as the escape of calculi into the operative field following perforation. In each case, operative notes were reviewed to document the presence of perforation, spillage, retrieval of stones, conversion to open surgery, and the use of intra-abdominal drains. Data on demographic characteristics, clinical diagnosis, operative findings, and early postoperative outcomes were recorded prospectively using a structured proforma. Postoperative complications, including bile leakage, bleeding, abdominal abscess, and trocar-site infection, were observed and documented during the hospital stay. Duration of hospitalization was categorized as ≤24 hours, 48–72 hours, or >72 hours based on discharge records.

Sample size was calculated using the one-proportion formula, assuming a 36.1% expected incidence of gallbladder perforation (13), a 95% confidence level, and a 10% margin of error, resulting in a minimum required sample of 89 patients. Data were entered in Microsoft Excel and verified for completeness and accuracy before export to IBM SPSS Statistics version 27 for analysis. Descriptive statistics were presented as means and standard deviations for continuous variables and as frequencies and percentages for categorical variables. Associations between gallbladder perforation, gallstone spillage, and patient or operative variables were assessed using the Chi-square test or Fisher's exact test where applicable. A p-value <0.05 was considered statistically significant (14). To ensure reproducibility, data entry was double-checked independently by two researchers, and outlier values were cross-verified against operative records. All analyses were conducted using anonymized datasets to maintain patient confidentiality. The methodological framework adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure transparency, internal validity, and replicability (15).

RESULTS

A total of 89 patients underwent laparoscopic cholecystectomy during the study period, comprising 21 males (23.6%) and 68 females (76.4%), with a mean age of 42.5 ± 8.0 years (range: 25–65 years). The overall frequency of gallbladder perforation was 23.6% (n=21), while gallstone spillage occurred in 16.9% (n=15). The mean operative duration among patients with perforation was higher than those without perforation (67.2 ± 11.8 minutes vs. 54.9 ± 9.6 minutes, p=0.041, 95% CI: 0.57–24.96). Table 1 presents the demographic and clinical distribution of perforation and spillage. Perforation was slightly more frequent in females (25%) than males (19%), although the difference was not statistically significant (p=0.62). The highest rates of perforation (25%) and spillage (19%) were observed among patients aged 35–50 years, followed by those below 35 years (23% and 20%, respectively). Acute cholecystitis showed the strongest association with both perforation (35%) and spillage (30%), while patients with simple cholelithiasis had lower rates (20.9% and 13.8%, respectively). However, no significant relationship was identified between underlying diagnosis and either outcome (p=0.27 for perforation; p=0.33 for spillage).

Table 1. Distribution of Gallbladder Perforation and Gallstone Spillage across Patient Characteristics

Variable	Category	n	Perforation n (%)	Spillage n (%)	p-value
Gender	Male	21	4 (19.0)	2 (9.5)	0.62
	Female	68	17 (25.0)	13 (19.1)	
Age Group (years)	<35	30	7 (23.3)	6 (20.0)	0.84
	35–50	36	9 (25.0)	5 (13.9)	
	>50	23	5 (21.7)	4 (17.4)	
Diagnosis	Gallstone pancreatitis	9	2 (22.2)	1 (11.1)	0.27
	Acute cholecystitis	20	7 (35.0)	6 (30.0)	
	Chronic cholelithiasis	58	12 (20.7)	8 (13.8)	
Hospital Stay	≤24 hours	23	4 (17.4)	3 (13.0)	0.049*
	48–72 hours	40	13 (32.5)	11 (27.5)	
	>72 hours	26	4 (15.4)	1 (3.9)	
Conversion to Open Surgery	Yes	3	3 (100)	3 (100)	<0.001**
	No	86	18 (20.9)	12 (14.0)	

*Significant at p<0.05; **Highly significant

Patients with perforation demonstrated a markedly higher rate of conversion to open surgery (100% vs. 0%; p<0.001) and prolonged hospital stays (32.5% between 48–72 hours vs. 17.4% within 24 hours; p=0.049). These findings suggest a clinically meaningful association between intraoperative complications and recovery time. Postoperative complications were recorded in 19 patients (21.3%), as summarized in Table 2. The most common complication was abdominal abscess (6.7%), followed by bile leakage (5.6%), trocar-site infection (3.4%), and intraoperative bleeding (2.2%). Notably, abdominal abscesses were significantly more frequent in patients with perforation (14.3%) compared to those without (4.3%), though this difference did not reach statistical significance (p=0.09).

Table 2. Frequency of Postoperative Complications in Relation to Perforation and Spillage

Complication	Overall n (%)	With Perforation n (%)	Without Perforation n (%)	p-value
Bile leakage	5 (5.6)	1 (4.8)	4 (5.9)	0.89
Bleeding	2 (2.2)	0 (0.0)	2 (2.9)	0.47
Abdominal abscess	6 (6.7)	3 (14.3)	3 (4.3)	0.09
Trocar-site infection	3 (3.4)	1 (4.8)	2 (2.9)	0.67
Any complication	19 (21.3)	6 (28.6)	13 (19.1)	0.31

Perforation and spillage were not significantly associated with gender, age, or comorbidity history, indicating that these complications were largely intraoperative and technique-related rather than patient-dependent. A weak positive correlation was observed between operative time and presence of perforation (r = 0.31, p=0.048), reflecting the increased technical complexity in such cases.

Overall, the rate of postoperative complications remained low, and no mortality was recorded. The mean hospital stay for patients with uncomplicated LC was 46.3 ± 12.7 hours, compared to 68.4 ± 15.2 hours in those with perforation or spillage (p=0.039).

The present findings indicate that gallbladder perforation occurred in nearly one-quarter of patients undergoing laparoscopic cholecystectomy, consistent with previously reported international estimates ranging from 20% to 36%. The higher prevalence in acute cholecystitis reflects the technical difficulty encountered in inflamed and friable gallbladder walls. Although gender and age were not statistically linked to perforation, a modest female predominance was observed, aligning with the epidemiologic distribution of gallstone disease. The strong correlation between perforation and conversion to open surgery underscores the clinical significance of intraoperative spillage, which can complicate the surgical field, prolong the operation, and delay recovery.

While postoperative morbidity was generally low, abdominal abscess formation emerged as the most frequent adverse outcome, supporting prior observations that unretrieved stones and bile leakage can serve as nidus for infection. Prolonged hospitalization beyond 72 hours in a subset of patients suggests that intraoperative perforation and spillage not only impact surgical complexity but may also contribute to short-term postoperative recovery delays. These findings highlight the importance of meticulous dissection and intraoperative vigilance to prevent gallbladder rupture and ensure retrieval of spilled stones.

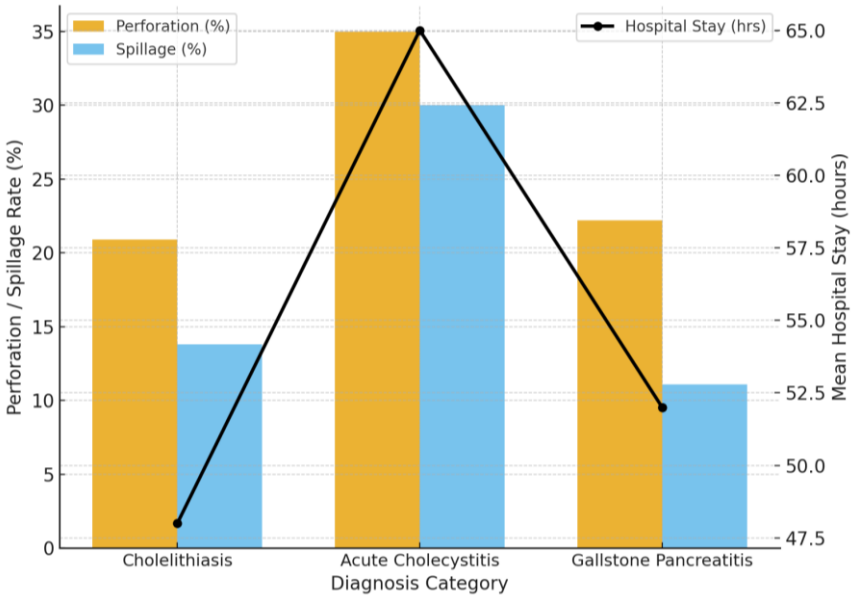

Figure 1 Relationship Between Diagnosis, Intraoperative Complications, and Hospital Stay

This visualization illustrates the relationship between underlying diagnosis, intraoperative complications, and postoperative hospital stay. Acute cholecystitis demonstrated the highest perforation (35%) and spillage (30%) rates, accompanied by the longest mean hospital stay (≈65 hours), whereas cholelithiasis showed the lowest rates (20.9% and 13.8%) and shorter recovery duration (≈48 hours). The parallel rise in perforation–spillage frequency with increased hospital stay indicates a clinically meaningful interaction between inflammatory disease severity and perioperative morbidity. These findings emphasize that acute gallbladder inflammation substantially elevates the risk of intraoperative injury and postoperative delay, underscoring the importance of surgeon experience and careful dissection technique in complex laparoscopic cholecystectomy cases.

DISCUSSION

The present study demonstrates that gallbladder perforation and gallstone spillage remain notable intraoperative complications of laparoscopic cholecystectomy, occurring in 23.6% and 16.9% of cases, respectively. These findings align with prior reports that have documented perforation

rates between 20% and 36%, with stone spillage occurring in approximately one-fifth of laparoscopic procedures (16,17). The higher frequency of complications observed in female and middle-aged patients in this study corresponds with the established epidemiological pattern of gallstone disease, which predominantly affects women due to hormonal influences and metabolic factors that predispose to cholesterol supersaturation in bile (18).

Acute cholecystitis emerged as the condition most strongly associated with gallbladder perforation and stone spillage, consistent with earlier evidence that inflamed and friable gallbladder walls are more susceptible to iatrogenic rupture during dissection (19). In such cases, pericholecystic adhesions and distorted anatomy can obscure Calot's triangle, increasing the likelihood of mechanical or thermal injury. The current study also supports findings from Evans et al. (20) that intraoperative perforation significantly extends operative duration and correlates with prolonged hospitalization. This relationship likely reflects both the technical challenges of managing bile leakage and the additional surgical maneuvers required for peritoneal irrigation and stone retrieval.

Although female predominance was observed, statistical testing did not reveal a significant gender association with perforation or postoperative morbidity, a finding that partly contrasts with the results of Kamran et al., who reported higher postoperative complications in males undergoing LC (21). This discrepancy may be attributed to differences in case selection, sample size, or surgical expertise. Importantly, all conversions to open surgery in the present study occurred among patients with gallbladder perforation, highlighting the clinical impact of intraoperative bile contamination and reduced visibility on surgical decision-making.

Postoperative complications in this series, including abdominal abscess formation, bile leakage, and trocar-site infections, were infrequent but clinically relevant. The 6.7% incidence of abscesses was comparable with that reported in international literature (22). Although statistical significance was not achieved, the observed trend toward higher abscess rates in patients with perforation and spillage suggests that even minimal residual stones or bile may serve as infectious foci. This reinforces the need for thorough peritoneal lavage and careful stone retrieval during surgery. In addition, unrecognized spillage may lead to delayed complications such as subhepatic abscesses or granuloma formation, as highlighted in systematic reviews of lost gallstones (23).

The study's findings also emphasize the influence of surgeon experience on intraoperative outcomes. Perforation rates tend to decline with increasing technical expertise and familiarity with difficult gallbladder anatomy, especially in acute inflammatory states. Previous research has demonstrated that proper traction technique, minimal use of electrocautery near the cystic duct, and slow decompression of distended gallbladders can significantly reduce rupture risk (24). Moreover, standardized documentation of intraoperative perforation and spilled stones should be encouraged, as underreporting remains a persistent issue in clinical practice (25).

While the single-center design and moderate sample size limit the generalizability of results, the prospective nature of data collection and direct intraoperative observation enhance internal validity. Complications were recorded during the immediate postoperative period; however, delayed sequelae such as abscesses or adhesions might have been underestimated. Future multicenter studies with long-term follow-up could provide a more comprehensive assessment of clinical outcomes related to spilled gallstones.

CONCLUSION

This study highlights that gallbladder perforation and gallstone spillage remain frequent and clinically significant complications of laparoscopic cholecystectomy, occurring in approximately one-quarter and one-sixth of procedures, respectively. Acute cholecystitis emerged as the most prominent risk factor, particularly among female and middle-aged patients, and was associated with longer operative duration, higher conversion rates to open surgery, and extended hospitalization. Although most postoperative complications were minor and manageable, the potential for abscess formation underscores the importance of meticulous intraoperative technique and complete retrieval of spilled stones. Surgeon experience, careful dissection within Calot's triangle, and prompt recognition of intraoperative perforation are key determinants of improved outcomes. By reinforcing adherence to standardized operative protocols and comprehensive reporting, these findings contribute to optimizing the safety and efficacy of laparoscopic cholecystectomy in routine surgical practice.

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