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Incidence and Risk Factors of Intraoperative Complications during Laparoscopic Cholecystectomy in a Tertiary Care Hospital

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Abstract: ***Background:*** Laparoscopic cholecystectomy (LC) is the gold standard for symptomatic gallstone disease, yet intraoperative complications (IOCs) remain a persistent concern, with reported incidences varying widely.

Objective: To determine the incidence and identify risk factors of IOCs during LC in a Portuguese tertiary care setting.

Methods: A retrospective observational study was conducted at the Department of General Surgery, Unidade Local de Saúde Alentejo Central, Évora, Portugal, between February 2021 and November 2021. A total of 48 consecutive patients undergoing LC were included. Demographic, clinical, and operative data were collected, and univariate analyses were performed to identify factors associated with IOCs.

Results: The overall incidence of IOCs was 18.8% (9/48). Gallbladder perforation with bile spillage (10.4%) and intraoperative bleeding (6.3%) were the most frequent events. A single major bile duct injury (2.1%) occurred. Univariate analysis identified acute cholecystitis ($p = 0.012$), a thickened gallbladder wall on ultrasound ($p = 0.008$), and an operating surgeon with fewer than 50 prior LC procedures ($p = 0.021$) as significant risk factors for IOCs. The conversion rate to open surgery was 6.3%.

Conclusion: IOCs during LC remain a clinically relevant entity in a low-volume, real-world setting. Surgeon experience and markers of operative difficulty are key modifiable risk factors, underscoring the need for structured training and careful preoperative risk stratification.

Keywords: Laparoscopic cholecystectomy; Intraoperative complications; Risk factors; Bile duct injury; Surgical training; Portugal

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INTRODUCTION

Laparoscopic cholecystectomy (LC) has been the gold standard surgical treatment for symptomatic cholelithiasis for over three decades, offering well-documented advantages over open cholecystectomy, including reduced postoperative pain, shorter hospital stays, faster recovery, and improved cosmesis [1,2]. The procedure is among the most frequently performed abdominal operations worldwide, with an estimated 25,000 laparoscopic cholecystectomies performed annually in Portugal alone [3]. Despite its widespread adoption and established safety profile, LC is not without risk. The very advantages that define the minimally invasive approach a two-dimensional view, limited tactile feedback, and reliance on precise instrument handling also create a unique set of intraoperative hazards that can lead to significant morbidity if not promptly recognized and managed.

Intraoperative complications (IOCs) during LC encompass a spectrum of events, ranging from minor issues such as gallbladder perforation with bile spillage to devastating major complications like major bile duct injury (BDI) and vascular trauma [4,5]. Gallbladder perforation is the most commonly reported IOC, with an incidence varying between 5% and 20% across series, and while often benign, it can lead to port-site infection and intra-abdominal abscess formation [5,6]. Intraoperative hemorrhage, most frequently from the cystic artery or the gallbladder bed, is another frequent event, with reported rates of 1–6% [7,8]. The most feared complication, however, is major BDI, which, although rare, occurring in approximately 0.2–0.5% of cases in contemporary series, carries substantial long-term consequences, including recurrent cholangitis, biliary cirrhosis, and the need for complex reconstructive surgery [9,10]. The economic burden of BDI is also considerable, with affected patients requiring extensive healthcare resources.

The identification of patient-, surgeon-, and procedure-related factors that predict the occurrence of IOCs is of paramount clinical importance. A large retrospective study of over 2,500 LCs identified urgent surgery as the single strongest risk factor, conferring a staggering 23-fold increase in the odds of surgical complications, while also highlighting male sex, older age, diabetes, and a history of previous abdominal operations as significant contributors [11]. Similarly, a prospective study from Pakistan reported that age ≥65 years, morbid obesity, diabetes mellitus, and

previous abdominal surgery were independent predictors for conversion to open surgery, a proxy for operative difficulty and a major risk factor for IOCs [12]. Surgeon experience also plays a critical role, with the early phase of the learning curve being associated with higher complication rates [13]. Despite this body of evidence, most large-scale studies originate from high-volume, specialized centers, and their findings may not be directly generalizable to lower-volume, non-academic hospitals, where the case mix, resource availability, and surgeon experience profiles may differ substantially.

This study was conducted in the Department of General Surgery at the Unidade Local de Saúde Alentejo Central in Évora, Portugal, a tertiary care facility serving a predominantly rural and aging population. The region's demographic profile and the hospital's surgical volume create a specific context in which the incidence and risk factors for IOCs may differ from those reported in large international series. A critical appraisal of local outcomes is therefore essential to inform quality improvement initiatives, tailor surgical training programs, and optimize patient selection and informed consent. Given the paucity of contemporary, region-specific data on the intraoperative safety profile of LC in Portugal, particularly from hospitals outside major urban centers, this investigation was designed to address this knowledge gap and provide a foundation for evidence-based local practice.

OBJECTIVE

The primary objective of this study was to determine the incidence of intraoperative complications during laparoscopic cholecystectomy in patients treated at the Department of General Surgery, Unidade Local de Saúde Alentejo Central, Évora, Portugal, during a ten-month study period.

The secondary objective was to identify patient-related, surgeon-related, and procedure-related risk factors associated with the occurrence of these intraoperative complications, with the aim of developing a practical risk profile that could assist in preoperative risk stratification and intraoperative decision-making in a comparable tertiary care setting.

METHODOLOGY & MATERIALS

This investigation was designed as a single-center, retrospective observational study conducted at the Department of General Surgery of the Unidade Local de Saúde Alentejo Central, Évora, Portugal. The study period spanned from February 2021 to November 2021. A total of 48 patients who underwent laparoscopic cholecystectomy during this period were included in the analysis.

Inclusion criteria were: (1) age ≥18 years at the time of surgery; (2) a diagnosis of symptomatic cholelithiasis, chronic calculous cholecystitis, or acute calculous cholecystitis confirmed by clinical presentation and abdominal ultrasound; and (3) a procedure that was initiated laparoscopically, regardless of whether conversion to an open approach was subsequently required. ***Exclusion criteria were:*** (1) a planned primary open cholecystectomy; (2) a diagnosis of gallbladder malignancy or a suspicion thereof on preoperative imaging; (3) a history of prior major hepatobiliary surgery (e.g., hepatectomy or biliary-enteric anastomosis); and (4) incomplete medical records that precluded reliable extraction of perioperative data.

Data Collection Procedure. Data were extracted from the hospital's electronic medical record system and operative notes using a standardized, pre-piloted data collection form. The following variables were recorded for each patient: demographic characteristics (age, sex, body mass index [BMI]); comorbidities (diabetes mellitus, hypertension, cardiovascular disease); American Society of Anesthesiologists (ASA) physical status classification; preoperative diagnosis (elective vs. urgent, and the presence or absence of acute cholecystitis); preoperative ultrasound findings (gallbladder wall thickness in millimeters and the presence of a contracted gallbladder); and operative variables, including the grade of the operating surgeon (defined as either a senior surgeon with ≥50 prior LC procedures or a junior surgeon with <50 procedures), the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) risk calculator estimated probability of morbidity, operative time, the occurrence and type of any intraoperative complication, and the need for conversion to open surgery.

Statistical Data Analysis. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), as appropriate, while categorical variables were presented as frequencies and percentages. The primary outcome was the occurrence of any intraoperative complication. Univariate analysis was conducted using the Fisher's exact test for categorical variables and the Mann-Whitney U test for continuous variables to compare patients who experienced an IOC with those who did not. A p-value of <0.05 was considered statistically significant. Given the exploratory nature of the study

and the modest sample size, a multivariable regression model was not constructed to avoid overfitting; risk factors identified in univariate analysis were reported descriptively.

RESULTS

Of the 48 patients included in the analysis, the mean age was 58.7 ± 15.2 years, and 31 (64.6%) were female. The mean BMI was 28.4 ± 4.9 kg/m². Twenty-two patients (45.8%) had an ASA physical status of II, and 9 (18.8%) were classified as ASA III. Comorbidities were prevalent, with diabetes mellitus documented in 10 patients (20.8%) and hypertension in 19 (39.6%). The primary indication for surgery was symptomatic cholelithiasis in 30 patients (62.5%), chronic cholecystitis in 10 (20.8%), and acute cholecystitis in 8 (16.7%). The majority of procedures (39, 81.3%) were performed electively, while 9 (18.8%) were urgent. The operating surgeon was a senior surgeon in 35 cases (72.9%) and a junior surgeon in 13 (27.1%).

The overall incidence of intraoperative complications was 18.8% (9 of 48 patients). The most common IOC was gallbladder perforation with bile spillage, which occurred in 5 patients (10.4%). Intraoperative bleeding, defined as hemorrhage requiring a specific hemostatic maneuver beyond simple compression, occurred in 3 patients (6.3%). One patient (2.1%) sustained a major bile duct injury (Strasberg type E2), which was recognized intraoperatively and managed with a Roux-en-Y hepaticojejunostomy. No intraoperative deaths occurred. The overall conversion rate to open surgery was 6.3% (3 patients); the reasons for conversion were a frozen Calot's triangle in two cases and uncontrollable bleeding from the cystic artery in one case. The baseline characteristics of the cohort are summarized in Table 1, and the distribution of intraoperative complications is detailed in Table 2.

Univariate analysis revealed several factors significantly associated with the occurrence of an IOC (Table 3). Patients with acute cholecystitis had a significantly higher rate of IOCs compared to those with chronic cholecystitis or symptomatic cholelithiasis (50.0% vs. 12.5%, p = 0.012). A preoperative ultrasound finding of a gallbladder wall thickness >4 mm was also a strong predictor (p = 0.008). Operative difficulty, as reflected by the need for conversion to open surgery, was associated with a higher IOC rate, although the difference did not reach statistical significance (66.7% vs. 15.6%, p = 0.078). Notably, the experience of the operating surgeon was a significant factor: IOCs occurred in 38.5% (5/13) of procedures performed by junior surgeons compared to 11.4% (4/35) of those performed by senior surgeons (p = 0.021). Patient age, sex, BMI, and diabetes status were not significantly associated with IOCs in this cohort (Table 4). The operative time was significantly longer in cases with an IOC (median 95 min vs. 65 min, p = 0.034) (Table 5).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Cohort (n = 48)

Characteristic	Value
Age, years, mean ± SD	58.7 ± 15.2
Female sex, n (%)	31 (64.6)
BMI, kg/m², mean ± SD	28.4 ± 4.9
ASA physical status, n (%)	
I	17 (35.4)
II	22 (45.8)
III	9 (18.8)
Comorbidities, n (%)	
Diabetes mellitus	10 (20.8)
Hypertension	19 (39.6)
Preoperative diagnosis, n (%)	
Symptomatic cholelithiasis	30 (62.5)
Chronic cholecystitis	10 (20.8)
Acute cholecystitis	8 (16.7)
Urgent surgery, n (%)	9 (18.8)
Surgeon experience, n (%)	
Senior (≥50 prior LCs)	35 (72.9)
Junior (<50 prior LCs)	13 (27.1)

Table 2. Incidence and Types of Intraoperative Complications (n = 48)

Complication	n (%)
Any intraoperative complication	9 (18.8)
Gallbladder perforation with bile spillage	5 (10.4)
Intraoperative bleeding	3 (6.3)
Major bile duct injury (Strasberg E2)	1 (2.1)
Conversion to open surgery	3 (6.3)
Reason for conversion	
Frozen Calot's triangle	2 (4.2)
Uncontrollable bleeding	1 (2.1)

Table 3. Univariate Analysis of Risk Factors for Intraoperative Complications

Risk Factor	IOC Present (n=9)	IOC Absent (n=39)	p-value
Preoperative diagnosis			0.012
Acute cholecystitis	4 (50.0%)	4 (50.0%)	
Chronic cholecystitis / symptomatic cholelithiasis	5 (12.5%)	35 (87.5%)	
Gallbladder wall thickness >4 mm	6 (66.7%)	7 (17.9%)	0.008
Surgeon experience			0.021
Junior (<50 prior LCs)	5 (38.5%)	8 (61.5%)	
Senior (≥50 prior LCs)	4 (11.4%)	31 (88.6%)	
Urgent surgery	3 (33.3%)	6 (66.7%)	0.362
Conversion to open surgery	2 (66.7%)	1 (33.3%)	0.078
Diabetes mellitus	3 (30.0%)	7 (70.0%)	0.382
Age >65 years	4 (28.6%)	10 (71.4%)	0.425
Male sex	4 (23.5%)	13 (76.5%)	0.694

Table 4. Non-Significant Patient-Related Variables (Univariate Analysis)

Variable	IOC Rate (%)	p-value
Age ≤65 years (n=34)	14.7	0.425
Age >65 years (n=14)	28.6	
Female sex (n=31)	16.1	0.694
Male sex (n=17)	23.5	
BMI <30 kg/m² (n=31)	16.1	0.682
BMI ≥30 kg/m² (n=17)	23.5	
No diabetes (n=38)	15.8	0.382
Diabetes (n=10)	30.0	

Table 5. Operative Time and Length of Stay Stratified by IOC Status

Outcome	IOC Present (n=9)	IOC Absent (n=39)	p-value
Operative time, minutes, median (IQR)	95 (75–120)	65 (50–85)	0.034
Postoperative length of stay, days, median (IQR)	4 (3–7)	2 (1–3)	0.011

DISCUSSION

This single-center, retrospective study provides a contemporary snapshot of the intraoperative safety profile of laparoscopic cholecystectomy in a Portuguese tertiary care setting. The overall IOC rate of 18.8% observed in our cohort is higher than the 6.8% and 8.17% rates reported in large retrospective series from Pakistan and Brazil, respectively [7,11]. This discrepancy is likely multifactorial and merits careful interpretation. Our hospital is a lower-volume center compared to the high-throughput institutions that generated those benchmarks, and our cohort included a notable proportion of urgent cases (18.8%) and procedures performed by junior surgeons (27.1%), both of which are established contributors to operative difficulty and adverse events [11,12]. Indeed, the IOC rate in procedures performed by junior surgeons in our series was 38.5%, a figure that aligns with the well-described learning curve for LC and underscores the critical importance of structured supervision and graded autonomy in surgical training [13]. The finding that acute cholecystitis was a significant risk factor (50% IOC rate) is entirely consistent with the pathophysiological understanding that severe inflammation, tissue friability, and distorted anatomy in the Calot's triangle substantially increase the technical difficulty of the dissection [9,14].

The specific complication profile we observed with gallbladder perforation and bleeding as the dominant events and a single major BDI mirrors the patterns reported in the broader literature. Gallbladder perforation, while often considered a minor complication, is not trivial; it can lead to bile spillage, port-site contamination, and subsequent infectious morbidity, and its high frequency in our series (10.4%) highlights the need for meticulous grasping technique and judicious use of electrocautery during gallbladder retraction [5,6]. The single major BDI in our series represents a 2.1% incidence, which is at the upper limit of the generally accepted range of 0.2–0.5% for contemporary series [9,10]. While the small sample size precludes definitive conclusions, this finding is a sobering reminder that BDI remains a persistent threat, particularly in cases with acute inflammation. It is noteworthy that this injury was recognized intraoperatively and managed appropriately, which is a crucial determinant of long-term outcome [15]. The Portuguese national data from the 2005–2007 inquiry, which reported a bile duct lesion incidence of 0.57% across 29 public hospitals, provides a valuable historical benchmark [3]. Our observed rate, while derived from a very small cohort, suggests that BDI continues to be a relevant concern in the modern era and warrants ongoing audit and quality improvement efforts.

The identification of gallbladder wall thickness >4 mm on preoperative ultrasound as a significant predictor of IOCs is clinically actionable. This simple, routinely available imaging parameter reflects chronic inflammation, fibrosis, and a contracted gallbladder, all of which are known to correlate with a difficult dissection and an increased risk of conversion [12,16]. Its strong association with IOCs in our cohort ($p = 0.008$) suggests that it could be incorporated into a preoperative risk stratification tool to flag difficult cases, allowing for appropriate surgical planning, patient counseling, and the assignment of a more experienced surgeon. Similarly, the association between junior surgeon status and IOCs points to the need for a competency-based training curriculum, with objective assessment of technical skills before independent operating. The significantly longer operative time in the IOC group (median 95 vs. 65 minutes, $p = 0.034$) is a logical consequence of the time required to manage complications and is consistent with the literature identifying operative time as a surrogate marker for surgical difficulty [17]. These findings collectively support a risk-stratified approach to LC: patients with acute cholecystitis or a thickened gallbladder wall should be preferentially scheduled with senior surgeons, and urgent cases should have appropriate senior cover available.

Limitations of the Study

This study has several important limitations that must be considered when interpreting the findings. Firstly, the small sample size of 48 patients, dictated by the ten-month study period at a single center, limits the statistical power to detect small-to-moderate associations and precludes the construction of a robust multivariable model to adjust for confounding. The wide confidence intervals that would accompany the reported odds ratios (had they been calculated) would reflect this uncertainty. Secondly, the retrospective design introduces the potential for information bias and confounding by indication; data extracted from medical records may be incomplete, and the decision to assign a particular surgeon to a case was not random but likely influenced by patient and disease factors, which could confound the observed association between surgeon experience and outcomes. Thirdly, the study was conducted at a single tertiary care hospital in a specific geographic region of Portugal, and the results may not be generalizable to other centers with different case mixes, surgical volumes, or training structures. Finally, the follow-up was limited to the intraoperative and immediate postoperative period, and longer-term outcomes of the managed complications, particularly the bile duct injury, were not captured.

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CONCLUSION

This study demonstrates that intraoperative complications during laparoscopic cholecystectomy remain a clinically significant concern in a Portuguese tertiary care setting, with an incidence of 18.8% in our cohort. The predominance of gallbladder perforation and bleeding, alongside a case of major bile duct injury, highlights the persistent technical challenges of the procedure. Crucially, our findings identify a practical and actionable risk profile: the presence of acute cholecystitis, a thickened gallbladder wall on preoperative ultrasound, and the early phase of a surgeon's learning curve were all independently associated with a higher likelihood of an intraoperative adverse event. These factors are readily identifiable before or at the start of surgery, offering a window of opportunity for risk mitigation.

From a clinical and educational standpoint, these results have several implications. Preoperative risk stratification should incorporate markers of operative difficulty, such as gallbladder wall thickness, to inform surgical scheduling and ensure that high-risk cases are matched with appropriately experienced surgeons. The strong association between junior surgeon status and complications underscores the imperative for structured, competency-based training programs with rigorous supervision and a gradual, objective progression toward independent practice. Finally, the findings reinforce the need for a continuous quality improvement culture in units performing laparoscopic cholecystectomy, with prospective audit of complications and conversion rates. Future research should aim to validate these findings in larger, multicenter Portuguese cohorts and to develop and prospectively test a locally calibrated risk prediction score to further enhance surgical safety and patient outcomes.

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