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Evaluation Of Risk Factors and Clinical Outcome Of Accidental Gall Bladder Perforation During Laparoscopic Cholecystectomy.

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Abstract

General Background: Laparoscopic cholecystectomy is the gold standard procedure for symptomatic gallstone disease, yet accidental gallbladder perforation remains a frequent intraoperative complication associated with bile and gallstone spillage. **Specific Background:** Previous studies discussing the postoperative consequences of gallbladder perforation during laparoscopic cholecystectomy have reported inconsistent findings regarding operative and clinical outcomes. **Knowledge Gap:** Limited evidence has comprehensively evaluated both the predisposing risk factors and postoperative outcomes of accidental intraoperative gallbladder perforation in elective laparoscopic cholecystectomy. **Aims:** This study aimed to investigate the risk factors and clinical outcomes associated with accidental gallbladder perforation during laparoscopic cholecystectomy. **Results:** A prospective comparative observational study involving 210 patients identified that older age, male gender, higher body mass index, diabetes mellitus, ischemic heart disease, previous abdominal surgery, and acute-on-chronic cholecystitis weresignificantly associated with gallbladder perforation. Most perforations occurred during separation from the liver bed (75%). Patients with perforation experienced higher rates of postoperative ileus, prolonged operative time, prolonged hospitalstay, port-siteinfection, and intra-abdominalabscess. **Novelty:** This study provides a comparative clinical evaluation integrating demographic characteristics, medical history, operative findings, and postoperative complications related to accidental gallbladder perforation during laparoscopic cholecystectomy. **Implications:** The findings emphasize the importance of identifying high-risk patients and applying meticulous surgical techniques to reduce perforation-related morbidity, prolonged hospitalization, postoperative infection, and increased healthcare burden.

Highlights:
- Older age, male gender, obesity, diabetes mellitus, and previous abdominal surgery were major predictors of intraoperative gallbladder perforation.
- Separation of the gallbladder from the liver bed represented the most frequent stage of perforation occurrence during surgery.
- Accidental perforation was associated with ileus, longer operative duration, extended hospitalization, and higher postoperative infection rates.

Keywords: Acute Cholecystitis, Gallbladder Perforation, Laparoscopic Cholecystectomy, Postoperative Complications; Surgical Risk Factors

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1. Introduction

Gallbladder inflammation is referred to as " cholecystitis, Cholecystitis is best treated surgically, Gallstones are present in about 95% of patients with cholecystitis, As the prevalence of age increases development of gallstones increases, and females are more susceptible to gallstones more than males [1] Laparoscopic cholecystectomy is the gold standard treatment of symptomatic gallstone disease. It offers an unquestionable advantage over open cholecystectomy to the patient and the health care system. It was introduced in the late 1980s and quickly gained popularity among patients with symptomatic gallstones. It has a clear advantage over the traditional approach with decreased morbidity, less pain ,and quicker recovery; however, it remains associated with a three- to five-fold increase in bile duct injury (BDI).

Moreover, the traditional absolute contraindications for laparoscopic cholecystectomy in certain specialized situations have largely been resolved and rendered relative, including the presence of acute cholecystitis, a history of previous abdominal surgery, morbid obesity, pregnancy, cirrhosis, and even situs inversus total is, Operative conversion from Laparoscopic cholecystectomy to open cholecystectomy is 1%-15%.

Two previous reviews agreed on only two important risk factors when considering conversion, namely, male gender and old age. Acute cholecystitis, a gallbladder wall thickness > 3 mm, and a history of previous surgeries are all predictive factors for conversion [2]. One of the prevailing complications of LC, which is less addressed in the literature, is gallbladder perforation. The rate of gallbladder perforation differs from 1.3% to 40% (2). Moreover, gallbladder perforation is increasing in frequency because of increased efforts to perform minimally invasive surgery, which has limited the visual field and mobility of the surgical instruments, Gallbladder perforation can lead to gallstone spillage and, in many cases, an unsuccessful retrieval of the stones. Several studies have demonstrated the effect of intraperitoneal contamination on the spillage of bile juice and gallstones. Previously the majority of surgeons believed that gallstone spillage during laparoscopic cholecystectomy is a benign complication and it does not justify conversion to laparotomy, even if a large number of gallstones remain in the abdomen, However ,some reports have demonstrated the complications of gallstone spillage, such as intraperitoneal abscesses, adhesions, small bowel obstruction, cutaneous fistulas ,and septicemia [2]. The leading causes of gallbladder perforation during LCs are injury to the gallbladder during diathermy dissection from the gallbladder fossa, traction injury to Hartmann's pouch, and extraction from the epigastric port. Gallbladder perforation causes an increase in the time of surgery, prolongation of postoperative hospital stay, and, an increase in the total hospital costs, this leads to a reduction of the advantages of LC compared with classic laparotomy. The average operative time was longer in the perforated group this was likely due to the time needed for abundant irrigation to get a clear aspiration and retrieve the gallstones. The postoperative hospital stay was also prolonged in the perforated group, as a result of increased pain and ileus, with constipation. There are a few studies on the correlation between gallbladder perforation and pain, which may result from irritation of the peritoneum due to the spillage of bile juice and gallstones [3] Statistically significant risk factors that lead to gallbladder perforation are the experience of the surgeon and the difficulty of the surgery (acute cholecystitis ,adhesions and previous surgery , pain before surgery >96 hours, and palpable gallbladder preoperatively. Patient factors include high BMI ,older age ,and systemic disease like DM and male gender . Although recent technical approaches and procedures were applied to dissect the gallbladder free from the liver bed such as ultrasonic dissector, harmonic scalpel diathermy, and laser instead of the standard dissection with monopolar electrocautery, but are not helpful in minimizing the risk of gallbladder perforation during the surgery .

The aim of the study

The present study was aimed to investigating the risk factors for accidental intraoperative gallbladder perforation during laparoscopic cholecystectomy and outcome.

Patients and Methods:

2. Methodology

It is a prospective comparative observational study designed to assess the risk factors of accidental gall bladder perforation and its outcome during laparoscopic cholecystectomy. The study was conducted at Al-Basrah Teaching Hospital, General Surgery Dept, spanning from January 2022 to September 2025.

A total of 210 participants who underwent elective laparoscopic cholecystectomy by different surgeons were enrolled in this study involving (100)participants who experienced accidental gall bladder perforation during the procedure compared with (110) participants who did not experience gall bladder perforation during the procedure.

Inclusion Criteria:

- Individuals aged 18 to 65 years

- Both male and female participants.

- Patients undergoing laparoscopic cholecystectomy for symptomatic gallstone disease.

Exclusion Criteria:

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- Patients with a history of biliary tract surgery.

- Patients with severe cardiopulmonary disease or other serious comorbidities.

- Patients who were converted to open cholecystectomy for other causes rather than gall bladder perforation.

- Patients with CBD stone.

- Patients with liver disease

- Patients with Acute pancreatitis .

Ethical approval was obtained from the Institutional Review Board the scientific council of the Iraqi Board of Health Specialization. All patients were fully informed and a written consent was taken. Also, a predesigned proforma which included: age, gender, stage at which gallbladder perforation occurred, operative time post-operative pain, postoperative complications(ileus, port site infection), and duration of hospital stay was made for all patients. Pre-operative evaluation includes the clinical assessment which focuses on detailed history- taking to understand the symptoms, the presence/absence of previous surgery; the experience of the operator (resident, surgeon), past medical history of Diabetes mellitus, Ischemic heart disease, hypertension, smoking and alcoholics, and allergies. This physical examination focuses on the abdominal region and specifically on the right upper quadrant tenderness, which is typical in gallbladder diseases, laboratory and Imaging Investigations that include: blood tests including (complete blood count, liver function tests, and coagulation profile), and imaging studies to assess the gallbladder and surrounding structures, and lastly the anesthesia assessment which had been evaluated by an anesthesiologist to assess the risk of anesthesia and to plan the anesthetic management.

Meanwhile, the post-operative evaluation included: immediate post-operative assessment (monitoring vital signs, pain, and signs of complications in the recovery room), and follow-up appointments, Port site infection is diagnosed based on clinical findings such as increased redness and pain with pus discharge .review any pathology reports(no malignancy), and monitor for any late complications. If required, conduct investigations such as blood tests or imaging to assess the liver and biliary tract.

The surgical procedures involved pre-operative preparation that focused on fasting for 8 hours. prophylactic antibiotics (ceftriaxone 1g) were administered one hour preoperatively. Classical laparoscopic cholecystectomy with four ports was performed, and in all patients with gallbladder perforation, bile was aspirated and irrigation of the gallbladder bed with sterile saline solution was done, removal of spilled stones, most gallbladders were removed from the epigastric port, with about seventeenth cases of accidentally perforated gallbladder tube drains inserted.

Operative time (in minutes): mean time starts from skin incision till finishing the skin closure. Postoperative hospital stay: means the number of days spent in the hospital from the day of the operation till the discharge of the patients to their homes .

Ilieus: failure of return of bowel functions after 48 hours after surgery

The surgeons assessed the suitability for discharge, considering the clinical symptoms. And continue to follow up with the patients.

Statistical analysis was performed using Statistical Package for the Social Sciences version 26 (SPSS Inc.). Categorical data were represented in numerical and percentage formats, and the distinctions among the groups were assessed using the chi-square test (X^2) and Fisher's exact test. A 95% confidence interval was used for statistical analysis, and p-values below 0.05 were regarded as statistically significant.

3. Results

The table compares two groups: patients with accidental intraoperative gallbladder perforation during laparoscopic cholecystectomy and those without gallbladder perforation during laparoscopic cholecystectomy. Significant differences were observed in age (mean

54.86 years in the accidentally perforated gall bladder group vs. 35.94 years in the non- perforated) and gender distribution (32% male in perforated vs 7% in the non-perforated group), with P values less than 0.001 indicating high statistical significance.

Table 1. Age, and Sex data distribution among the studied patients

Variables	Perforated G.B group	Non- Perforated G.B group	R. R	P value
Age (years) (Mean ±SD)	54.86±7.51	35.94±5.87	1.368*	<0.001

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Sex	Male	32 (32.0%)	7 (6.4%)	34.211	<0.001
	Female	68 (68.0%)	103 (93.6%)		

*Odd ratio

The table outlines predisposing risk factors for accidental gallbladder perforation during laparoscopic cholecystectomy. Key observations include a higher Body Mass Index (BMI) and increased prevalence of diabetes mellitus in the perforated group. No significant difference was noted in hypertension rates. Higher smoking rates were observed in the accidentally GB perforated group, but without statistical significance, similar to alcohol consumption. A notable correlation exists between prior abdominal surgeries and accidental intraoperative gallbladder perforation during laparoscopic cholecystectomy. Chronic cholecystitis is more common in the non-perforated group, while acute on chronic cases are exclusive to the perforated group, which also sees more frequent drain usage.

Table 2. Predisposing factors for accidental gall bladder perforation during LC

		G.B group	**G.B group**		
Body mass index (BMI) (Mean ±SD)		27.10-1.65	24.81-1.53	2.782*	<0.001
Past medical history	Diabetes mellitus (29)	23 (23.0	6 (5.5	3.475	<0.001
	Hypertension (21)	13 (13.0	8 (7.3	2.417	0.167
	Ischemic heart disease(11)	9 (9.0	2 (1.8	2.985	0.020
Smokers		10 (10.0%)	4 (3.6%)	1.893	0.065
Alcoholic		2 (2.0	1 (0.9	------	0.458
Past surgical history	Appendicectomy	19 (19.0%)	1 (0.9%)	3.154	<0.001
	Cesarean section	22 (22.0%)	2 (1.8%)	4.671	<0.001
	Abdominal hernia repair	28 (28.0%)	1 (0.9%)	5.951	<0.001
	Laparoscopic sleeve gastrectomy	6 (6.0	1 (0.9	3.759	0.04
Cholecystitis status	Acute on chronic	30 (30.0%)	0 (0.0%	2.571	<0.001
	Chronic	70 (70.0%	110 (100.0%)		

The table shows the frequency of accidental intraoperative gallbladder perforations during various surgical steps. The least frequent cause, occurring in only 3% of cases, is during the Callot Triangle dissection. Bile spillage during traction accounts for 8% of perforations. An accidental gall bladder perforation also occurs during gallbladder extraction from the epigastric port, contributing to 14% of cases. Notably, the majority (75%) of perforations occur during separation from the liver bed, highlighting this as the most critical phase for avoiding perforations.

Table 3. Steps of perforation data distribution among the studied patients

Time of perforation	Callot triangle dissection	3	3.0%
	Bile spillage during traction by the	8	8.0%

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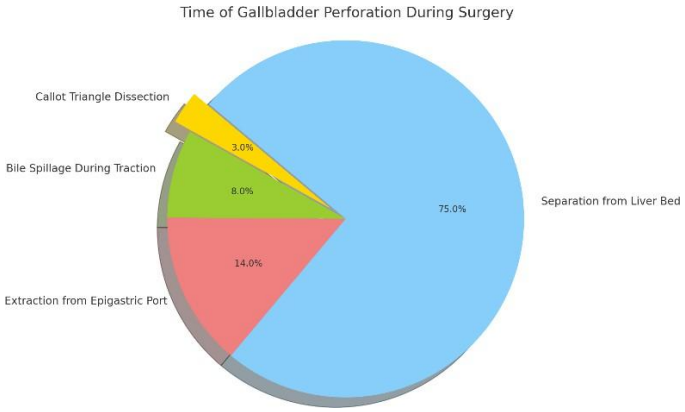
	Extraction of G.B from the epigastric port	14	14.0%
	Separation from the liver bed	75	75.0%

Figure 1. Steps of perforation



The table compares outcomes of patients with accidental perforated gall bladder versus non-perforated gallbladders during laparoscopic cholecystectomy. Key findings include a 45% occurrence of Ilieus in the perforated group with an Odds Ratio (OR) of 4.896, indicating a higher likelihood of this condition post-perforation. The accidentally perforated gall bladder group during laparoscopic cholecystectomy also experiences longer hospital stays (63%). Port site infections and intra-abdominal abscesses are more common in the perforated group, with ORs of 2.437 and 5.628, respectively. Prolonged operation times are significantly higher in the perforated group, with 83% of cases experiencing extended surgery. All variables show a P value less than 0.001, denoting significant statistical differences between the groups.

Table 4. Post-operative outcome distribution among the studied patients

Variables	Perforated G.B group	Non- Perforated G.B group	Odd Ratio	P value
Ilieus	45 (45.0%)	0 (0.0%)	4.896	<0.001
Prolong hospital stay	63 (63.0%)	2 (1.8%)	9.945*	<0.001
Port site infection	14 (14.0%)	0 (0.0%)	2.437	<0.001
Intra-abdominal abscess	4 (4.0%)	0 (0.0%)	5.628	<0.001
Prolong operation time	83 (83.0%)	0 (0.0%)	1.04	<0.001

* Significant at P value <0.05

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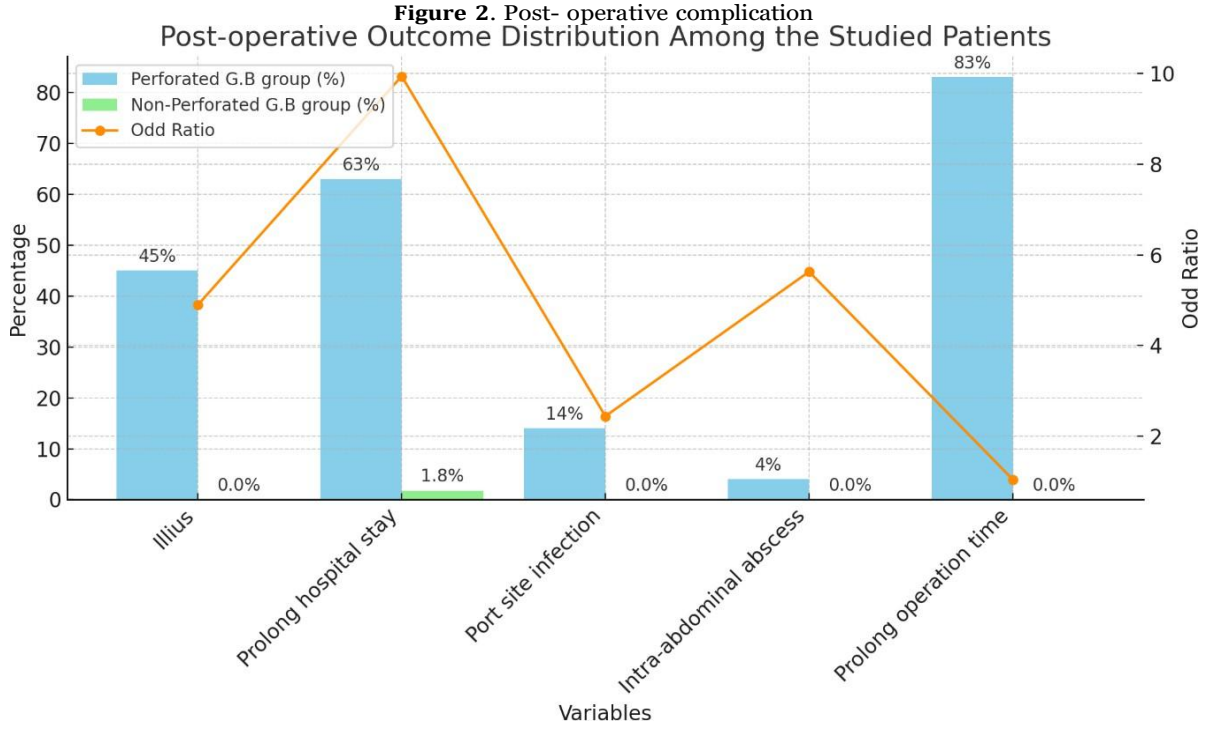
Figure 2. Post- operative complication



4. Discussion

This study warranted the importance of understanding the risk factors associated with accidental gallbladder perforation during laparoscopic cholecystectomy. It also aims to investigate and compare the postsurgical outcomes between cases with accidental perforation and those without.

4.1 Predisposing factors:

- **Age and Gender:** In this study, a significant association was found between accidental gallbladder perforation during laparoscopic cholecystectomy and increasing age. Existing literature indicates that accidental gallbladder perforation during laparoscopic cholecystectomy is a rare complication more frequently encountered in older patients(31). This could be the fact that older adults are more predisposed to gallstones and cholecystitis, both significant risk factors for complications such as accidental gall bladder perforation during laparoscopic cholecystectomy. (32) Moreover, persistent inflammation in these conditions contributes to increased gallbladder wall thickness due to fibrosis(33). Consequently, this could make the dissection and removal of the gallbladder more challenging and could increase the risk of perforation. The study also revealed a significantly higher incidence of accidental gallbladder perforation during laparoscopic cholecystectomy among male patients compared to females. The observed significant P-value suggests a notable association. A few studies have explored gender as a potential risk factor for accidental gallbladder perforation during laparoscopic cholecystectomy, and findings from Suh et al. support the notion that males are more susceptible to such perforations, corroborating the results of this study(34). In another study by Sarli et al. on the risk factors of gallbladder perforation during laparoscopic cholecystectomy, they reported a notably higher proportion of male patients within the group experiencing a bile leak(35). Although the reason for the increased susceptibility of the male gallbladder to perforation is not explained, it may mostly be due to multiple adhesions around the gallbladder in males, which could be a result of late presentation(36). In contrast to this study,

Altuntas et al. stated that demographic factors like age and gender distribution were not significant(37).

- **Obesity or high BMI:** Additionally, this study suggests a correlation between accidental gallbladder perforation during laparoscopic cholecystectomy and higher BMI. Akmoosh et al. have noted that a BMI exceeding (30) represents a risk factor for the safe execution of laparoscopic cholecystectomy. Obesity introduces challenges in trocar access, necessitating longer instrumentation when the abdominal wall is thicker. This can increase the risk of injuries to the gallbladder wall and perforation. Furthermore, fat deposition in peritoneal layers would demand a more meticulous dissection at the Calot's triangle(38). Moreover, Thyagarajan et al. stated that obesity is considered one of the predictive factors of conversion from laparoscopic to open cholecystectomy, due to potential complications in obese patients during the laparoscopic procedure(39).

- **Past Medical History:** Regarding medical history, the group that sustained accidental gall bladder perforation during laparoscopic cholecystectomy displays a notably higher incidence of diabetes mellitus and ischemic heart disease. However, there isn't a significant difference observed concerning hypertension. Various studies in the literature have revealed an overall increased risk of accidental gallbladder perforation during laparoscopic cholecystectomy in individuals with diabetes mellitus(40). Derici et al. stated that patients with diabetes mellitus exhibit a higher susceptibility to accidental gallbladder

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perforation during laparoscopic cholecystectomy compared to the general population(41). Moreover, according to Nandyala et al., diabetes is frequently identified as a significant risk factor for accidental gallbladder perforation during laparoscopic cholecystectomy following acute calculus cholecystitis, leading to empyema of the gallbladder(42). This elevated occurrence is linked to vascular disorders associated with diabetes(43). Furthermore, diabetic patients, are thought to experience a failure of the immune system in effectively combating infections, which is considered a risk factor for perforation(44). Concerning ischemic heart disease, Derici et al. further stated that susceptibility to accidental gallbladder perforation during laparoscopic cholecystectomy is higher in patients with atherosclerotic heart disease compared to the general population(41). Stefanidis et al. also observed that cardiovascular comorbidity is another significant risk factor for perforation, affecting half of the patients who experience accidental gall bladder perforation during laparoscopic cholecystectomy in their study(31). In addition, in their review of risk factors for accidental gallbladder perforation during laparoscopic cholecystectomy, Roskyn et al. discovered that individuals aged above 60 years experiencing accidental gallbladder perforation during laparoscopic cholecystectomy more frequently presented with severe systemic diseases like diabetes and atherosclerotic heart disease (45).

- **Previous abdominal surgery:** This study also found a potential association between previous abdominal surgeries and accidental gallbladder perforation during laparoscopic cholecystectomy. Previous upper abdominal surgeries can lead to adhesions at the Calot's triangle and port sites, making trocar access hard. This may predispose to tissue injuries during access(38). This aligns with existing literature indicating that the presence of adhesions is linked to a higher incidence of perforation(46). A meta-analysis of 5366 patients undergoing laparoscopic cholecystectomy by Evans et al. stated that adhesions caused by previous operations are a significant risk factor for accidental intraoperative gallbladder perforation during LC(47). Moreover, Handaya et al. stated that extensive adhesions represent a significant challenge when attempting to access the gallbladder, particularly in laparoscopic surgery (48).

- **Acute cholecystitis:** In addition, it was found in this study that acute cholecystitis cases undergoing laparoscopic cholecystectomy are more liable to get an accidental gall bladder perforation during laparoscopic cholecystectomy. This aligns with Gharaibeh et al.'s study which reported a significantly higher perforation rate in successful laparoscopic cholecystectomy for acute cholecystitis compared to chronic cholecystitis. The rates were 31.1% and 18%, respectively(49). This can be attributed to the increased friability of the gallbladder wall caused by the inflammatory process in acute cholecystitis, making it more susceptible to tearing when subjected to the stress of traction and dissection during the surgical procedure. This increased vulnerability likely contributes to the higher perforation rate in cases of acute cholecystitis compared to chronic cholecystitis(50).

4.2 Postoperative complications and outcomes

It was also observed that accidental gallbladder perforation during laparoscopic cholecystectomy correlates with an increased likelihood of adverse postoperative outcomes compared to cases without perforation.

- **Prolonged operation time:** The most frequent complication in the accidental intraoperative perforated gallbladder during LC cases was prolonged operation time averaging 60 ± 15 minutes. In contrast, the non-perforated group had a shorter average operation time, lasting around 30 ± 10 minutes. This aligns with the study by Hanashe et al., which concluded that the average operative time was prolonged in the perforated groups. Specifically, the mean operative time for cases with accidental gallbladder perforation during laparoscopic cholecystectomy in their study, was 75 minutes, compared to 45 minutes in cases without perforation(50). This indicates that the presence of accidental gallbladder perforation is associated with a statistically significant increase in the duration of the operative procedure. Prolonged operative times may be attributed to the time required for copious irrigation to achieve clear aspiration and retrieve gallstones. Moreover, Altuntas et al. observed that the incidence of drain use increases in the occurrence of accidental intraoperative gallbladder perforation during LC, this is to ensure adequate peritoneal irrigation and drainage(51).

- **Prolonged hospital stays:** The postoperative hospital stay was also significantly prolonged in the accidentally perforated gall bladder group, lasting approximately 72 hours. This may be due to increased pain resulting from irritation of the peritoneum due to spillage of gallstones and bile. In contrast, patients undergoing the same procedure without accidental intraoperative gallbladder perforation typically had a shorter hospital stay of only 24 hours. Hanashe et al. similarly reported an increase in mean hospitalization time in the accidentally perforated GB group, with an average of 48 hours compared to 24 hours in the non-perforated group(50). Suh et al. also reported similar complications(34).

- **Postoperative ileus and postoperative pain:** Other complications encountered in this study within the accidentally perforated gall bladder group included ileus, postoperative pain, and an increased need for analgesia. These conditions also contributed to extended hospitalization. Ileus was observed in 45% of the accidentally perforated GB group in this study, a finding close to Suh et al.'s study (42.4%) (34). Ileus is likely due to peritoneal irritation resulting from the spillage of bile and calculi, which could also contribute to post-operative pain and the subsequent need for analgesia.

- **Postoperative infection (port site and intra-abdominal infection/abscess):** Additionally, port site infection affected 14% of the accidentally perforated GB group, and an intra-abdominal abscess was observed in 4%. Suh et al. also reported the incidence of port site infection and intra- abdominal abscess in their study, aligning with the complications observed in the perforated group in this study(34). The contamination of bile in the abdominal cavity can contribute to surgical site infections (SSI) and may lead to the formation of residual abscesses. (52)

We also expected that there is a risk of adhesion and an increased chance of intestinal obstruction in the patients who sustained accidental gall bladder perforation during laparoscopic cholecystectomy.

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4.3 Limitations of the study

This study on accidental gall bladder perforation during laparoscopic cholecystectomy, while comprehensive, has inherent limitations. It is a single-center study, which may affect the generalizability of its findings to other settings. Additionally, the follow-up period might not be sufficient to assess long-term postoperative outcomes. There could also be potential biases in participant selection and data interpretation. These factors should be considered when evaluating the study's conclusions and applying them in broader clinical contexts.

5.1 Conclusion

This study underscores that accidental intraoperative gall bladder perforation during laparoscopic cholecystectomy prolonged operative time and complicated postoperative outcomes like ileus, more pain and use of analgesia and prolonged hospital stay and predispose for more use of antibiotics duration and increased chance of surgical infection (intra-abdominal infection /abscess and port site infection) and late complication due to increasing risk of adhesion, thereby increase the cost and economical effect. this study also illuminated that male gender, higher BMI, increasing age and specific medical history were the main risk factors for an accidental GB perforation.

5.2 Recommendations

1. Enhanced Surgical Precision: Surgeons are strongly advised to exercise heightened diligence during the dissection of the gallbladder. This includes a thorough understanding and proficiency in the anatomical nuances of the biliary tree, including its common variants and potential anomalies.

2. Tissue Integrity and Handling: Paramount importance should be placed on maintaining tissue integrity. This involves meticulous handling and precise dissection techniques to respect the delicate nature of the tissue structures involved. Surgeons should be committed to minimizing tissue trauma to the greatest extent possible.

3. Prevention of Gallbladder Perforation: Utmost efforts should be made to avoid accidental intraoperative gallbladder perforation. In cases where such an event occurs, it is imperative to implement strategies that reduce the risks associated with spilled gallstones and bile.

4. Management of Intraoperative Complications: In the event of accidental intraoperative gallbladder perforation, immediate steps should be taken. These include abundant irrigation of the peritoneal cavity to minimize contamination and stone extraction, Endobag also may be beneficial.

5. Prophylactic Antibiotic Therapy: Additionally, consideration should be given to the administration of extended prophylactic antibiotic therapy. The duration of such therapy may necessitate extension beyond the usual period, particularly in cases of accidental gallbladder perforation.

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