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DEGREE OF GALLBLADDER ADHESION AS A PREDICTOR FOR COMMON BILE DUCT INJURY AND CONVERSION TO OPEN IN LAPAROSCOPIC CHOLECYSTECTOMY

General Surgery

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ABSTRACT

Background: Gallbladder adhesions encountered during Laparoscopic Cholecystectomy can distort biliary anatomy, increasing the risk of iatrogenic injury and conversion to open surgery. This study evaluates the predictive value of adhesion severity on surgical outcomes. **Objectives:** This study aimed to assess the degree of gallbladder adhesion, predict the risk of common bile duct injury, and determine the likelihood of conversion to open cholecystectomy. **Patients And Methods:** This analysis was conducted on ninety patients admitted for elective laparoscopic cholecystectomy at a tertiary care hospital. Data were collected on accrual. Adhesions were graded intraoperatively into four tiers based on severity and anatomical involvement. Primary outcomes were conversion rates and common bile duct injuries. **Results:** Severe adhesions (>50% or buried gallbladder) were present in 34.4% of patients. The overall conversion rate was 8.9%, which rose to 44.4% in patients with a completely buried gallbladder ($p=0.001$). Common bile duct injury occurred in 5.6% of patients, with the highest incidence (22.2%) in the most severe adhesion group ($p=0.026$). Increasing adhesion severity was significantly associated with longer operative times and greater intraoperative blood loss ($p<0.001$). **Conclusion:** The intraoperative degree of gallbladder adhesion is a significant predictor of conversion to open surgery and common bile duct injury. A systematic assessment of adhesions is crucial for intraoperative risk stratification and decision-making to ensure patient safety.

KEYWORDS

Gallbladder Adhesion, Laparoscopic Cholecystectomy, Common Bile Duct Injury, Conversion Surgery, Difficult Cholecystectomy, Surgical Outcomes

INTRODUCTION

Laparoscopic Cholecystectomy (LC) has become the definitive gold standard for the treatment of symptomatic gallstone disease since its introduction [1]. First performed successfully in 1985, the technique was widely adopted for its significant advantages over traditional open cholecystectomy (OC), including reduced postoperative pain, shorter hospital stays, faster recovery times, and improved cosmesis [2, 3]. Despite its widespread success, LC is a technically demanding procedure with a distinct set of potential complications, the most feared of which is iatrogenic common bile duct (CBD) injury [4,5]. Such injuries, though rare, can lead to devastating consequences, including prolonged morbidity, the need for complex reconstructive surgeries, and long-term sequelae like biliary strictures [6].

A primary factor contributing to the complexity and risk of LC is the presence of gallbladder adhesions. These fibrous bands, which form as a result of the body's healing response to inflammation, infection, or prior surgical trauma, can significantly distort the anatomy of Calot's triangle [7]. The pathophysiology involves a cascade of inflammation, fibroblast activation, and extracellular matrix remodelling, leading to the formation of dense scar tissue that tethers the gallbladder to adjacent structures like the liver, duodenum, or omentum [8]. This anatomical distortion can make it exceedingly difficult to achieve the "critical view of safety" (CVS), a foundational principle for the safe identification and ligation of the cystic duct and artery [9].

When adhesions obscure these critical landmarks, the risk of misidentification and inadvertent injury to the CBD or nearby vascular structures increases substantially. Furthermore, the presence of severe adhesions is a leading cause for conversion from a laparoscopic to an open procedure [10]. While conversion is a prudent step to ensure patient safety, it negates the primary benefits of the minimally invasive approach and is associated with longer operative times and recovery periods [11]. Given these challenges, identifying predictors of a difficult LC is crucial for preoperative planning, patient counselling, and intraoperative strategy. This study was therefore designed to systematically evaluate the degree of intraoperative gallbladder adhesion as a predictor for CBD injury and conversion to OC.

Patients And Methods

Study Design And Setting

This cross-sectional study was conducted in the Department of General Surgery at Sri Siddhartha Medical College Hospital, Tumkur, a tertiary care centre, over a 24-month period from January 2021 to December 2022. The study protocol was reviewed and approved by the Institutional Ethical Committee (Ref No: SSMC/MED/IEC-049/March-2023) prior to commencement.

Study Duration And Participants

Data from ninety consecutive patients were collected on accrual over a 24-month period from January 2021 to December 2022. Participants were selected based on predefined criteria:

- **Inclusion Criteria:** Adult patients (≥ 18 years) diagnosed with benign gallbladder disease (e.g., symptomatic cholelithiasis, chronic cholecystitis) who were indicated for and provided informed written consent for elective LC.
- **Exclusion Criteria:** Patients with suspected or confirmed gallbladder malignancy, uncontrolled coagulopathies, severe systemic comorbidities contraindicating general anaesthesia or laparoscopy, and patients presenting with emergencies such as gallbladder perforation requiring an upfront open procedure.

Study Procedure

All enrolled patients underwent a standardized protocol.

- **Preoperative Evaluation:** A detailed history and physical examination were performed. Laboratory investigations included a complete blood count, liver and renal function tests, and coagulation profiles. An abdominal ultrasonography (USG) was conducted to confirm gallstones, assess gallbladder wall thickness, and screen for CBD stones or pericholecystic fluid.
- **Surgical Technique:** All procedures were performed under general anaesthesia using a standard four-port technique. After establishing a pneumoperitoneum, an initial inspection of the gallbladder fossa was performed.
- **Adhesion Grading:** The degree of gallbladder adhesion was assessed intraoperatively by the operating surgeon and categorized according to a standardized four-point scale:
- **Grade 1 (No/Simple Adhesion):** Gallbladder free or with filmy adhesions limited to the neck/Hartmann's pouch.
- **Grade 2 (<50% Adhesion):** Fibrous adhesions covering less than half of the gallbladder surface area.
- **Grade 3 (>50% Adhesion):** Dense adhesions covering more than half the gallbladder, involving the hepatic flexure or duodenum.
- **Grade 4 (Completely Buried):** Dense, fibrotic adhesions completely encasing the gallbladder, making anatomical

identification challenging.

- **Dissection And Completion:** Dissection was carried out to achieve the CVS. The decision to convert to OC was made if the anatomy remained unclear after a reasonable attempt at dissection, if significant bleeding occurred, or if a CBD injury was suspected. Following cholecystectomy, the specimen was retrieved and haemostasis was confirmed.
- **Postoperative Care:** Patients were monitored in the recovery room and managed with standard postoperative analgesia, antiemetics, and intravenous fluids. Early ambulation and resumption of oral intake were encouraged.

Study Parameters And Data Analysis

Primary outcome measures were the incidence of CBD injury and the rate of conversion to OC. Secondary outcomes included operative time, estimated intraoperative blood loss, duration of hospital stay, and postoperative complications (e.g., wound infection, bile leak).

All data were entered into a spreadsheet and analysed using SPSS. Descriptive statistics were used to summarize variables. The Chi-square test or Fisher's Exact Test was used to examine associations between categorical variables, while ANOVA or t-tests were used for continuous variables. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic And Baseline Characteristics

The analysis included ninety patients, with a female predominance (60%). The largest cohort of patients (31.1%) was in the 41–50-year age group. Nearly half the patients (48.9%) had a normal Body Mass Index (BMI). Symptomatic cholelithiasis was the most frequent indication for surgery (80.0%), followed by chronic cholecystitis (15.6%). USG findings most commonly revealed multiple gallstones (55.6%) and gallbladder wall thickening >3 mm (31.1%).

Intraoperative Findings

The distribution of adhesion grades was as follows: 26.7% of patients had Grade 1 adhesions, 38.9% had Grade 2, 24.4% had Grade 3, and 10% had Grade 4 (completely buried gallbladder). A clear and statistically significant correlation was found between the severity of adhesions and all primary and secondary outcomes.

- **Operative Time And Blood Loss:** Mean operative time increased progressively from 46.2 minutes for Grade 1 to 85.7 minutes for Grade 4 ($p<0.001$). Similarly, mean estimated intraoperative blood loss rose from 40.1 mL in Grade 1 to 95.6 mL in Grade 4 ($p<0.001$).
- **Conversion To Open Cholecystectomy:** The overall conversion rate was 8.9% (8 patients). The rate increased dramatically with adhesion grade: 0% for Grade 1, 2.9% for Grade 2, 13.6% for Grade 3, and 44.4% for Grade 4 ($p=0.001$). Patients who required conversion had a significantly longer mean operative time compared to those who did not (95.2 vs. 57.1 minutes, $p<0.001$).
- **Common Bile Duct Injury:** Five patients (5.6%) sustained a CBD injury. The incidence was directly correlated with adhesion severity, rising from 0% in Grade 1 to 22.2% in Grade 4 ($p=0.026$). Of the five injuries, two were Bismuth Type I (40%), one was Type II (20%), and two were Type III (40%).

Postoperative Outcomes

The mean hospital stay was significantly longer for patients with more severe adhesions, increasing from 2.1 days for Grade 1 to 4.2 days for Grade 4 ($p<0.001$). The overall postoperative complication rate was 11.1%, with complications including wound infection (4.4%) and bile leak (3.3%). The occurrence of complications was significantly associated with higher adhesion grades ($p=0.032$). No mortality was reported in this study cohort.

DISCUSSION

This study confirms that the intraoperative degree of gallbladder adhesion is a powerful and reliable predictor of a difficult laparoscopic cholecystectomy. Our findings demonstrate a direct, statistically significant relationship between adhesion severity and increased operative time, higher blood loss, a greater likelihood of conversion to open surgery, and an elevated risk of common bile duct injury. These results are consistent with a large body of literature that identifies adhesions as a primary challenge in minimally invasive surgery [11,12].

The significant prolongation of operative time in cases of severe adhesions reflects the technical difficulty of dissecting through fibrotic planes while attempting to identify critical anatomy. This finding aligns with previous studies which have also documented longer surgical durations in difficult gallbladder cases [4,5]. The increased blood loss observed is likewise attributable to the hypervascularity of inflamed tissues and the need for extensive dissection.

Our overall conversion rate of 8.9% is comparable to rates reported in other contemporary series, which range from 3% to 9% [3,6,13]. Crucially, the conversion rate in our most severe adhesion group (44.4%) highlights that while LC is feasible for most, a substantial portion of complex cases will require conversion to ensure safety. This reinforces the surgical dictum that conversion is not a complication but a mark of sound surgical judgment [14].

Perhaps the most critical finding is the strong association between adhesion severity and CBD injury. The 5.6% injury rate in our cohort, while higher than the oft-quoted rate of <1% for routine LC, is reflective of a population that includes complex cases. Other studies analysing difficult cholecystectomies have reported similar challenges [7, 15]. The inability to achieve the CVS in a field obscured by dense, fibrous adhesions is the final common pathway to misidentification and injury. This underscores the need for alternative strategies in such scenarios, including intraoperative imaging or a willingness to perform a subtotal cholecystectomy [16].

Our study also reinforces the value of preoperative risk stratification. While USG is not perfectly predictive, findings such as a thickened gallbladder wall should raise a surgeon's suspicion for a difficult dissection, as suggested by other researchers [8, 9]. Recognizing these high-risk patients allows for more detailed informed consent regarding the potential for conversion and complications. Ultimately, our data provide clear, quantitative evidence that a systematic approach to grading adhesions can help surgeons anticipate challenges and modify their operative strategy to prioritize patient safety [10].

CONCLUSION

Severe adhesions can obscure critical structures within Calot's triangle, leading to the need for conversion to open surgery in some patients; this conversion should be seen as a proactive safety measure, not a surgical failure. While the overall conversion rate was 8.9%, nearly half of the patients with a completely "buried" gallbladder required an open procedure. The study confirms that while laparoscopic cholecystectomy is a safe and effective procedure, the degree of gallbladder adhesion is a primary predictor of the surgery's complexity. With a thorough preoperative evaluation and careful intraoperative management, even patients with significant gallbladder adhesions can still be considered suitable candidates for laparoscopic surgery.

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