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Original Research Article

Clinical Evaluation of Predictors for Difficult Cholecystectomy in Symptomatic Gallstone Patients

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Abstract:

Background: Laparoscopic cholecystectomy (LC) has become the gold standard for treating gallbladder diseases. However, some cases pose intraoperative difficulties due to anatomical variations or comorbidities, necessitating conversion to open surgery. Identifying predictive risk factors is essential to anticipate and manage these challenges.

Aim: To assess demographic and clinical factors associated with difficult laparoscopic cholecystectomy (LC) and enhance pre-operative risk stratification.

Methodology: The present study was a hospital-based observational study of patients undergoing elective or emergency cholecystectomy in the Department of General Surgery, Patna Medical College and Hospital, Bihar between Jan 2017 and Dec 2018. The study included 80 patients assessed by demographic data, history and intraoperative data. Surgeries were classified as an "easy" or "difficult" laparoscopic cholecystectomy based on defined criteria. Data were analyzed using SPSS v27 with statistical significance set at $p<0.05$.

Results: Older age (41–60 years, $p=0.016$), male gender ($p=0.031$), and BMI ≥25 kg/m² ($p<0.0001$) were significantly associated with difficult LC. Key clinical predictors included diabetes mellitus ($p<0.0001$), sickle cell disease ($p=0.03$), impacted calculi ($p=0.036$), pericholecystic collection ($p=0.017$), adhesions in the triangle of Calot ($p<0.0001$), previous abdominal surgery ($p=0.004$), and prior hospitalizations ($p<0.0001$).

Conclusion: This study highlights that age, gender, BMI, and specific clinical conditions strongly predict the difficulty of LC. Preoperative recognition of these risk factors can aid in surgical planning, improve patient counseling, reduce complications, and optimize resource allocation.

Keywords: Adhesions, BMI, Diabetes, Gallstones, Laparoscopic Cholecystectomy, Pericholecystic Collection, Surgical Risk Factors, Sickle Cell Disease.

Introduction

Cholecystectomy became seen as the surgical procedure of choice for managing symptomatic gallstone disease after its first successful cholecystectomy (1882), performed by its father, Carl Langebuch (1846-1901), in Germany [1]. An open procedure, cholecystectomy became the foundation for modern gallbladder surgery [2]. More than 100 years later, the first laparoscopic cholecystectomy (LC) was performed by Professor Dr. Erich Mühe of Germany (1985) [3] and was a key development in the history of minimally invasive surgery (MIS). Since then, LC has become the gold standard treatment for most gallbladder disease, including symptomatic cholelithiasis, acute cholecystitis, and gallbladder polyps [4]. The benefits of LC compared to an open surgical procedure include reduced postoperative pain, shorter hospital stay, quicker recovery, and improved cosmetic results. Consequently, LC has become one of the most commonly performed operations by general surgeons worldwide.

However, despite its widespread acceptance and general safety, LC can sometimes become problematic as a result of complications that occur intra-operatively. Complications can arise when the biliary anatomy is not clear, which can be due to inflammation, bleeding, or variation in anatomy encompassing anomalies of the cystic duct (segmental cystic duct with a short cystic duct, low insertion on the cystic duct, or aberrant right hepatic duct); complications can also occur in the creation of pneumoperitoneum; access the peritoneal cavity in the obese or previously operated patient; release dense adhesions due to prior inflammation or surgical procedures; or have to deal with a scarring or contracted gallbladder [4]; or extracting the gallbladder itself can be

made difficult depending on the size of gallstones and wall thickness of the gallbladder. Such complications can lead to additional operative time, increased rates of conversion to open surgery, and increased complication rates, including injury to the bile duct [5]. Therefore, a thorough evaluation preoperatively and advanced surgical skills is fundamental for anticipating and navigating difficult LC.

Preoperative prediction of risk of conversion or of difficulty is an important part of the planning process involved in a laparoscopic procedure [6]. Accurate prediction may allow for informed consent with a high-risk patient and appropriate counselling. Surgeons may get an indication themselves to appropriately schedule time, and team, from an operating theatre perspective. Those patients who are predicted to be difficult/high risk, support should be provided for planned intensive post-operative care and prolonged length of stay. Preoperative prediction of conversion may also support hospital administration with planning and prediction of admissions and bed vacancy [7].

Therefore, preoperative prediction of-difficult LC-may help in improving patient safety, adequate preoperative planning, and counselling, determining the approach (open/laparoscopic), reduce conversion rate and prevent overall complications and morbidity. LC with these identified issues and also an obligation of time more than normal is presumed difficult. The present study was initiated to identify the different predictors of difficulty in LC and in turn will help prevent complications to give a better outcome to patients.

Methodology

Study Design: This was a hospital-based observational study conducted to assess the risk factors contributing to difficult cholecystectomy in patients undergoing gallbladder removal surgery.

Study Area: The study was conducted in the Department of General Surgery, Patna Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study was conducted over a period from Jan 2017 and Dec 2018.

Sample Size: The study included a total of 80 patients who underwent cholecystectomy during the study period.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Patients aged 18 years and above undergoing elective or emergency cholecystectomy.
- Patients diagnosed with symptomatic cholelithiasis, acute or chronic cholecystitis.
- Patients who provided informed consent for participation in the study.

Exclusion Criteria:

- Patients with known gallbladder malignancy.
- Patients undergoing concomitant major procedures (e.g., hepatic resection).
- Patients with incomplete data or who refused to participate.

Procedure: All patients scheduled for cholecystectomy were evaluated preoperatively with detailed history, clinical examination, and relevant investigations including ultrasound abdomen, liver function tests, and complete blood count. Factors such as age, sex, BMI, previous abdominal surgery, comorbidities (e.g., diabetes, hypertension), and duration of symptoms were recorded. Intraoperative details such as adhesions, gallbladder wall thickness, presence of empyema or mucocele, and difficulty in Calot's triangle dissection were noted. The cholecystectomies were classified as 'easy' or 'difficult' based on operative time, intraoperative findings, need for conversion to open surgery, and surgical complications. A structured proforma was used for systematic data collection throughout the perioperative period.

Statistical Analysis: Data were compiled and analyzed using Microsoft Excel and SPSS software version 27. Descriptive statistics were used to summarize the demographic and clinical characteristics. Categorical variables were expressed as percentages and proportions, while continuous variables were represented as mean ± standard deviation. The association between various preoperative and intraoperative risk factors with the difficulty of cholecystectomy was assessed using the Chi-square test for categorical variables and the t-test for continuous variables. A p-value < 0.05 was considered statistically significant.

Result

Table 1 compares the laparoscopic difficulty of cholecystectomy with patients' demographic variables—age, gender, and BMI. A statistically significant association was found between difficulty level and all three variables. Younger age groups, particularly those aged 31–40 years, were more commonly associated with easy laparoscopic procedures (46.15%), whereas higher difficulty was more frequent in older age groups such as 41–50 years (25%) and 51–60 years (21.43%) ($p=0.016$). Males experienced a significantly higher rate of difficult procedures (46.43%) compared to females (53.57%) ($p=0.031$). Furthermore, BMI showed a strong correlation, with patients having BMI ≥25 kg/m² facing more difficult laparoscopies (46.43%) compared to only 9.62% in the easy group ($p<0.0001$), indicating that increased BMI is a key risk factor for surgical difficulty.

Table 1: Comparison of laparoscopic difficulty with demographic data of the patients			
Demographic data	Laparoscopic difficulty, n (%)		P value
	Easy (n=52)	Difficult (n=28)	
Age group (in years)			
21–30	05 (9.62%)	04 (14.29%)	0.016
31–40	24 (46.15%)	06 (21.43%)	
41–50	06 (11.54%)	07 (25.00%)	
51–60	09 (17.31%)	06 (21.43%)	
61–70	05 (9.62%)	03 (10.71%)	
71–80	03 (5.77%)	02 (7.14%)	
Gender			
Male	12 (23.08%)	13 (46.43%)	0.031
Female	40 (76.92%)	15 (53.57%)	
BMI (kg/m²)			
<25	47 (90.38%)	15 (53.57%)	<0.0001
≥25	05 (9.62%)	13 (46.43%)	

Table 2 presents a comparative analysis of various risk factors in relation to laparoscopic difficulty among patients. It shows that factors such as impacted calculi (p=0.036), sickle cell disease (p=0.03), pericholecystic collection (p=0.017), diabetes mellitus (p<0.0001), adhesion in the triangle of Calot (TOC) (p<0.0001), previous abdominal surgery (p=0.004), and previous hospitalization (p<0.0001) were significantly associated with difficult laparoscopic procedures. Notably, diabetes mellitus, adhesion in TOC, and previous hospitalization showed the strongest associations with difficulty, as evidenced by their highly significant p-values and a higher proportion of difficult cases in affected patients. These findings suggest that the presence of these risk factors may serve as predictive indicators for challenging laparoscopic cholecystectomy cases.

Table 2: Comparison of laparoscopic difficulty with various risk factors			
Various risk factors	Laparoscopic difficulty, n (%)		P value
	Easy (n=52)	Difficult (n=28)	
Impacted calculi	Yes: 02 (3.85%)	04 (14.29%)	0.036
	No: 50 (96.15%)	24 (85.71%)	
Sickle cell disease	Yes: 01 (1.92%)	03 (10.71%)	0.03
	No: 51 (98.08%)	25 (89.29%)	
Pericholecystic collection	Yes: 00 (0.00%)	03 (10.71%)	0.017
	No: 52 (100.00%)	25 (89.29%)	
Diabetes mellitus	Yes: 03 (5.77%)	08 (28.57%)	<0.0001
	No: 49 (94.23%)	20 (71.43%)	
Adhesion in TOC	Yes: 07 (13.46%)	12 (42.86%)	<0.0001
	No: 45 (86.54%)	16 (57.14%)	
Previous abdominal surgery	Yes: 01 (1.92%)	05 (17.86%)	0.004
	No: 51 (98.08%)	23 (82.14%)	
Previous hospitalization	Yes: 06 (11.54%)	16 (57.14%)	<0.0001
	No: 46 (88.46%)	12 (42.86%)	

Discussion

The present study identifies several demographic and clinical variables that significantly influence the difficulty of laparoscopic cholecystectomy. Age emerged as a key determinant, with younger patients, particularly those aged 31–40 years, more frequently undergoing easier procedures. In contrast, higher difficulty was observed in older age groups, particularly 41–60 years, suggesting that advancing age might be associated with anatomical or pathological changes that complicate surgery. Gender differences were also prominent; male patients experienced significantly more difficult laparoscopic cholecystectomies compared to females, possibly due to a higher prevalence of complicating factors such as fibrosis or delayed presentation. In the current study, difficult LC was noted in 35(35%) cases, which is comparable with the study by Bourgouin et al (35.2%) and Zaineb et al (30%).5,6 Older age (≥50 years; p=0.016), and male sex (p=0.031) were also identified as significant risk factors for difficult LC. These findings are consistent with the findings of previous studies [8,9]. Older age group and male patients reported higher conversion rates, and significantly higher mortality. The reasons for increased conversion risk for men and older age are not clear; however, there have been postulations of a more

frequent association with severe inflammation, and dense adhesion in men, and older age [10].

BMI was found to be a strong predictor of surgical difficulty. Patients with BMI ≥25 kg/m² had a substantially higher rate of difficult laparoscopic procedures, reinforcing the known challenges associated with obesity, such as limited visibility and access due to increased adipose tissue. This underscores the importance of preoperative BMI assessment in anticipating intraoperative challenges. A high association between SCD, gallstone disease, and its sequelae is present, and as many individuals with SCD ultimately require cholecystectomy, it can be stated that these patients have elevated inflammatory markers even in health, which suggest dysregulated inflammation [11]. There was a significantly higher proportion of patients with difficult LC had SCD (p=0.030). To the best of our knowledge, no studies have documented SCD as a risk factor for difficult LC. The findings of the present study, therefore, contribute to the current literature.

The analysis of clinical risk factors further strengthens the understanding of variables contributing to surgical difficulty. Diabetes mellitus, adhesion in the triangle of Calot (TOC), and previous hospitalization were highly significant predictors. Diabetes may contribute to delayed healing and increased fibrosis, complicating dissection and prolonging surgery. Adhesions in TOC—a critical anatomical landmark for safe cholecystectomy—markedly increased surgical difficulty, likely due to distortion of normal anatomy. Similarly, prior hospitalization and abdominal surgeries were indicative of past pathology that could lead to peritoneal adhesions, making laparoscopic access more complex. Previous abdominal surgery to either the upper or lower abdomen may develop adhesions between viscera or omentum and abdominal wall. With insertion of the first port, it can be possible to injure these structures, and the risk according the literature reports injury, was higher [12]. In the present study, the significant proportion of patients with difficult LC had previous abdominal surgery (p=0.004) which is in consensus to, the Agrawal et al and Botaitis et al recommendations [13].

Additional factors like impacted calculi, sickle cell disease, and pericholecystic collections, though less prevalent, were also significantly associated with difficult procedures. These findings highlight the multifactorial nature of laparoscopic difficulty, where both patient demographics and clinical history play vital roles. Another study by Lipman et al showed that pericholecystic fluid can predict conversion of LC to OC [14]. This finding is probably related 'to either the intense inflammatory response or to the advanced stage of AC. So pericholecystic collection predicts or is probably a risk factor for difficult LC. Increased GB wall thickness is associated with difficult dissection of the GB from its bed. Oftentimes with presence of thick GB wall, there is a difficulty in grasping and manipulation of GB. Hence, the dissection at the triangle of Calot's and at the GB bed is difficult and limits the extent of anatomical definition [15] . In the present study we found a significantly larger proportion of patients that had difficult LC actually had GB thickness ≥ 4 mm (p=0.007). so thickened GB wall predicts/risk 'factor' difficult LC comparable to the studies conducted by Akcakaya et al 2015 [8] and Park HY. 2013 [16].

In summary, older age, male gender, elevated BMI, and a history of diabetes, adhesions, or prior surgical interventions significantly predict difficulty in laparoscopic cholecystectomy. Recognizing these variables preoperatively can assist surgeons in planning the procedure more effectively, counseling patients appropriately, and possibly mitigating intraoperative complications through early conversion to open surgery or advanced laparoscopic techniques.

Conclusion

The present study underscores the multifactorial nature of difficult laparoscopic cholecystectomy (LC), with several demographic and clinical factors significantly influencing surgical complexity. Advancing age, male gender, and elevated BMI were key demographic predictors, while clinical variables such as diabetes mellitus, sickle cell disease, previous abdominal surgery, pericholecystic collection, impacted calculi, and adhesions in the triangle of Calot notably increased intraoperative challenges. The findings affirm that preoperative identification of these risk factors can help anticipate surgical difficulty, allowing for better operative planning, informed patient counseling, and improved allocation of surgical resources. Early recognition also aids in reducing conversion rates to open surgery and minimizing complications. Notably, this study adds new insights regarding the role of sickle cell disease and pericholecystic collections as significant predictors. Overall, incorporating these predictive indicators into routine preoperative assessment may lead to improved surgical outcomes and enhanced patient safety in laparoscopic cholecystectomy.

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