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Original Article

From the operating room: Surgeons' views on difficult laparoscopic cholecystectomies

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Backgrounds/Aims: Assessing surgical difficulty in laparoscopic cholecystectomy (LC) is challenging due to variations in surgeon proficiency and institutional protocols. This study evaluates surgeons' perspectives on procedural difficulty and examines how intraoperative findings and preoperative imaging contribute to refining difficulty assessment criteria.

Methods: A cross-sectional survey was conducted among 50 laparoscopic surgeons in India, providing insights into tolerances for surgical duration and blood loss, reasons for conversion, and predictors of complexity. Responses were analyzed using SPSS, with statistical significance set at $p < 0.05$.

Results: Among surveyed surgeons, 82.0% were male, and 78.0% worked in private institutions and 52.0% had performed over 1,000 LCs. Conversion to open surgery was primarily influenced by significant blood loss (68.0%) and biliary injury (94.0%). While 38.0% preferred surgeries under 60 minutes, 26.0% imposed no time constraints. Key intraoperative challenges included dense adhesions, cholecysto-enteric fistulas, and fibrosis. Less experienced surgeons reported greater challenges with scarring adhesions and anatomical variations, but no significant differences were found for other factors like edematous or necrotic changes. Preoperative imaging was considered essential by most surgeons.

Conclusions: This study underscores the limited reliability of traditional parameters for assessing difficulty in LC. Surgeons highlighted the importance of objective intraoperative findings and preoperative imaging in predicting surgical challenges. Factors such as adhesions, fibrosis, and anatomical variations significantly impact LC difficulty, with decisions regarding conversion to open surgery largely driven by individual judgment rather than experience. Standardized grading systems incorporating these factors could improve surgical planning, reduce complications, and enhance patient outcomes.

Key Words: Laparoscopic cholecystectomy; Cholecystitis; Conversion to open surgery; Cholelithiasis; Decision making

INTRODUCTION

Laparoscopic cholecystectomy (LC) is globally the preferred surgical approach for managing acute cholecystitis. Since its introduction in 1985, enhancements in laparoscopic technology and techniques have revolutionized surgical practice, offering significant benefits over the traditional open cholecystectomy. These advantages include reduced postoperative pain, accelerated recovery, earlier restoration of bowel function, and a shorter duration of hospitalization [1]. Despite these advantages, LC is not devoid of complications. Although the prevalence of vasculobiliary injuries associated with LC has decreased to between 0.32% and 0.52%, it is still higher than the 0.1% to 0.2% rate observed with the conventional open approach [2-5]. Nonetheless, the morbidity and mortality rates demonstrate no significant differences between the two techniques.

A primary cause of bile duct injuries during LC is the misinterpretation of biliary anatomy, accounting for 71% to 97% of such cases [6]. Inflammation of the gallbladder can exacerbate complications in LC, with vasculobiliary injuries occurring in 0.2% to 1.1% of cases, considerably higher than those observed

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in open procedures [7]. Although these complications are relatively rare, the widespread adoption of LC leads to a substantial aggregate number of adverse events, characterizing these complications as both "rare but common." Research conducted by Sugrue et al. [8], reports conversion rates from LC to open cholecystectomy as high as 14.3%, with prominent factors such as an embedded gallbladder, an impacted stone in Hartmann's pouch, biliary peritonitis, and fistulas increasing the likelihood of conversion. Therefore, identifying predictive factors for surgical difficulty is crucial for enhancing patient outcomes.

Traditionally, the duration of surgery and conversion rates have been used as markers of surgical difficulty [9,10], but these metrics are often influenced by factors such as surgical expertise and institutional protocols therefore complicating comparisons across studies. Intraoperative findings that indicate the severity of gallbladder inflammation may provide more objective and reliable indicators of surgical difficulty. Given the complexities and potential risks associated with LC, the establishment of standardized criteria for assessing intraoperative difficulty is imperative. Surgeons' insights into particular intraoperative challenges could inform the development of objective criteria that consistently predict difficult cases. Such standardized criteria would facilitate uniform risk stratification, support the formulation of evidence-based protocols for surgical planning, resource allocation, and team preparedness. Ultimately, standardized assessments of difficulty could enhance patient safety and outcomes, improve surgical training, enable inter-institutional research comparisons, and elevate the quality of LC procedures across healthcare settings.

MATERIALS AND METHODS

A cross-sectional survey-based study was conducted to evaluate surgeons' perspectives on factors contributing to the difficulty of LC. The questionnaire, developed based on previous research by Iwashita et al. [11], was designed to capture surgeons' experiences and approaches in managing challenging LC cases. It included variables such as surgeons' demographic and professional backgrounds, surgical strategies, reasons for conversion to open surgery or subtotal cholecystectomy, and perceptions of challenging intraoperative findings. The questionnaire was developed in English and administered via an online platform from January 2023 to June 2023. It was structured to elicit detailed information about each surgeon's experience with LC, including strategies for tackling complex cases, thresholds for maximum surgical duration and estimated blood loss, precautionary measures, and triggers for conversion to open or subtotal procedures.

The survey included 50 surgeons specializing in laparoscopic, hepatobiliary, and pancreatic surgery across India. Only surgeons actively performing LC procedures were eligible to participate. Responses were gathered electronically and analyzed using SPSS version version 23.0 software (IBM Corp.) Data were presented as frequencies and percentages for categorical variables, and disparities in responses were assessed across different levels of experience using the χ^2 test or Fisher's exact test, with a significance threshold set at a p-value of <0.05.

The study was conducted following approval from the ethics committee at Ramaiah Medical College (Reg No. ECR/215/Inst/KA/2013/RR-22). All participants provided informed consent, and their responses were anonymized to maintain confidentiality.

RESULTS

A total of 82.0% of the surgeons surveyed were male, with 18.0% female. The majority were affiliated with private institutions (78.0%), followed by 14.0% working in government settings and 8.0% in both. Surgeons demonstrated varying levels of experience, with 52.0% having performed over 1,000 LCs, 18.0% having performed between 500 and 999, and 12.0% between 1 and 199 LCs. Surgeons differed in their preferences regarding acceptable operation times, with 38.0% considering less than 60 minutes acceptable, 14.0% less than 90 minutes, 18.0% less than 120 minutes, and 26.0% reporting no time limit. Regarding acceptable blood loss, 64.0% stated that less than 100 mL was preferable.

Conversion to open surgery was primarily influenced by factors such as significant blood loss (68.0%), adjacent organ or biliary injury (94.0%), and dense adhesions or severe fibrosis in the Calot's triangle (64.0%) (Table 1). However, conversion was less likely with prolonged operative time (72.0%). Notably, only 14.0% of surgeons reported that conversion made the procedure easier, whereas 44% felt it did not, and 30.0% found it equally challenging.

Participants were surveyed regarding three key safety techniques in LC: intraoperative cholangiography (IOC), the "Critical View of Safety" (CVS) technique, and the identification of Rouvière's sulcus. Among these, IOC was consistently utilized ("always" or in the "majority of cases") by only 12.0% of respondents, while the CVS technique and identification of Rouvière's sulcus were applied in approximately 68.0% and 56.0% of cases, respectively. Notably, the use of these techniques did not significantly vary with the level of surgical experience (p = 0.34, p =0.072, and p = 0.56, respectively).

Several factors were identified as significantly influencing the difficulty of LC. The most critical contributors were "scarring adhesion of surrounding organs" (88.0%), "fibrotic adhesion of surrounding organs" (78.0%), and "spontaneous perforation or abscess formation" (80.0%). Additional factors included "necrotic changes in the dissected area" (64.0%) and "edematous changes in the gallbladder bed" (58.0%). Surgeons also highlighted challenges posed by "collateral vein formation due to liver cirrhosis" (82.0%) and "cholecysto-enteric fistula" (90.0%) (Table 2). These factors underscore the multifactorial nature of surgical difficulty, often prompting a transition from

Table 1. Experience in LC and acceptable maximum duration of surgery and estimated blood loss

	Number (%)	*p*-value
Number of cholecystectomy (open & LCs) cases performed as an operator or instructor		
1–199	6 (12.0)	
200–499	9 (18.0)	
500–999	9 (18.0)	
≥ 1,000	26 (52.0)	
Number of LCs cases performed as an operator or instructor		
1–199	7 (14.0)	0.01
200–499	12 (24.0)	
500–999	13 (26.0)	
≥ 1,000	18 (36.0)	
Maximum duration of surgery		
≤ 60 min	19 (38.0)	0.09
≤ 90 min	7 (14.0)	
≤ 120 min	9 (18.0)	
≤ 180 min	2 (4.0)	
No time limit	13 (26.0)	
Maximum estimated blood loss		
Less than 100 mL	32 (64.0)	0.12
Less than 200 mL	9 (18.0)	
Less than 300 mL	2 (4.0)	
Less than 400 mL	0 (0.0)	
Less than 500 mL	1 (2.0)	
No limits	6 (12.0)	
Intraoperative clinical scenarios to abandon conventional LC		
Extensive operative time	14 (28.0)	0.11
Extensive blood loss	34 (68.0)	0.24
Damage to adjacent organs or biliary tract injury	47 (94.0)	0.32
Extensive and dense adhesion to surrounding organs and/or greater omentum	32 (64.0)	0.14
Severe fibrosis and scarring in Calot's triangle or gallbladder bed due to inflammation	32 (64.0)	0.22
Thoughts on if open conversion makes the operation easier		
Yes	7 (14.0)	0.02
Depends on case	6 (12.0)	
No	22 (44.0)	
Equally difficult	15 (30.0)	

LC, laparoscopic cholecystectomy.

laparoscopic to open cholecystectomy or other procedures.

The results revealed significant differences in how surgeons of varying experience levels perceived and managed intraoperative challenges. Surgeons with fewer than 1,000 surgeries were more inclined to attribute increased surgical difficulty to factors such as scarring adhesion of surrounding organs (p = 0.025), cholecysto-enteric fistula (p = 0.014), excessive visceral fat (p = 0.04), anomalous cystic duct (p = 0.026), and gallbladder neck mounting on the common bile duct (CBD) (p = 0.01) compared to their counterparts with greater experience (over 1,000 surgeries). They also reported encountering increased difficulty in managing fibrosis (p = 0.035) and scarring (p = 0.016) in the gallbladder bed, as well as during dissection of both Calot's triangle (p = 0.01) and the gallbladder bed (p = 0.023) (Table 2). No significant differences were observed between the groups regarding their perception of factors such as edematous changes, necrotic alterations, and abscess formation in the dissected area, Calot's triangle, or gallbladder bed (p > 0.05). These findings suggest that while certain intraoperative challenges are universally recognized as difficult, the capability to manage more complex conditions significantly enhances with surgical experience.

In preoperative planning, specific ultrasonographic features were consistently identified as important. The diameter of the CBD was considered "Useful Always" by 52.0% of surgeons, while gallbladder wall thickness was similarly regarded by

Table 2. Surgeons' opinions on potential factors contributing to surgical difficulty identified during operation

	Overall			Experience < 1,000 surgeries			Experience > 1,000 surgeries			*p*-value
	Easy LC	Difficult LC	Cannot comment	Easy LC	Difficult LC	Cannot comment	Easy LC	Difficult LC	Cannot comment	
Appearance of gall bladder and surrounding										
Edematous change in the dissected area	25 (50.0)	19 (38.0)	6 (12.0)	12 (50.0)	11 (45.8)	1 (4.2)	13 (50.0)	8 (30.8)	5 (19.2)	0.212
Fibrotic adhesion of surrounding organs due to inflammation	8 (18.0)	39 (78.0)	3 (6.0)	2 (8.3)	19 (79.2)	3 (12.5)	6 (23.1)	20 (76.9)	0 (0.0)	0.084
Scarring adhesion of surrounding organs	2 (4.0)	44 (88.0)	4 (8.0)	2 (8.3)	18 (75.0)	4 (16.7)	0 (0.0)	26 (100.0)	0 (0.0)	0.025*
Easy bleeding during adhesiolysis	17 (34.0)	22 (44.0)	11 (22.0)	10 (41.7)	11 (45.8)	3 (12.5)	7 (26.9)	11 (42.3)	8 (30.8)	0.256
Necrotic changes in the dissected area	6 (12.0)	32 (64.0)	12 (24.0)	4 (16.7)	15 (62.5)	5 (20.8)	2 (7.7)	17 (65.4)	7 (26.9)	0.593
Spontaneous (non-iatrogenic) perforation of the gallbladder wall and/or abscess formation towards the abdominal cavity noted during adhesiolysis	9 (18.0)	40 (80.0)	1 (2.0)	5 (20.8)	19 (79.2)	0 (0.0)	4 (15.4)	21 (80.8)	1 (3.8)	0.568
Cholecysto-enteric fistula	0 (0.0)	45 (90.0)	5 (10.0)	0 (0.0)	19 (79.2)	5 (20.8)	0 (0.0)	26 (100.0)	0 (0.0)	0.014*
Excessive visceral fat	18 (36.0)	23 (46.0)	9 (18.0)	9 (37.5)	14 (58.3)	1 (4.2)	9 (34.6)	9 (34.6)	8 (30.8)	0.04*
Inversion of the gallbladder in the gallbladder bed due to liver cirrhosis	3 (6.0)	42 (84.0)	5 (10.0)	2 (8.3)	20 (83.3)	2 (8.3)	1 (3.8)	22 (84.6)	3 (11.5)	0.76
Collateral vein formation due to liver cirrhosis	3 (6.0)	41 (82.0)	6 (12.0)	2 (8.3)	17 (70.8)	5 (20.8)	1 (3.8)	24 (92.3)	1 (3.8)	0.127
Appearance of the Calot's triangle										
Edematous change in the Calot's triangle	25 (50.0)	19 (38.0)	6 (12.0)	14 (58.3)	9 (37.5)	1 (4.2)	11 (42.3)	10 (38.5)	5 (19.2)	0.223
Fibrotic change in the Calot's triangle	4 (8.0)	44 (88.0)	2 (4.0)	3 (12.5)	21 (87.5)	0 (0.0)	1 (3.8)	23 (88.5)	2 (7.7)	0.221
Scarring in the Calot's triangle	2 (4.0)	46 (92.0)	2 (4.0)	2 (8.3)	22 (91.7)	0 (0.0)	0 (0.0)	24 (92.3)	2 (7.7)	0.134
Easy bleeding during dissection of the Calot's triangle	12 (24.0)	30 (60.0)	8 (16.0)	6 (25.0)	18 (75.0)	0 (0.0)	6 (23.1)	12 (46.2)	8 (30.8)	0.01*
Necrotic changes in the Calot's triangle	2 (4.0)	45 (90.0)	3 (6.0)	1 (4.2)	23 (95.8)	0 (0.0)	1 (3.8)	22 (84.6)	3 (11.5)	0.229
Impacted gallstone in the cystic duct	15 (30.0)	28 (56.0)	7 (14.0)	7 (29.2)	16 (66.7)	1 (4.2)	8 (30.8)	12 (46.2)	6 (23.1)	0.126
Anomalous cystic duct	11 (22.0)	29 (58.0)	10 (20.0)	6 (25.0)	17 (70.8)	1 (4.2)	5 (19.2)	12 (46.2)	9 (34.6)	0.026*
Short cystic duct	14 (28.0)	31 (62.0)	5 (10.0)	7 (29.2)	17 (70.8)	0 (0.0)	7 (26.9)	14 (53.8)	5 (19.2)	0.074
Gallbladder neck mounting on common bile duct	9 (18.0)	33 (66.0)	8 (16.0)	6 (25.0)	18 (75.0)	0 (0.0)	3 (11.5)	15 (57.7)	8 (30.8)	0.01*
Appearance of the gallbladder bed										
Edematous change in the gallbladder bed	29 (58.0)	21 (42.0)	0 (0.0)	15 (57.7)	9 (34.6)	0 (0.0)	14 (53.8)	12 (46.2)	0 (0.0)	0.536
Fibrotic change in the gallbladder bed	15 (30.0)	30 (60.0)	5 (10.0)	10 (38.5)	14 (53.8)	0 (0.0)	5 (19.2)	16 (61.5)	5 (19.2)	0.035*
Scarring in the gallbladder bed	11 (22.0)	33 (66.0)	6 (12.0)	8 (30.8)	16 (61.5)	0 (0.0)	3 (11.5)	17 (65.4)	6 (23.1)	0.016*
Easy bleeding during dissection of the gallbladder bed	16 (32.0)	27 (54.0)	7 (14.0)	9 (34.6)	15 (57.7)	0 (0.0)	7 (26.9)	12 (46.2)	7 (26.9)	0.023*
Necrotic changes in the gallbladder bed	12 (24.0)	35 (70.0)	3 (6.0)	6 (23.1)	17 (65.4)	1 (3.8)	6 (23.1)	18 (69.2)	2 (7.7)	0.868
Abscess formation towards the liver parenchyma	6 (12.0)	39 (78.0)	5 (10.0)	2 (7.7)	21 (80.8)	0 (0.0)	3 (11.5)	18 (69.2)	5 (19.2)	0.076

LC, laparoscopic cholecystectomy.
*Statistically significant ($p < 0.05$).

42.0%. Impacted stones were considered essential by 60.0% of the respondents. Conversely, liver echogenicity and gallbladder measurements were voted as "Useful Occasionally" by 56.0% and 48.0%, respectively. Parameters such as portal vein flow velocity and pericholecystic fluid collection were classified as "Not Required" by 65.0% and 58.0% of surgeons.

DISCUSSION

Our study highlights the multifaceted influences on the complexity of LC and the decision-making process concerning conversion to open surgery. Although trends such as the impact of intraoperative complications like significant blood loss (68.0%), biliary or adjacent organ injury (94.0%), and dense adhesions in the Calot's triangle (64.0%) were noted, the decision to convert seemed to be more heavily influenced by individual surgeon judgment than by experience or institutional affiliation. This observation corroborates findings from earlier studies demonstrating the subjective nature of decision-making in laparoscopic surgery, such as those conducted by Kortram et al. [12], Sakpal et al. [13], and Coffin et al. [14], which indicated that more experienced surgeons were less likely to convert to open surgery, although factors like the extent of fibrosis and anatomical anomalies were critical in determining surgical difficulty and conversion rates.

Our data also underscore the complexity of factors contributing to surgical difficulty in LC. The incidence of "scarring adhesion of surrounding organs" (88.0%) and "fibrotic adhesion" (78.0%) aligns with studies by Tang and Cuschieri [15], Yang et al. [16], and El Nakeeb et al. [17], which report that fibrosis—arising from chronic inflammation, previous surgeries, or liver cirrhosis—complicates the dissection and visualization of critical structures, thereby increasing the complexity of the surgery [16]. Complications such as "spontaneous perforation or abscess formation" and "necrotic changes" are prevalent in advanced cholecystitis and other severe gallbladder conditions. These complications significantly elevate the risk of converting to open surgery, as evidenced by national registries reporting a tripling in conversion rates compared to cases of straightforward acute cholecystitis [18,19].

We found that only 12% of surgeons reported consistently performing IOC "always" or in the "majority of cases," despite its proven effectiveness in enhancing surgical safety during LC. IOC provides real-time imaging of the biliary anatomy, thereby reducing bile duct injury risk [20]. However, its underutilization may be attributed to factors such as time restrictions, reliance on alternative safety techniques, or the absence of standardized institutional protocols. Although the CVS technique and identification of Rouvière's sulcus are effective in minimizing complications, integrating IOC with these methods can further enhance surgical safety. The absence of significant variability in the application of safety techniques depending on surgical experience underscores the necessity for thorough training programs and institution-specific guidelines to promote consistent application of IOC. Implementing routine IOC, particularly in complex cases, could markedly improve patient outcomes and reduce the incidence of complications.

Our study observed that surgeons with fewer than 1,000 LC surgeries were more likely to identify factors such as scarring adhesion, cholecysto-enteric fistula, excessive visceral fat, anomalous cystic duct, and mounting of the gallbladder neck on the CBD as significant contributors to surgical difficulty compared to their more experienced counterparts. This finding suggests that seasoned surgeons are more adept at navigating these complexities due to their familiarity with anatomical variations and intraoperative scenarios, thereby reducing the risk of serious complications such as bleeding and fibrosis [7].

No significant differences were detected between the groups regarding other intraoperative complications, such as edematous changes, necrotic changes, or abscess formation, indicating that these challenges are uniformly perceived as difficult, irrespective of surgical experience. This suggests that certain complications represent universal challenges for surgeons, regardless of their level of expertise. Overall, these findings underscore the need for targeted training to address specific challenges encountered by less experienced surgeons.

The role of preoperative imaging in assessing surgical difficulty was also emphasized. Ultrasonographic features such as the diameter of the CBD and gallbladder wall thickness were consistently rated as essential, with over 50% of respondents considering them "Always Useful." This aligns with findings from other studies that emphasize the predictive value of CBD diameter and wall thickness in assessing the complexity of LC [21]. Studies by Alotaibi [22] and Costi et al. [23] suggested that CBD dilation and thickened gallbladder walls are indicative of chronic cholecystitis or complicated biliary disease, both associated with higher surgical complexity. Furthermore, the presence of impacted stones, as reported by 60% of respondents, is recognized as a key predictor of difficulty during LC, as also reported by Blohm et al. [24].

In contrast, parameters such as liver echogenicity, gallbladder measurements, portal vein flow velocity, and pericholecystic fluid collection were deemed less critical. This is consistent with findings by Puggioni and Wong [25], who reported that liver echogenicity and other nonspecific ultrasonographic features have limited utility in predicting intraoperative difficulties during LC. Similarly, Fuks et al. [26] reported that pericholecystic fluid was not significantly associated with conversion. However, the presence of a gallstone in the infundibulum was the only factor significantly associated with conversion. The selective use of these parameters suggests that while they may provide some insight into patient anatomy, they are not sufficiently reliable for predicting the technical challenges of the surgery itself.

The variability in both acceptable operation time and blood loss underscores the subjective nature of assessing surgical

difficulty. Although 64% of surgeons deemed blood loss under 100 mL as acceptable, opinions on the suitable duration of operations varied widely. These observations imply that perceptions of surgical difficulty can vary depending on a surgeon's experience and complication threshold. Surgeons with more experience tend to report fewer operations as difficult, regardless of extended duration or significant blood loss.

Our study emphasizes the multifactorial nature of LC difficulty and the decision-making process regarding conversion to open surgery, highlighting that surgeon judgment plays a more pivotal role than either experience or institutional protocols. While intraoperative complications such as significant blood loss, injuries to the biliary system or adjacent organs, and dense adhesions at the Calot's triangle seem to influence the decision to convert, our results indicate that surgeon judgment outweighs factors like experience or institutional guidelines. Previous studies have shown that experienced surgeons are less likely to convert to open surgery, with elements like fibrosis and anatomical anomalies critically affecting surgical complexity and conversion rates.

Despite its confirmed safety advantages, IOC was underutilized, indicating a need for enhanced training and institutional protocols to ensure its consistent application. Furthermore, prioritizing preoperative imaging data that delineates critical features such as CBD diameter, gallbladder wall thickness, and the presence of impacted stones is essential for anticipating potential challenges.

In conclusion, our study exposes significant variability in the criteria for converting to open cholecystectomy, influenced predominantly by individual surgeon judgment rather than by experience or institutional factors. It underscores the role of conditions such as adhesions, fibrosis, and anatomical variations in determining surgical complexity. Preoperative imaging is vital for predicting surgical challenges, yet objective intraoperative findings provide greater precision and should be integrated into standardized criteria for assessing surgical difficulty. In the future, we plan to develop a risk prediction tool using preoperative variables to improve the anticipation of intraoperative challenges and refine patient selection for laparoscopic or open cholecystectomy.

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CONFLICT OF INTEREST

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AUTHOR CONTRIBUTIONS

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