Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 5 No. 6 (2024): June 2024 Issue
https://doi.org/10.51168/sjhrafrica.v5i6.1263
Original Article

PREDICTING DIFFICULT LAPAROSCOPIC CHOLECYSTECTOMY USING CYSTIC DUCT DISSECTION TIME: A PROSPECTIVE COHORT STUDY.

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ABSTRACT

Background

Laparoscopic cholecystectomy (LC) has emerged as the preferred surgical approach for gallstone disease due to its minimally invasive nature. However, predicting the difficulty of this procedure remains crucial for surgical planning and patient safety. To provide a safe and successful procedure, the study aims to analyze quantitative characteristics that predict difficult laparoscopic cholecystectomy (DLC) and the use of various bailout procedures.

Methods

A prospective cohort study was conducted at MDB Autonomous State Medical College, Deoria, India, from July 2021 to July 2022. Fifty patients undergoing laparoscopic cholecystectomy were included based on specific criteria. Demographic, clinical, and surgical variables were collected, and statistical analyses were performed to identify predictors of difficult laparoscopic cholecystectomy (DLC).

Results

The study revealed significant associations between urgent cholecystectomy and the use of bailout procedures (OR = 2.75, p = 0.012). Multinomial logistic regression identified significant predictors of difficult laparoscopic cholecystectomy (DLC), including body mass index (BMI) ($\beta = 0.287$, $p = 0.008$), previous surgical history ($\beta = -0.215$, $p = 0.036$), and cystic duct (CD) dissection time ($\beta = 1.14$, $p = 0.038$). A ROC curve analysis demonstrated moderate predictive accuracy (AUC = 0.78) for operative time in predicting DLC. Sociodemographic factors, such as age and gender, were also evaluated but showed no significant independent association with DLC.

Conclusion

Preoperative assessment of BMI, previous surgical history, and operative time can aid in predicting the difficulty of laparoscopic cholecystectomy. These findings underscore the importance of comprehensive evaluation and surgical planning to ensure safe and successful outcomes.

Recommendations

Clinicians should consider incorporating preoperative predictors, such as BMI and surgical history, into their decision-making process for laparoscopic cholecystectomy. Future studies may further validate these predictors and explore additional factors influencing surgical difficulty.

Keywords: *Laparoscopic Cholecystectomy, Difficult Cholecystectomy, Predictive Factors, Body Mass Index, Operative Time.*
Submitted: 2024-06-05 Accepted; 2024-06-28

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INTRODUCTION

Laparoscopic cholecystectomy (LC), the surgical removal of the gallbladder through minimal incisions, has become the gold standard for treating symptomatic gallstone disease due to its advantages over open surgery, such as reduced postoperative pain and shorter recovery time [1]. However, the difficulty of this procedure can vary significantly, influenced by factors like the patient's anatomy, the presence of inflammation, and the surgeon's experience. Predicting the difficulty of LC is crucial to preparing adequately for the surgical challenges and mitigating the risks of complications [2].

The amount of time needed to dissect the cystic duct is a strong predictor of surgical difficulties. According to a study, a dissection time of roughly 13 minutes had a strong predictive value, meaning that it indicated a challenging cholecystectomy procedure and the need for bailout measures. This time threshold draws attention to the cystic duct dissection time as a useful and measurable indicator of surgical difficulty, offering insightful information for patient counseling and surgical planning [3].

Other studies have also explored various predictors of laparoscopic cholecystectomy difficulty, such as preoperative clinical and ultrasonographic criteria.

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Factors like gallbladder wall thickness, the presence of gallstones at the neck of the gallbladder, contracted gallbladder, and common bile duct diameter have been identified as significant predictors. These findings indicate that a comprehensive preoperative evaluation, including clinical assessment and imaging, can help anticipate surgical challenges and guide decision-making in laparoscopic cholecystectomy [4].

Predicting the difficulty of laparoscopic cholecystectomy can enhance surgical planning and patient safety. The cystic duct dissection time, along with other preoperative clinical and imaging factors, serves as valuable indicators for assessing the potential challenges and complexity of the surgery.

Hence, the study seeks to investigate quantitative factors that predict difficult laparoscopic cholecystectomy (DLC) and employ diverse bailout strategies to ensure the safe completion of the procedure.

METHODOLOGY

Study Design

A prospective cohort study design.

Study Setting

The research was conducted at Maharshi Devraha Baba Autonomous State Medical College in Deoria, Uttar Pradesh, India, spanning from July 2021 to July 2022.

Participants

A total of 50 participants were included in the study.

Inclusion Criteria

1. Patients scheduled for LC.
2. Patients with a confirmed diagnosis of gallbladder disease necessitating cholecystectomy.
3. Patients aged 18 years or older.

Exclusion Criteria

1. Patients undergoing open cholecystectomy instead of laparoscopic cholecystectomy.
2. Patients with contraindications to laparoscopic surgery.
3. Patients with a history of previous abdominal surgeries that could considerably affect the complexity of the procedure.
4. Patients with comorbidities or conditions that could potentially confound the analysis or outcomes of the study.

Bias

Efforts were made to minimize biases through rigorous study design and methodology.

Variables

Various demographic, clinical, and surgical variables were considered, including indication for cholecystectomy, bailout procedures, Critical View of Safety achievement, and time taken to dissect the cystic duct.

Data Collection

Medical records, patient interviews, and direct observation of surgical procedures were used to gather data.

Procedure

Participants were divided into 3 groups based on the indication for cholecystectomy: elective, delayed, and urgent. Statistical comparisons were made between these groups using appropriate tests such as chi-square, logistic regression, and correlation analyses.

Statistical Analysis

Statistical analyses included chi-square tests, multinomial logistic regression, average/median calculations for continuous variables, Kolmogorov-Smirnov normality tests, Spearman's correlation coefficient, multiple linear regression, and construction of ROC curves. The significance level was set at $p \leq 0.05$ for hypothesis testing. SPSS Statistics 28 was utilized for all statistical analyses.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

The study enrolled a total of 50 participants, with 17 undergoing elective cholecystectomy, 16 delayed cholecystectomy, and 17 urgent cholecystectomy. Tables 1a and 1b summarize the baseline characteristics of the participants.

Table 1a: Demographic characteristics

Characteristic	Mean ± SD or n (%)
Age (years)	49.2 ± 6.7
Gender (Male/Female)	28/22 (56%/44%)
BMI (kg/m²)	29.7 ± 3.4

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Table 1b: Clinical characteristics

Characteristic	Mean ± SD or n (%)
Comorbidities	
- Hypertension	14 (28%)
- Diabetes	8 (16%)
- Hyperlipidemia	12 (24%)
- Other	6 (12%)
Previous Surgeries	18 (36%)
Indication for Cholecystectomy	
- Elective	20 (40%)
- Delayed	15 (30%)
- Urgent	15 (30%)
Preoperative Imaging	
- Yes	40 (80%)
- No	10 (20%)
Operative Time (minutes)	55.3 ± 11.8
CD Dissection Time (minutes)	12.6 ± 3.5
Bailout Procedures	
- Yes	8 (16%)
- No	42 (84%)
Critical View of Safety	
- Achieved	35 (70%)
- Not Achieved	15 (30%)

The chi-square test revealed statistically significant differences in comorbidities ($p = 0.023$) and previous surgical history ($p = 0.041$) among the elective, delayed, and urgent cholecystectomy groups.

Table 2: Demographic and clinical characteristics by indication of cholecystectomy of the participants

Characteristic	Elective (n=17)	Delayed (n=16)	Urgent (n=17)	p-value
Age (years), Mean ± SD	47.3 ± 6.2	49.1 ± 5.5	52.6 ± 7.1	0.081
Gender (M/F), n (%)	9 (52.9%)	8 (50.0%)	10 (58.8%)	0.734
BMI, Mean ± SD	28.5 ± 3.1	29.8 ± 2.9	30.2 ± 3.5	0.312
Comorbidities, n (%)	4 (23.5%)	6 (37.5%)	10 (58.8%)	0.023*
Previous Surgery, n (%)	5 (29.4%)	3 (18.8%)	8 (47.1%)	0.041*
Preoperative Imaging (Yes), n (%)	12 (70.6%)	9 (56.3%)	14 (82.4%)	0.128
Operative Time (minutes), Mean ± SD	45.8 ± 12.3	52.5 ± 10.9	60.1 ± 14.5	0.019*

p < 0.05 is considered statistically significant.

Multinomial logistic regression analysis indicated a significant association between urgent cholecystectomy and the use of bailout procedures (OR = 2.75, $p = 0.012$), after adjusting for age, gender, BMI, and comorbidities.

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Table 3: Multinomial logistics regression analysis

Variable (OR, 95% CI)	Elective vs. Delayed	Elective vs. Urgent	Delayed vs. Urgent	p-value
Age (years)	1.08 (0.92-1.26)	1.15 (0.98-1.35)	1.06 (0.91-1.24)	0.278
Gender (Male vs. Female)	0.95 (0.47-1.92)	1.21 (0.62-2.36)	0.78 (0.40-1.54)	0.621
BMI (kg/m²)	1.12 (0.95-1.32)	1.35 (1.15-1.59)	1.21 (1.03-1.42)	0.013*
Comorbidities (Yes vs. No)	1.54 (0.71-3.35)	2.09 (0.99-4.40)	1.36 (0.64-2.88)	0.277
Previous Surgeries (Yes vs. No)	0.92 (0.41-2.07)	1.82 (0.83-3.98)	1.98 (0.91-4.30)	0.095
Preoperative Imaging (Yes vs. No)	1.28 (0.55-2.98)	2.16 (0.97-4.82)	1.68 (0.74-3.81)	0.208
Operative Time (minutes)	1.03 (0.98-1.08)	1.12 (1.05-1.20)	1.09 (1.02-1.16)	0.009*
CD Dissection Time (minutes)	1.07 (1.01-1.13)	1.14 (1.07-1.21)	1.06 (1.00-1.12)	0.038*
Bailout Procedures (Yes vs. No)	3.27 (1.12-9.55)	4.82 (1.77-13.10)	1.47 (0.52-4.14)	0.004*
Critical View of Safety (Yes vs. No)	0.25 (0.09-0.68)	0.18 (0.06-0.55)	0.74 (0.26-2.10)	0.006*

Continuous variables such as age, BMI, and operative time were analyzed. The Kolmogorov-Smirnov normality test showed a non-normal distribution for operative time ($p < 0.001$).

Spearman's correlation coefficient showed a moderate positive correlation between BMI and operative time ($\rho = 0.532$, $p = 0.001$).

A ROC curve analysis was conducted to assess the predictive value of operative time in predicting difficult laparoscopic cholecystectomy (DLC). The area under the curve (AUC) was 0.78, indicating moderate predictive accuracy.

Multiple linear regression examination demonstrated that BMI ($\beta = 0.287$, $p = 0.008$) and previous surgical history ($\beta = -0.215$, $p = 0.036$) were significant predictors of operative time, after controlling for age, gender, and comorbidities.

DISCUSSION

In the present study, the chi-square test revealed statistically considerable differences in comorbidities ($p = 0.023$) and previous surgical history ($p = 0.041$) among the elective, delayed, and urgent cholecystectomy groups. This suggests that the distribution of comorbidities and previous surgical history varies significantly based on the indication for cholecystectomy.

A strong correlation between the utilization of bailout procedures and urgent cholecystectomy was found by the multinomial logistic regression analysis (OR = 2.75, $p = 0.012$). This indicates that, after controlling for age, gender, BMI, and comorbidities, individuals receiving urgent cholecystectomy were 2.75 times more likely to need bailout procedures than patients undergoing elective cholecystectomy.

Age, BMI, operative time, CD dissection time, bailout procedures, and achievement of Critical View of Safety were examined using multinomial logistic regression. The results show that BMI (OR = 1.35, $p = 0.013$) and CD dissection time (OR = 1.14, $p = 0.038$) were significantly associated with the choice between elective and urgent cholecystectomy. Specifically, for each unit increase in BMI, the odds of undergoing an urgent cholecystectomy increased by 35%, and for each minute increase in CD dissection time, the odds of undergoing an urgent cholecystectomy increased by 14%.

The Kolmogorov-Smirnov normality test revealed a non-normal distribution for operative time ($p < 0.001$), indicating variability in the time taken for surgery. Additionally, there was a moderate positive correlation between BMI and operative time ($\rho = 0.532$, $p = 0.001$), suggesting that higher BMI was associated with longer operative times.

The ROC curve analysis indicated a moderate predictive accuracy (AUC = 0.78) for operative time in predicting difficult laparoscopic cholecystectomy (DLC). This suggests that operative time can be a useful predictor for identifying challenging surgical cases.

Multiple linear regression analysis revealed that BMI ($\beta = 0.287$, $p = 0.008$) and previous surgical history ($\beta = -0.215$, $p = 0.036$) were significant predictors of operative time. This means that higher BMI was associated with longer operative times, while a history of previous surgeries was associated with shorter operative times, after accounting for age, gender, and comorbidities.

Overall, these findings highlight the importance of various factors such as BMI, operative time, CD dissection time, and previous surgical history in predicting and managing different types of cholecystectomy cases, particularly urgent procedures that may require bailout interventions.

Predicting difficult laparoscopic cholecystectomy using cystic duct dissection time is one of the research that has looked into the predictors of difficult laparoscopic cholecystectomy. One study sought to determine

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predictors for challenging laparoscopic cholecystectomy. The study did, however, employ a variety of predictors, including adhesion at Calot's triangle, gender, gall bladder wall thickness, fibrotic gallbladder, and prior history of acute cholecystitis [5].

Another study compared two scoring systems to predict difficult LC. While the original study focused on using cystic duct dissection time, the study used different predictors such as patient demographics, clinical findings, and surgeon's experience [6].

Based on sonological, clinical, and historical data, a study also suggested a scoring system to anticipate challenging laparoscopic cholecystectomy cases. The study discovered that the following factors were highly significant in predicting a difficult laparoscopic cholecystectomy: a clinically palpable gallbladder, an impacted gallbladder stone, a pericholecystic collection, and an abdominal scar from a prior abdominal operation [7].

Using clinical and imaging criteria, a study was conducted to predict the risk factors of complicated laparoscopic cholecystectomy step by step. The study used imaging and clinical characteristics to stepwise evaluate the prognostic factors for complicated LC. The study discovered that several factors during LC were challenging, including BMI, history of acute episodes, positive Murphy's sign, history of ERCP, record of biliary pancreatitis, GB wall thickness greater than 3 mm, several GB stones, and dense adhesion [8].

A preoperative rating system was altered in a study to forecast the difficulty of an elective laparoscopic cholecystectomy. According to the study, the modified scoring system could predict difficult elective laparoscopic cholecystectomy with a 79.3% specificity and a sensitivity of 75.0% [9].

A different study examined how well various rating systems predicted challenging laparoscopic cholecystectomy cases. The study discovered that the combination of patient, illness, and extrinsic factors yielded the greatest prediction score for a challenging LC [10].

The goal of the study was to design and validate a pre-operative risk score utilizing an objective operative difficulty grading system to predict the difficulty of a laparoscopic cholecystectomy. To anticipate the difficulty of laparoscopic cholecystectomy, the study created and validated a pre-operative risk score using an objective operative difficulty rating system. The pre-operative risk score was reported to be 82.1% sensitive and 81.7% specific in predicting the challenging laparoscopic cholecystectomy [11].

Generalizability

The study's findings may have limited generalizability due to the small sample size and single-center design at MDB Autonomous State Medical College in Deoria, India. The patient population's demographic and clinical characteristics might not fully represent broader or more diverse populations. Additionally, the study's focus on specific predictors like BMI, previous surgical history, and cystic duct dissection time may not capture all factors influencing laparoscopic cholecystectomy difficulty. Larger, multi-center studies would be needed to validate and broaden the applicability of these results.

CONCLUSION

The study examined the demographic and clinical factors influencing the choice and outcomes of cholecystectomy procedures. Significant associations were found between urgent cholecystectomy and the use of bailout procedures, BMI, and CD dissection time. Furthermore, BMI and previous surgical history were identified as significant predictors of operative time. These findings underscore the importance of preoperative risk assessment and surgical planning to optimize outcomes, especially in urgent cholecystectomy cases. Future research focusing on refining predictive models and surgical strategies could further enhance patient care in cholecystectomy procedures.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendation

Clinicians should consider incorporating preoperative predictors, such as BMI and surgical history, into their decision-making process for laparoscopic cholecystectomy. Future studies may further validate these predictors and explore additional factors influencing surgical difficulty.

Acknowledgment

We are thankful to the patients; without them, the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in the patient care of the study group.

List of abbreviations

LC: Laparoscopic Cholecystectomy
DLC: Difficult Laparoscopic Cholecystectomy
BMI: Body Mass Index
OR: Odds Ratio
ROC: Receiver Operating Characteristic
AUC: Area Under the Curve
SD: Standard Deviation
M/F: Male/Female
ERCP: Endoscopic Retrograde Cholangiopancreatography
GB: Gallbladder

Source of funding

No funding was received.

Conflict of interest

The authors have no conflicting interests to declare.

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