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Cystic Duct Dissection Time as a Predictor of Difficult Laparoscopic Cholecystectomy

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ABSTRACT

Background: The Tokyo 2018 guidelines call for the study of quantitative predictors of surgical difficulty in laparoscopic cholecystectomy for complete cholecystectomy in a safe context.
Objective: To evaluate the cystic duct (CD) dissection time as a predictor of surgical difficulty.
Materials and methods: This prospective study included 193 patients who underwent laparoscopic cholecystectomy in 2022 and were grouped according to the indication for cholecystectomy: Urgent, Delayed, and Elective. Multiple linear regression and multinomial logistic regression analyses were used to identify the preoperative and operative predictive variables of surgical difficulty. The predictive value of the time spent dissecting the CD was estimated using a ROC curve.
Results: The CD dissection time of 13 min had 100% sensitivity and 99% specificity, PPV 100%, NPV 1%, OR 3.3 to predict the use of bailout techniques.
Conclusions: The time required to dissect the cystic duct, with or without success, is a practical predictor of the subsequent use of bailout procedures and, consequently, predicts the "Risk/Difficult Cholecystectomy".

Keywords: Difficult laparoscopic cholecystectomy, predictors of difficult cholecystectomy, bailout procedures, cystic dissection time, risk of cholecystectomy.

INTRODUCTION

The 2018 Tokyo guidelines recommend that "surgeons should take into account the difficulty of cholecystectomy when selecting a treatment method," however they do not provide any risk assessment model, nor do they provide any definition of "difficult laparoscopic cholecystectomy (DLC)". [1,2] Although numerous studies have incorporated this term, no consensus has been reached on its definition or its predictors; however, the definition itself is questionable because it involves the surgeon, skills, technical aspects, and the pathologic findings of the gallbladder. Traditionally, DLC is the prelude to conversion, even a direct indication; therefore, for most authors, the predictors of operative difficulty are the same predictors for conversion, while others consider conversion as an optional bailout technique, given that in some hospitals surgeons have little experience with open technique, conversion may not be a safe option. [3-6]

Possible reasons for the almost null use of prediction systems are implementation difficulties due to the complexity of such scales, making them impractical. [7–10] As prolongation of operative time is closely related to patient morbidity, most predictor scales include the time factor; however, while an experienced surgeon completes the cholecystectomy in >50% of his standard time, the values obtained do not apply to all. [11] Previous studies have documented that primary problems with Calot's triangle dissection are associated with difficulty; thus, hypothesizing that failure to complete Calot's triangle dissection within a predetermined period may be an early predictor of DLC and the development of complications. [11,12]

It is widely accepted that during laparoscopic cholecystectomy, the most important strategy is to achieve the critical view of security (CVS), as it represents the final point of dissection. Little emphasis has been placed on the technical details of how surgeons should reach this endpoint. A multi-society consensus on bile duct injury prevention has not identified level 1 evidence to support CVS over other methods for anatomic identification. The description of CVS does not address how and where to begin and advance dissection to achieve this endpoint, despite the conclusion that injury to the main bile ducts would occur after such a view is achieved. [13,14] In cases where it is not feasible to obtain CVS, several "bailout" options have been described. [15–17] Prevention of bile duct injury during laparoscopic cholecystectomy is an unresolved problem. Clarifying the surgical difficulty using intraoperative findings may contribute to the search for best practices for cholecystectomy, but so far, no such method of evaluation has been established. In cases of severe inflammation and fibrosis of the gallbladder and surrounding areas, laparoscopic cholecystectomy is difficult and often associated with complications, which should be avoided. Therefore, it is necessary to establish an accurate, objective, and practical grading system to select the appropriate bailout procedure based on this evaluation. [3,18–21] In this work, we followed the universal invitation of the Tokyo guidelines [15], studying quantitative predictors of DLC and using various bailout techniques to complete cholecystectomy in a safe context.

MATERIALS & METHODS

A prospective study was conducted at the ISSSTE Puebla Regional Hospital in 2022. We divided the patients into three groups, to the indication for cholecystectomy: elective, delayed, and urgent. The ordinal and categorical variables of these groups were compared using the chi-square test and included the demographic and clinical variables. Multinomial logistic regression analysis was applied to the sets of categorical dependent variables, such as those related to the use of bailout procedures and impossibility of achieving a Critical View of Safety. In the analysis of the continuous variables the average ± standard deviation or median was used, depending on the nature of the distribution, Kolmogorov-Smirnov normality test and Spearman's correlation coefficient was used, and were analyzed with multiple linear regression. A $p \leq 0.05$ or 5 % (α-error) was considered statistically significant for a two-tailed hypothesis test.

A ROC curve was constructed to estimate the predictive value of the time taken to dissect the cystic duct (CD). Multivariate analysis was used for complementary analysis of the variables. SPSS Statistics 28 was used for all the analyses. This study was conducted in accordance with the Helsinki International Code of Ethics, which was reviewed and approved by the Research Ethics Committee of ISSSTE Puebla Regional Hospital (registration number 3922022).

RESULT

In total, 193 patients were included in this study (Table 1).

Table 1. Demographic and clinical characteristics.	
Variable	n= 193. F (%)
Sex	
Man	88 (45.6)
Woman	105 (54.4)
Comorbidities	
No comorbidity	25 (13)
Type II diabetes	116 (60)
Arterial Hypertension	100 (52)
Obesity	31 (16)
Smoking	6 (3)
Neurological comorbidity	5 (2.6)
Chronic kidney disease	2 (1)
Medical history	
Biliary colic	158 (82)
Acute pancreatitis	9 (4.7)
Upper abdominal surgery	7 (3.6)
Lower abdominal surgery	135 (70)
American Society of Anaesthesiologists score	
I	22 (11)
II	156 (81)
III	15 (8)
Indication for cholecystectomy	
Urgent	59 (30.6)
Delayed	22 (11.4)
Elective	112 (58)
Parkland Scale	
I	15 (7.8)
II	122 (63)
III	17 (8.8)
IV	28 (14.5)
V	11 (5.7)
Nassar Scale	
I	92 (47.7)
II	62 (32.1)
III	27 (14)
IV	12 (6.2)
Tokyo Severity	
Not applicable	145 (75)
Mild	27 (14)
Moderate	14 (7.3)
Severe	6 (3)
Placement of drainage	31 (16)
Bailout procedure	40 (20)
Puncture and aspiration	8 (20)
Fundus first	2 (5)
Fundus first + Puncture	5 (12.5)
Infundibular approach	3 (7.5)
Reconstituting cholecystectomy	7 (17.5)
Segment IV approach	1 (2.5)
Additional port placement	3 (7.5)
Cholangiography	1 (2.5)
Partial cholecystectomy + Cholangiography	1 (2.5)
Cystic Lymph Node Identification Approach	2 (5)
Partial cholecystectomy	3 (7.5)
Conversion	4 (10)

The patients were grouped according to the indication for cholecystectomy into three groups: Urgent, Delayed, and Elective (Table 2).

Table 2. Demographic and clinical characteristics by indication for cholecystectomy.				
Variable	**Urgent. n= 59, Freq. (%)**	**Delayed. n=22, Freq. (%)**	**Elective. n=112, Freq. (%)**	***p**
Sex				
Man	30 (50.8)	11 (50.0)	47 (42.0)	.491
Woman	29 (49.2)	11 (50.0)	65 (58.0)	
Comorbidities				
No comorbidity	16 (27)	8 (36.4)	53 (47.3)	.031
Type II diabetes	43 (72.1)	14 (63.6)	59 (52.7)	.035
Arterial Hypertension	35 (59.3)	11 (50)	54 (48.2)	.379

Obesity	19 (32.2)	0 (0.0)	12 (10.7)	<0.001
Smoking	3 (5)	0 (0.0)	3 (2.7)	.463
Neurological comorbidity	3 (5)	0 (0.0)	2 (1.8)	.312
Chronic kidney disease	1 (1.7)	0 (0.0)	1 (0.9)	.778
Medical history				
Biliary colic	42 (71.2)	15 (68.2)	158 (81.9)	.002
Acute pancreatitis	2 (3.4)	6 (27.3)	1 (1)	<0.001
Upper abdominal surgery	1 (1.7)	0 (0.0)	6 (5.4)	.299
Lower abdominal surgery	27 (45.8)	13 (59)	95 (84.8)	<0.001
American Society of Anaesthesiologists score				
I	6 (10)	3 (13.6)	13 (11.6)	.902
II	47 (79.7)	19 (86.4)	90 (80.4)	.844
III	6 (10.2)	0 (0.0)	9 (8)	.377
No. trocars				
4	59 (100)	21 (99)	111 (99)	.194
5	0 (0.0)	1(1)	1(1)	
Parkland Scale				
I	0 (0)	0(0)	15 (13.4)	.003
II	32 (54)	8 (36.4)	82 (73)	<0.001
III	7 (12)	4 (18)	6 (5.4)	.093
IV	14 (23.7)	7 (31.8)	7 (6.3)	<0.001
V	6 (10)	3 (13.6)	2 (2)	.019
Nassar Scale				
I	32 (54.2)	8 (36.4)	52 (46.4)	.330
II	7 (12)	4 (18)	51 (45.5)	<0.001
III	13 (22)	7 (31.8)	7 (6)	<0.001
IV	7 (12)	3 (13.6)	2 (2)	.011
Tokyo Severity				
Not applicable	0(0.0)	0(0.0)	112 (100)	<0.001
Mild	25 (42.4)	4 (18)	0 (0)	<0.001
Moderate	20 (34)	15 (68)	0 (0)	<0.001
Severe	12 (20)	3 (13.6)	0 (0)	<0.001
Placement of drainage	17 (29)	9 (41)	5 (4.5)	<0.001
Bailout procedure	15 (25.4)	10 (45.5)	15 (13.4)	.002
Puncture and aspiration	1 (1.7)	4 (18)	3 (3)	.002
Fundus first	2 (3)	0 (0)	0 (0)	.101
Fundus first + Puncture	2 (3)	0 (0)	3 (3)	.691
Infundibular approach	1 (2)	1 (4.5)	1 (1)	.446
Reconstituting cholecystectomy	4 (6.8)	0 (0)	3 (3)	.247
Segment IV approach	1 (2)	0 (0)	0 (0)	.319
Additional port placement	0 (0)	2 (9)	1 (1)	.009
Cholangiography	0 (0)	0 (0)	1 (1)	.695
Partial cholecystectomy + Cholangiography	0 (0)	1 (4.5)	0 (0)	.020
Cystic Lymph Node Identification Approach	1 (2)	0 (0)	1 (1)	.778
Partial cholecystectomy	1 (2)	1 (4.5)	1 (1)	.446
Conversion	2 (3.4)	1 (4.5)	1 (1)	.380

*** Chi-square test**

The delayed cholecystectomy group had the highest percentage of both operative difficulty and the use of bailout techniques (p= 0.002). Preoperative and postoperative descriptive data were documented (Table 3).

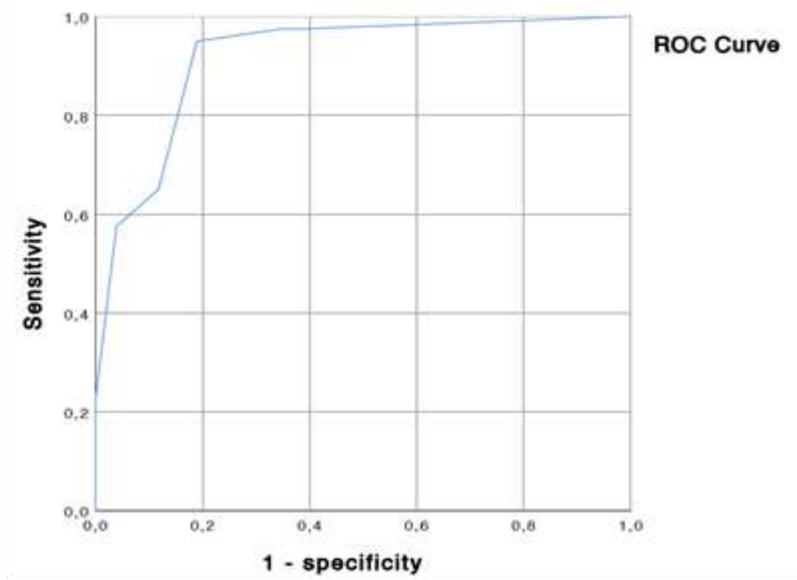
Table 3. Demographic and clinical characteristics. Descriptive data.

	n=193 (x̄± SD)
Age (years)	56 ± 11
At admission	
Leucocytes (per microliter)	9895 ± 4363
Neutrophils (per microliter)	8105 ± 4082
Hemoglobin (g/(dL))	14 ± 1
Alkaline phosphatase (U/l)	112 ± 121
AST (U/l)	83 ± 119
ALT (U/l)	82 ± 131
GGT (U/l)	80 ± 151
Total Bilirubin	1 ± 0.3
INR	1 ± 0.2
Surgical time (minutes)	86 ± 23
Cystic duct dissection time (minutes)	24 ± 10
Operative bleeding (ml)	77 ± 50
Days of hospital stay	2.3 ± 1

In the multivariate analysis, the variables statistically significantly related to the use of bailout procedures were: age ≥60 years, Parkland score ≥4, Tokyo Severity Grade III, total leukocyte count ≥13500/µL, total neutrophil count ≥11000/µL, alkaline phosphatase ≥166 IU/L, AST ≥170 U/L, ALT ≥190 U/L L, GGT ≥180 U/L, total bilirubin ≥1 mg/dL, ≥60 hours from pain onset to admission (in emergency cholecystectomy), gallbladder wall ≥12 mm, multiple gallstones ≥14 mm, fibrotic adhesions of Calot's triangle, intrahepatic gallbladder, scleroatrophic gallbladder, pericholecystic fluid, gallbladder hydrops, collateral venous circulation in the falciform ligament, abnormal bile duct, Moynihan’s hump, liver segment III abnormally enlarged, and the presence of subvesicular ducts.

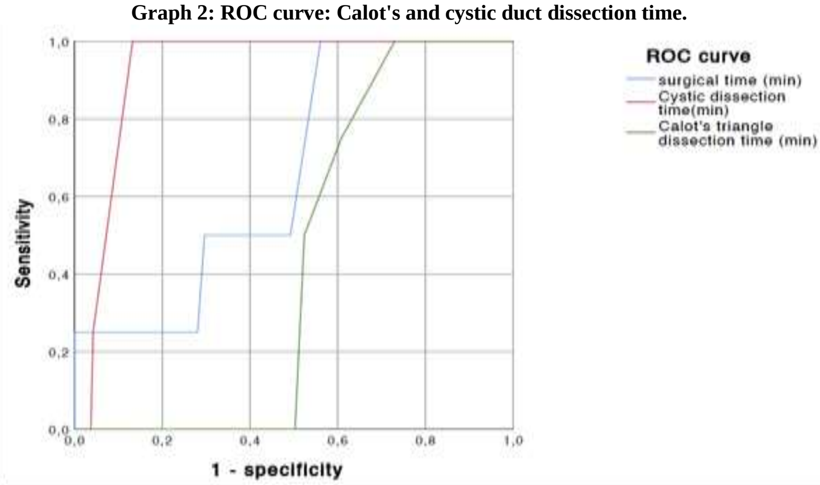
By estimating the area under the ROC curve of the time spent trying to dissect the CD, it was found to predict the use of bailout techniques (dissection time of 13 min had 100% sensitivity and 99% specificity; PPV 100%, NPV 1%, OR 3.3) (Figure 1).

Graph 1: ROC curve: Cystic duct dissection time.



However, the time spent trying to dissect the CD was also predictive of conversion, in relation to the dissection time of the Calot triangle (CD dissection time ≥25 min: sensitivity of 100% and specificity of 45% for conversion, OR 2.1) (Figure 2).

Graph 2: ROC curve: Calot's and cystic duct dissection time.



Finally, postoperative outcomes were evaluated with no readmission or mortality (Table 4). The mean hospital stay was 2 days. Drainage was placed in 31 patients (16%), most of whom were removed before a week (23/31, 74%), while fewer patients were removed after a week (8/31, 25%).

DISCUSSION

Most of the patients included were women, as in most studies [3,22,23] but in our series the age was slightly above average [3,22,23]. "DLC" has been used in many studies, but there is still no consensus on its definition [2,4,5,22–32]. We used the term when the SVC was not obtained and thus performed a bailout procedure to finish the cholecystectomy safely. In our study, we used bailout techniques for 40 (20%) patients, including conversion, because we have more experience with laparoscopic than open technique.

Variables linked to surgical difficulty were like those identified in other series. The age of ≥50 is regarded in other studies as a pre-operative predictor of difficulty [24,25,33], but for our study, the age was >60 years old. The parkland score is also considered a predictor, particularly at 4 (34). Total leukocyte and neutrophil counts, the mean counts of which are variable but like our findings [2,4,22,26,29]. 72 hours from onset of pain to OR admission to cholecystectomy is also considered a predictor [32,35], but our research shows that the significant association was more than >60 hours. Fibrotic adhesions of Calot's triangle, which make dissection difficult and are subjective data, are also included in predictive models [4,5,36], were also a variable associated with intraoperative difficulty in our study, both in multivariate analysis as well as in logistic regression.

Other variables identified in our study as related to surgical difficulties in laparoscopic cholecystectomy and that were also taken into account on prognostic scales in other series include the following: intrahepatic gallbladder; [5,36,37] scleroatrophic gallbladder; [5,26,36] pericholecystic fluid, [5,31,36,38–40] gallbladder hydrops, [5,14,36] collateral venous circulation in the falciform ligament, [36,37] abnormal bile duct, [15,36,37,41] Moynihan's Hump, [15,25,36,37,42] abnormally enlarged liver segment III, [5,15,36,37] and the presence of subvesicular duct(s). [15,36,37,43]

Although there are models predicting difficulty, they are complex and not practical. [7–10,24,25,34,44,44–48]. To predict the use of a bailout procedure in a more practical way, we estimated the area under the ROC curve of the time (minutes) spent trying to dissect the CD and found that it predicts the use of bailout techniques, as well as being a good predictor of conversion (see Graphs 1 and 2).

On average, the conversion rate, hospital stay, and drainage use are consistent with previous studies. [1,5,17,36,37,49] In some studies, the reported frequency of biliary tract injury is around 0.5-0.8%. [1,17,49] Although no biliary / biliary vascular injuries were observed in our study, there were four biliary leaks (2%) without documenting the site of leakage; therefore, we placed drainage in all of them and removed them after the first postoperative week (when the volume of the outflow completely decreased).

CONCLUSION

Subsequent technical difficulties can be predicted even after successful cystic dissection. Based on the dissection time of this structure, we can predict the likelihood of encountering problems during surgery. Therefore, the longer it takes to dissect the cystic duct, the more likely it is that rescue techniques will be used. In our study, we propose that each surgeon become familiar with the time it takes to dissect the cystic duct in order to consider the early use of a rescue technique. Conversion can be avoided, as well as prolonged surgical time, by becoming familiar with performing bailout techniques in laparoscopic surgery. The available evidence is heterogeneous in terms of objective identification of DLC predictors; thus, there is no consensus on its definition. In our study, we used the term "risk laparoscopic cholecystectomy" or "difficult laparoscopic cholecystectomy" when CVS was not achieved; therefore, bailout procedures were used to perform cholecystectomy safely. In particular, when we perform a bailout procedure, "moderate-difficulty laparoscopic cholecystectomy" is the term we use, and when we perform partial or subtotal cholecystectomy, "high-difficulty laparoscopic cholecystectomy" is used. Using this definition, we found that the time spent trying to dissect the cystic duct, with or without success, is a predictor of the subsequent use of a bailout procedure and, therefore, of risk cholecystectomy or "difficult cholecystectomy." Our study used validated scales for the classification of postoperative complications; however, there were limitations, including a non-randomized design, small sample size, exclusion of pediatric patients, and limited experience from a single institution. Large randomized multicenter studies are needed to determine the role of bailout techniques in reaching the CVS. Given these limitations, these associations should be cautiously interpreted.

Declaration by Authors

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