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### Validation of the Dash, Bhondave, and Gadekar Score System to Predict the Difficulties of Laparoscopic Cholecystectomy

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#### ABSTRACT

**Background:** One of the treatment options for cholelithiasis is laparoscopic cholelithiasis. The challenge of this procedure is to determine the level of surgery. **Methods:** This analytic cross-sectional study was conducted at Sanglah Hospital Denpasar from January 2019 to September 2020. Several risk factors data were assessed according to the Risk Scoring System for Laparoscopic Cholecystectomy. Receiver Operating Characteristic (ROC) curve was plotted to determine the cut-off score based on the most optimal sensitivity and specificity to predict the difficulty of surgery. Univariate statistical analysis was conducted based on the type of data with a p-value <0.05 considered significant. **Results:** From a total of 62 laparoscopic cholecystectomies, 36 (58.1%) case was a simple surgery, and 26 (41.9%) was difficult surgery. In the difficult surgical group, 17 surgeries (27.4%) were more than 60 minutes, nine surgeries (14.5%) with bile spillage, and one surgery (1.6%) with ductal injury. The scoring system had a sensitivity of 86.1%, a specificity of 76.9%, a positive predictive value of 83.7%, and a negative predictive value of 80%. **Conclusion:** A scoring system is a promising approach to estimating the difficulty of laparoscopic cholecystectomy. Further study to improve this scoring system is necessary.

#### 1. Introduction

One of the most common problems affecting the digestive tract is gallstone disease. Along with the increasing socio-economic conditions of the community, changes in food patterns, and improvements in diagnostic facilities, the prevalence of gallstone disease in developing countries tends to increase.<sup>1-3</sup> The incidence of cholelithiasis is 8% in men aged over 40 years and 40% in women over 65 years.<sup>4,5</sup> Most cases require surgery as therapy with laparoscopic cholecystectomy as the preferred method.<sup>6</sup>

In several cases, laparoscopic cholecystectomy can be difficult and requires more aggressive measures. It

is estimated that around 1-13% of laparoscopic cholecystectomy converted to open cholecystectomy due to various causes. The risk factors associated with this incidence vary, including surgeon factors, equipment failure, and patient factors such as age, gender, or body mass index (BMI).<sup>7</sup> Other factors related include a history of upper abdominal surgery, the incidence of acute cholecystitis, gallbladder wall thickness, increased body temperature, and diabetes.<sup>8</sup>

The degree of difficulty is challenging to determine for every patient. Nevertheless, it is essential to prepare the surgical process and explain to the patient the procedure to be carried out. Therefore, it would be

very beneficial if there were specific criteria that could assess operative risk.<sup>3,5,6,9-16</sup> Several assessment methods have been proposed with various criteria but are still controversial. Considering the risks of surgery and the purpose of obtaining the benefits of surgery for both the patient and the medical team, the authors consider it necessary to raise the topic of a scoring system to predict the difficulty level of laparoscopic cholecystectomy surgery.

## 2. Methods

This study is a cross-sectional analytic study that aims to determine the diagnostic value of clinical variables related to cholecystitis and predict difficulty in laparoscopic cholecystectomy. It was conducted from January 2019 to September 2020. The sample consisted of adult patients aged 18 years and more who had undergone a laparoscopic cholecystectomy procedure at Sanglah Hospital Denpasar. Samples

were taken from the affordable population by consecutive sampling. Subjects who had comorbidities in other organ systems that were not related to the predominant indication for surgery, the occurrence of a change in method due to failure of surgical equipment, and incomplete data were excluded.

The variables assessed included age, sex, body mass index, history of acute cholecystitis attacks, palpable gallbladder mass, scar tissue in the abdominal region, leukocyte count, gallbladder wall thickness, gallbladder distension, accumulation of fluid around the gallbladder, impacted gallstones, and changes in hepatic echotexture. Each variable assessed will be given a weight based on the Risk Scoring System for Laparoscopic Cholecystectomy. The scoring system used in this study was adapted from the scoring system published by Bhondave et al.<sup>3</sup> The scores for each variable are summarized in Table 1.

Table 1. Laparoscopic cholecystectomy surgery risk scoring system

Parameter	Score
Age	
>50	1
≤50	0
Gender	
Male	1
Female	0
BMI	
>30	1
≤30	0
History of acute cholecystitis attack	
Yes	4
No	0
Palpable gallbladder	
Yes	1
No	0
Leukocyte count	
> 12.000	1
≤ 12.000	0
Abdominal scar	
Yes	1
No	0
Gallbladder wall thickness	
> 4 mm	2
≤ 4 mm	0
Distended or contracted gallbladder	
Yes	1
No	0
Fluid accumulation around the gallbladder	
Yes	1
No	0
Impacted gallstone	
Yes	1
No	0
Changes in hepatic echotexture	
Yes	2
No	0
<b>Maximal score</b>	<b>17</b>

The assessment was divided into two categories, namely simple and difficult. The classification system was adapted from the criteria used by Bhondave et al.<sup>7</sup> In this study, we decided that if one of the criteria for

laparoscopic cholecystectomy was difficult to fulfill, then the operation was declared difficult. The criteria for each category are summarized in Table 2.

Table 2. The assessment of the difficulty level of laparoscopic cholecystectomy

Parameter	Classification
These three criteria must be met:	Simple
Duration of surgery ≤ 60 minutes	
No bile acids are spilled into the surrounding tissue	
No arterial or ductal damage	
There is one of the following criteria:	Difficult
Duration of surgery >60 minutes	
There are bile acids that spill into the surrounding tissue	
There are arterial or ductal damages	
Duration > 120 minutes	
Converted to open cholecystectomy	

Data analysis used the Statistical Package for Social Sciences (SPSS) program. Univariate statistical analysis was used to describe the general characteristics and distribution of the variables. The cut-off score will be plotted in the Receiver Operating Characteristic (ROC) curve to assess the feasibility of the scoring system with the Area Under the Curve (AUC) and p-value. A threshold value with the most optimal sensitivity and specificity is determined to predict the difficulty of surgery. Sensitivity and specificity values, as well as positive and negative predictive values, were calculated after determining the threshold using a 2x2 table. This study obtained Ethical Clearance from the Research Ethics Commission of the Faculty of Medicine, Universitas Udayana/Sanglah Hospital Denpasar. Subjects were explained the study objectives and filled out the written informed consent.

### 3. Results

This study involved 62 respondents in determining the diagnostic value of clinical variables related to cholecystitis and predicting difficulty in laparoscopic cholecystectomy. Based on the difficulty of the operation during the study period, we found that 36 operations (58.1%) of laparoscopic cholecystectomy met the criteria for a simple surgery and 26 operations (41.9%) met the difficult criteria. Of the 26 difficult operations, 17 operations (27.4%) were more than 60 minutes, nine operations (14.5%) with bile spillage, and one operation (1.6%) with ductal injury. The characteristics of the study are described in a single distribution table presented in Table 3. To determine the ability of laparoscopic cholecystectomy scoring to predict the difficulty of surgery, we use the ROC curve (Figure 1 and Table 4).

Table 3. Descriptive data

Characteristics	Difficulty during surgery	
	Difficult	Simple
Age (n,%)		
> 50 years	12 (19,3%)	11 (17,7%)
≤ 50 years	14 (22,5%)	25 (40,3%)
Gender (n,%)		
Male	8 (12,9%)	7 (11,2%)
Female	18 (29,2%)	29 (46,7%)
Body mass index (n,%)		
> 30 Kg/m <sup>2</sup>	17 (27,4%)	19 (30,6%)
≤ 30 Kg/m <sup>2</sup>	9 (14,5%)	17 (27,4%)
History of cholecystitis (n,%)		
Yes	26 (41,9%)	20 (32,2%)
No	16 (25,8%)	0 (0%)
Abdominal scar (n,%)		
Yes	3 (4,8%)	5 (8,1%)
No	23 (37,1%)	31 (50%)
Palpable gallbladder (n,%)		
Yes	3 (4,8%)	0 (0%)
No	23 (37,1%)	36 (58,1%)
Leukocytes (n,%)		
> 12000	24 (38,7%)	10 (16,1%)
≤ 12000	2 (3,2%)	26 (41,9%)
Gallbladder wall thickness (n,%)		
> 4 mm	26 (42%)	21 (33,8%)
≤ 4 mm	0 (0%)	15 (24,2%)
Distended gallbladder (n,%)		
Yes	20 (32,4%)	6 (9,6%)
No	6 (9,6%)	30 (48,4%)
Fluid accumulation (n,%)		
Yes	17 (27,4%)	10 (16,1%)
No	9 (14,6%)	26 (41,9%)
Impacted gallstone (n,%)		
Yes	20 (32,4%)	12 (19,2%)
No	6 (9,6%)	24 (38,8%)
Hepatic echotexture (n,%)		
Yes	0 (0%)	0 (0%)
No	26 (42%)	36 (58%)

Table 4. AUC values

Score	AUC value	95% CI	p-value
Laparoscopic cholecystectomy scoring	90,8	0,83-0,97	0,0001

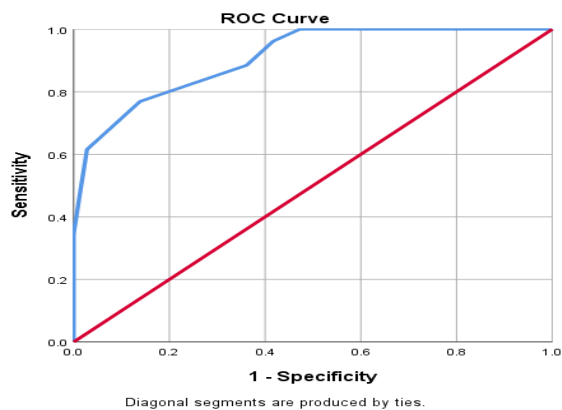


Figure 1. ROC curve of laparoscopic cholecystectomy score.

ROC curve showed a sensitivity score for laparoscopic cholecystectomy with an AUC value of 90.8%. It described that if the laparoscopic cholecystectomy score is used to predict the difficulty of surgery in 62 respondents, the correct conclusion will acquire 56 patients. Clinically, this AUC value was

very satisfactory because it was greater than the minimum value expected, which was 75%. The cut-off point score calculated based on the coordinates of the curve processed using the excel program was obtained with a value of 9.5. The best cut-off point results were analysed using a 2x2 table presented in Table 5.

Table 5. Dash, Bhondave, and Gadekar score system validity test in difficulty during laparoscopic cholecystectomy surgery

Variable	Difficulty during surgery		Sensitivity	Specificity	NPP	NPN	Accuracy	RR
	Simple	Difficult						
Score < 9,5	31	6	86,1%	76,9%	83,7%	80%	82,2%	4,1
Score ≥ 9,5	5	20						

The likelihood ratio value for the results of Dash, Bhondave, and Gadekar scores shows how many times the score can occur in the population group with difficulty during surgery compared to the simple operation group. Based on the likelihood ratio formula, the value is  $3.7 > 1$ , which means the greater the likelihood ratio value, the greater the possibility of experiencing difficulties during surgery. Based on the 2x2 table, the RR value is 4.1.  $RR > 1$  describes the laparoscopic cholecystectomy score increased the difficulty risk during surgery.

#### 4. Discussion

Laparoscopic cholecystectomy has become the gold standard in treating symptomatic cholelithiasis. Thus risk reduction is a crucial aspect of surgery planning. Predictions before surgery propose to avoid unnecessary time prolongation and to prevent complications.<sup>17</sup> Several patient characteristics can predict the difficulty of laparoscopic cholecystectomy. Characteristics of respondents based on age, sex, body mass index, and the presence of abdominal scar tissue were not significantly related to the difficulty of surgery in this study. These findings are in contrast to studies conducted by Lee et al.<sup>18</sup> and Bhondave et al.<sup>3</sup>, which found that age >50 years was a significant risk factor for the difficulty of laparoscopic cholecystectomy. The study by Agarwal et al.<sup>19</sup> found no difference in the total time required for laparoscopic

cholecystectomy between the sexes. Nikhil Gupta et al.<sup>10</sup> showed that BMI did not have a significant effect, and the results were the same whether in simple or difficult cases ( $p = 0.454$ ). Furthermore, Gupta et al.<sup>10</sup> also found that abdominal scars were not a significant confounding factor.

This study found an association between a history of cholecystitis and surgical difficulty ( $p < 0.0001$ ). A history of acute cholecystitis carries a greater risk of difficult surgery because of solid adhesions in the calot triangle and gallbladder fossa.<sup>6,20</sup> These results are in agreement with several other studies that have been reported.<sup>10,19</sup> The study of Bhondave et al.<sup>3</sup> found that 90.7% of patients did not have a palpable gallbladder, and there was a significant association between a palpable gallbladder and intraoperative difficulties ( $p = 0.004$ ). Similar results were found in this study ( $p = 0.037$ ) and several other studies.<sup>16,21</sup>

Data for leukocytes  $\leq 12,000$  were 41.9% more than leukocytes  $> 12,000$  ( $p < 0.0001$ ) found in this study. However, this finding is different from the study of Bhondave et al.<sup>3</sup>, where there were 95% more respondents with leukocytes  $\leq 12,000$ , and the total leukocyte count did not show a statistically significant association ( $p = 1.00$ ). Meanwhile, Nidoni et al.<sup>17</sup> showed the total number of leukocytes to be a significant predictor. Bhondave et al.<sup>3</sup> found that a thickness  $\leq 4$  mm was only 67.4% compared to a thickness  $> 4$  mm, and a gallbladder wall thickening  $> 4$

mm was associated with the difficulty of laparoscopic cholecystectomy ( $p = 0.000005$ ). Similar results were obtained in this study and supported by Gupta et al.<sup>16</sup> but differed in the study of Agarwal et al.<sup>19</sup>, which did not find a significant relationship between them.

Our study showed a significant association between the presence of fluid accumulation and surgical difficulty following other studies that have been reported.<sup>3,17,19</sup> Impacted gallstones were found to have an association, but different results were reported in another study.<sup>3</sup> There was no change in hepatic echotexture in this study. The duration of the surgery  $\leq 60$  minutes was 72.6%, while the duration  $> 60$  minutes were 27.4%. There was no association between bile spillage and ductus injury found in this study. The simple operation occurred (58.1%) more than the difficult (41.9%). This result is similar to the study of Bhondave et al.<sup>3</sup>, which found that 73% of simple surgery with the rest was difficult and very difficult surgery.

Laparoscopic cholecystectomy as operative management for cholelithiasis has various benefits.<sup>3,5,22</sup> Postoperative complications are about 2-6%. To further reduce the complication rate, there are several scoring systems for determining the degree of procedural difficulty that aim to predict the challenges before, during, and after surgery.<sup>3,5,10,12-15</sup> The study by Acharya et al.<sup>16</sup> used different criteria involving 114 respondents and obtained a low sensitivity of 71.42% and specificity of 97.22%. One of the scoring systems for the laparoscopic cholecystectomy procedure is the Dash, Bhondave & Gadekar scoring system. A pre-operative assessment was performed on each patient based on the history, physical examination, and radiological findings. The maximum total score on Dash, Bhondave, and Gadekar is 17 based on 12 parameters. A value of 0-5 is referred to as easy for surgery, 6-10 as difficult for surgery, and a value of 11-17 as very difficult.<sup>3,10</sup>

The results showed that the sensitivity was 86.1%, the specificity was 76.9%, the positive predictive value was 83.7%, and the negative predictive value was 80%, with an accuracy of 82.2%. The likelihood ratio value

of  $3.7 > 1$  implies that the greater the likelihood ratio value, the greater the possibility of experiencing difficulties during surgery. Based on the 2x2 table, the RR value is 4.1.  $RR > 1$  means that the laparoscopic cholecystectomy score increases the risk of difficulty during surgery.

Positive predictive value is the proportion of patients who are truly positive in all respondents who are confirmed positive. The sensitivity and specificity of the scoring method of Bhondave et al.<sup>3</sup> were found to reach 95.24% and 73.63%, respectively. Based on Bhondave's study, the scoring method found that from 76% of predicted easy cases, 70% of them were successful. Meanwhile, of 24% of predicted difficult cases, 16% presented to be difficult and 5% to be very difficult. The positive predictive values of this scoring method were 92% and 82% for easy and difficult cases, respectively. Based on all the parameters in the scoring system, only a few parameters showed a statistically significant relationship to the incidence of difficult cholecystectomy surgery. These parameters were a history of attacks of acute cholecystitis ( $p < 0.0002$ ), palpable gallbladder ( $p < 0.004$ ) and ultrasound findings such as gallbladder thickening ( $p < 0.000005$ ), gallbladder distension or contractions ( $p < 0.000001$ ), pericholecystic fluid accumulation ( $p < 0.0002$ ) and impacted gallstones ( $p < 0.003$ ).<sup>3</sup>

The different results presented by Vivek et al.<sup>12</sup> involved 323 patients. Age, gender, recurrent cholecystitis, obese patients, previous surgery history, patients requiring pre-operative endoscopic retrograde cholangiopancreatography (ERCP), abnormal liver and pancreatic enzyme serum profiles, gallbladder swelling, intra-peritoneal adhesions, structural anomalies or distortions and the presence of liver cirrhosis on ultrasonography were identified as predictors of difficulty in laparoscopic cholecystectomy. ROC analysis was performed with an area under a curve of 0.956. This study describes that the scoring system predicting the difficulty of laparoscopic cholecystectomy is feasible but needs further improvement.

This study showed that the sensitivity of the scoring system was 86.1% and a specificity of 76.9%. The positive predictive value is 83.7%, while the negative predictive value is 80%. These results are expected to prevent risks during surgery and guide health practitioners in predicting the difficulty level of pre-operative laparoscopic cholecystectomy using a scoring system.

## 5. Conclusion

A scoring system is a promising approach to estimating the difficulty of laparoscopic cholecystectomy. Further study to improve this scoring system is necessary.

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