AN INTRAOPERATIVE SCORING SYSTEM DURING LAPAROSCOPIC CHOLECYSTECTOMY IS A VALUABLE TOOL TO ASSESS CONVERSION RATES AND PERIOPERATIVE COMPLICATIONS

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ABSTRACT

Background

Laparoscopic cholecystectomy (LC) is currently the gold standard procedure for management of gall bladder diseases (GBD). Bile duct injuries are the most disaster complication during this procedure, especially in patients with acute cholecystitis. To decrease such biliary injuries intraoperatively and conversion rates, it is necessary to have preoperative and intraoperative assessment of gall bladder according to special grading scale. In this study for such evaluation and assessment in patients with acute cholecystitis we are using Parkland Grading Scale (PGS).

Objectives

To evaluate pre-operative findings, conversion rates, and perioperative complications of laparoscopic cholecystectomy through intra-operative assessment of the gallbladder during laparoscopic cholecystectomy.

Materials and Methods

A cohort of patients who underwent laparoscopic cholecystectomy were retrospectively studied. The Parkland Grading Scale for Cholecystitis (PGS), which consists of a five-tier grading system, was used for the intra-operative assessment of the gallbladder

Results

710 patients who underwent laparoscopic cholecystectomy were included in this study. High pre-operative white blood cell counts, as well as bilirubin and alkaline phosphatase levels and ultrasonography features such as gallbladder thickness, bile duct dilatation, and stones in the common bile duct, were significantly more often present in patients with grades 3, 4, and 5 than in patients with grades 1 and 2 ($p<0.0001$). Patients with grades 4 and 5 had the highest conversion rate compared with patients with other grades (50.0% and 66.7%, respectively, $p<0.0001$). Furthermore, the number of perioperative complications was highest with grades 4 and 5 compared with other grades (40.0% and 33.3%, respectively, $p<0.0001$). The incidence of bile duct injuries, seroma, and wound infections were highest with grade 4 compared with other grades (5%, 10%, and 20%, respectively, $p<0.0001$)

Conclusion

Intra-operative assessment of the severity of gallbladder disease using the Parkland Grading Scale for Cholecystitis (PGS) during laparoscopic cholecystectomy is a valuable tool to assess the difficultly of laparoscopic cholecystectomy, the conversion rates, and perioperative complications.

Keywords: *Intraoperative Scoring, Laparoscopic Cholecystectomy, Valuable Tool Perioperative Complications, Conversion Rates.*

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INTRODUCTION

Laparoscopic cholecystectomy is currently one of the most performed laparoscopic operations worldwide. [1, 2] While complications such as bile duct injury have declined in the past thirty years, the morbidity rate and mortality rate have remained unchanged. [3] However, these data should be interpreted with caution because the majority are based in high-income countries with often a high standard of health care [4]. Less is known regarding the outcomes of laparoscopic cholecystectomy in developing countries.

Several studies have found pre-operative findings such as white blood cell (WBC) count, gallbladder thickness, contracted gallbladder, age above 60, male sex, and acute cholecystitis to be risk factors for conversion to open cholecystectomy and post-operative complications [3, 5, 6]. However, there is paucity in the literature regarding an intra-operative scoring assessment of the gallbladder to predict the conversion rate and other perioperative complications.

Therefore, the main objective of this study was to evaluate pre-operative findings, conversion rates, and perioperative complications through intra-operative assessment of the gallbladder during laparoscopic cholecystectomy using the Parkland Grading Scale for Cholecystitis (PGS).

PATIENTS AND METHODS

In this retrospective study between December 2007 and January 2016, all the consecutive patients who underwent laparoscopic cholecystectomy by the author or a surgical resident under the direct supervision of the author were included. All surgeries were performed at the Sulaimani Teaching Hospital (Sulaimani, Kurdistan region, Iraqi), Barzi Private Hospital (Sulaimani, Kurdistan region, Iraqi), or Royal Private Hospital (Sulaimani, Kurdistan region, Iraqi). The current study was performed under the ethical standards of the institutional national research committee and with the 1964 Helsinki Declaration, including its later amendments, or comparable ethical standards.

Parkland classification

The Parkland Grading Scale for Cholecystitis (PGS) was used to intraoperatively assess the severity of gallbladder disease (Table 1) [7]. The PGS consists of a five-tier grading system that is based on the anatomy and inflammatory changes of the gallbladder. Previous studies showed excellent reliability between the surgeon who performed the surgery and three independent writers who used the PGS to assess the severity of gallbladder disease. In this study, the intraclass correlation coefficient (ICC) was found to be 0.82 (95% CI: 0.77 to 0.86, p= 0.0001) [7, 8].

Table 1. Parkland Grading Scale for Cholecystitis (PGS).

Cholecystitis Severity Grade	Description of Severity
1	Normal appearing gallbladder ("robin's egg blue") No adhesions present Completely normal gallbladder
2	Minor adhesions at the neck, otherwise normal gallbladder Adhesions restricted to the neck or lower of the gallbladder
3	Presence of ANY of the following: Hyperemia, pericholecystic fluid, adhesions to the body, or distended gallbladder
4	Presence of ANY of the following: Adhesions obscuring the majority of gallbladder Grade I-III with abnormal liver anatomy, intrahepatic gallbladder, or impacted stone (Mirrizi)
5	Presence of ANY of the following: Perforation, necrosis, inability to visualize the gallbladder due to adhesions

Inclusion and exclusion criteria

The medical charts of patients of all ages who underwent cholecystectomy were reviewed. The inclusion criteria were a primary diagnosis of acute cholecystitis, acute cholecystitis with choledocholithiasis, biliary pancreatitis, or symptomatic cholecystolithiasis with a follow-up period of more than 30 days. The exclusion criteria were open cholecystectomy performed during the initial operation, the PGS could not be extracted from the operation notes and insufficient data to perform data analysis.

Definitions and procedure

Perioperative complications were defined as any complications that occurred during the operation and within 30 days post-operatively. One exception was an incisional hernia, which was considered a peri-operative complication even after 30 postoperative days. Fever was defined as a body temperature of >38.3°C, according to the Society of Critical Care Medicine guidelines.(9) Alkaline phosphatase levels were considered high when > 130 μ/L, total bilirubin when > 1.2 mg/dL, amylase when > 100 μ/L and lipase when > 60 μ/L. All the operations were performed by the same team and senior surgeon who specialized in laparoscopic surgery (author). All patients with acute cholecystitis and choledocholithiasis underwent ERCP before laparoscopic cholecystectomy. Laparoscopic cholecystectomy was performed either in the same admission within 72 hours or six hours after the ERCP procedure. The laparoscopic cholecystectomy technique consisted of a standard four-port technique using the critical view of safety (CVS) method of identification of the cystic duct and cystic artery.

Baseline characteristics were included age and sex. The pre-operative data included the initial diagnosis, clinical findings, biochemical data, ultrasound findings, and pre-operative interventions such as ERCP. The author and a senior surgical resident with experience in laparoscopic cholecystectomy of more than 4 years independently scored the PGS based on the operation notes. Disagreement between both assessors on the PGS grades was resolved by discussion. The rate of conversion to open cholecystectomy and the number of perioperative complications were also included. All the data were anonymized before collection and analysis.

Statistical analysis

The data were analyzed using IBM SPSS Statistics for Windows, version 22 (IBM Corp., Armonk, N.Y., USA). Data are described as the mean ± standard deviation for normally distributed continuous data, as the median (range) for skewed continuous data, and as the number (proportion) for categorical data. One-way ANOVA was used when the data met the normality assumption to study the differences between the different PGS categories. However, the Kruskal–Wallis test was used when the data were not normally distributed. A p-value of <0.05 was considered statistically significant.

RESULTS

Inclusion and baseline characteristics

The medical records of 800 patients who underwent cholecystectomy were reviewed. Ninety medical records were excluded for the following reasons: 49 patients underwent initially open cholecystectomy, and 31 medical records contained insufficient information for further analysis.

The patient characteristics are presented in Table 2. The majority of the patients had PGS grades 1 and 2. There were only three patients with PGS grade 5, of whom two patients had cholecystoduodenal fistula. There was no statistically significant difference between PGS grades about age or sex.

Pre-operative findings

There were no statistically significant differences between different PGS grades in terms of the pre-operative symptoms (Table 3). However, the following trends were observed: the incidence of fever and recurrent attack in patients with PGS grades 3, 4, and 5 seemed to be higher than that in patients with a combination of PGS grades 1 and 2. Additionally, patients with PGS grades 3, 4, and 5 had a prolonged course of complaints compared with patients with grades 1 and 2.

The WBC was found to be statistically higher in patients with PGS grades 3, 4, and 5 than in patients with grades 1 and 2 ($p<0.0001$). Furthermore, patients with PGS grades 3, 4, and 5 had statistically higher bilirubin and alkaline phosphatase values than patients with PGS grades 1 and 2 (Table 3).

A statistically significant difference was found for different radiological findings on the ultrasound between different PGS grades (p= 0.000). Patients with features of gallbladder thickness, bile duct dilatation, and stones in CBD on ultrasonography were more often classified as PGS grades 3, 4, and 5 than patients with PGS grades 1 and 2 (Table 3).

Diagnosis

There was a statistically significant difference between PGS grades with regards to the pre-operative diagnosis (p= <0.0001; Table 4). Patients with PGS grades 1, 2, and 5 were more often diagnosed with symptomatic cholecystolithiasis than patients with PGS grades 3 and 4. Patients with PGS grades 3, 4, and 5 were more often diagnosed with acute cholecystitis with or without choledocholithiasis than patients with PGS grades 1 and 2.

Conversion rate and perioperative complications

A statistically significant difference was found between PGS grades about the conversion rate and perioperative complications (p<0.0001; Table 5). The total conversion rate was less than 1.4%. There were no conversions to open cholecystectomy in patients with grades 1 and 2. However, within the PGS grade, the conversion rate was significantly higher in patients with PGS grades 4 and 5 than in patients with grades 1, 2, and 3.

The number of total perioperative complications was higher in patients with PGS grades 1, 2, and 3 than in patients with PGS grades 4 and 5. However, among the PGS grades, the number of perioperative complications was significantly higher in patients with PGS grades 3, 4, and 5 than in patients with PGS grades 1 and 2.

Patients with PGS grades 4 and 5 significantly more often had seroma, surgical site infections, and cholangitis than patients with PGS grades 1, 2, and 3. The incidence of bile duct injury was highest in patients with PGS grade 4. Incisional hernia, deep vein thrombosis (DVT), and other perioperative complications were significantly highest in patients with PGS grades 1, 2, and 3. Among patients with PGS grades 1 and 2, one patient developed hepatitis A, and one patient developed facial palsy. Among patients with PGS grade 3, one patient developed pancreatitis, one patient had to undergo ascites punction, and one patient died because of delayed diagnosis of iatrogenic injury of the bowel peri-operatively.

Table 2. Patients' characteristics.

	PGS grade 1&2 (n= 505)	PGS grade 3 (n= 182)	PGS grade 4 (n= 20)	PGS grade 5 (n= 3)	p-value*
Age, years, median (range)	40 (9-85)	41 (9-84)	51 (25-70)	63 (27-68)	0.067
Gender, n (%)					0.123
Male	49 (9.7)	29 (15.9)	3 (15.0)	0 (0)	
Female	456 (90.3)	153 (84.1)	17 (85.0)	3 (100)	

*** Kruskal–Wallis test**

Table 3. Pre-operative clinical features, biochemical and radiological characteristics.

Varibilities	PGS grade 1&2 (n= 505)	PGS grade 3 (n= 182)	PGS grade 4 (n= 20)	PGS grade 5 (n= 3)	p-value*
Symptoms					**0.087***
Pain (continuous), Yes, n (%)	452 (89.5)	178 (97.8)	20 (100)	3 (100)	
Pain (colicky), Yes, n (%)	321 (63.3)	147 (80.8)	19 (95.0)	1 (33.3)	
Episodes of jaundice, Yes, n (%)	10 (2.0)	56 (30.8)	6 (30.0)	0 (0)	
Fever, Yes, n (%)	19 (3.9)	123 (67.6)	20 (100)	1 (33.3)	
Recurrent attack, Yes, n (%)	235 (46.5)	129 (70.9)	19 (95.0)	3 (100)	
Onset of complain, months, median (range)	14 (1-68)	20.5 (1-68)	25.5 (6-66)	18 (6-32)	
Bio-chemical					**<0.0001**
WBC, median (range), x 103	8 (4-16)	11.5 (5-16)	12.50 (11-20)	8 (8-10)	
Total bilirubin, high, n (%)	5 (1.0)	40 (22.0)	3 (15.0)	0 (0)	
Alkaline phosphatase, high, n (%)	3 (0.6)	25 (13.7)	2 (10.0)	0 (0)	
Amylase, high, n (%)	1 (0.2)	0 (0)	0 (0)	0 (0)	
Lipase, high, n (%)	2 (0.4)	0 (0)	0 (0)	0 (0)	
Radiological findings on ultra-sound					**<0.0001**
Gallbladder thickness, Yes, n (%)	39 (7.7)	135 (74.2)	19 (95.0)	2 (66.7)	
Multiple stones, Yes, n (%)	457 (90.5)	170 (93.4)	20 (100)	2 (66.7)	
Polyps, Yes, n (%)	6 (1.2)	0 (0)	0 (0)	0 (0)	
Bile duct dilatation, Yes, n (%)	4 (0.8)	30 (16.5)	2 (10)	0 (0)	
Stone in CBD, Yes, n (%)	2 (0.4)	28 (15.4)	2 (10)	0 (0)	

*** Kruskal–Wallis test [1], normal range: 3.5 – 10.0 x 10^3 cells/mm^3**

Table 4 Parkland Grading Scale for Cholecystitis among the patients.

Diagnosis	PGS grade 1&2 (n= 505)	PGS grade 3 (n= 182)	PGS grade 4 (n= 20)	PGS grade 5 (n= 3)	p-value*
					<0.0001
Symptomatic cholecystolithiasis	487 (96.4)	26 (14.3)	0 (0)	2 (66.7)	
Acute cholecystitis	15 (3.0)	132 (72.5)	18 (90)	1 (33.3)	
Acute cholecystitis and choledocholithiasis	1 (0.2)	24 (13.2)	2 (10)	0 (0)	
Biliary pancreatitis	2 (0.4)	0 (0)	(0)	(0)	

*** Kruskal–Wallis test**

Table 5: Conversion rate and per-operative complications.

	PGS grade 1&2 (n= 505)	PGS grade 3 (n= 182)	PGS grade 4 (n= 20)	PGS grade 5 (n= 3)	p-value*
Conversion to open, Yes, n	0	2	10	2	**<0.0001**
Within Parkland, n (%)	0	1.1	50.0	66.7	
Total, n (%)	0	0.3	1.4	0.3	
Peri-operative complications, Yes, n	19	22	8	1	**<0.0001**
Within Parkland, n (%)	3.8	12.1	40.0	33.3	
Total, n (%)	2.7	3.1	1.1	0.1	
Peri-operative complications, categories					**<0.0001**
Seroma, Yes, n	4	2	2	0	
Within Parkland, %	0.8	1.1	10.0	0	
Total, %	0.6	0.3	0.3	0	
Wound infection, Yes, n	9	7	4	0	
Within Parkland, %	1.8	3.8	20.0	0	
Total, %	1.3	1.0	0.6	0	
Cholangitis, Yes, n	2	6	1	0	
Within Parkland, %	0.4	3.3	5.0	0	
Total, %	0.3	0.8	0.1	0	
Bile duct injury, Yes, n	1	0	1	1	
Within Parkland, %	0.2	0	5.0	0	
Total, %	0.1	0	0.1	0	
Incisional hernia	1	2	0	0	
Within Parkland, %	0.2	1.1	0	0	
Total, %	0.1	0.3	0	0	
DVT, Yes, n	0	2	0	0	
Within Parkland, %	0	1.1	0	0	
Total, %	0	0.3	0	0	
Others	2	3	0	0	
Within Parkland, %	0.4	1.6	0	0	
Total, %	0.3	0.4	0	0	

*** Kruskal–Wallis test. Abbreviations: DVT, deep vein thrombosis; PGS, Parkland Grading Scale for Cholecystitis**

DISCUSSION

This study shows a significant increase in the conversion rate and perioperative complications with an increase in the severity of gallbladder disease when assessed with the PGS during laparoscopic cholecystectomy. This finding was obvious when PGS grades 3, 4, and 5 were compared with PGS grades 1 and 2. Therefore, intraoperative assessment of the severity of gallbladder disease using the PGS during laparoscopic cholecystectomy is a valuable tool to assess the difficulty of laparoscopic cholecystectomy, the conversion rate, and perioperative complications.

In the present study, pre-operative symptoms were not associated with the PGS grade. Higher pre-operative WBC counts, as well as bilirubin and alkaline phosphatase levels and ultrasonography features such as gallbladder thickness, bile duct dilatation, and stones in the CBD, were significantly more often present with PGS grades 3, 4, and 5 compared with PGS grades 1 and 2. Previous studies have demonstrated that various preoperative factors, such as gallbladder thickness and high WBC counts, are predictive for difficult laparoscopy and open conversion. [5, 10, 11] Furthermore, our results are in line with those of two recently published studies that showed that the preoperative level of WBCs and total bilirubin increased with the severity of gallbladder disease using the PGS.[7, 8].

The pre-operative diagnosis was an important tool to predict the severity of gallbladder disease during laparoscopic cholecystectomy because patients with PGS grades 3, 4, and 5 significantly more often had acute cholecystitis with or without choledocholithiasis than patients with PGS grades 1 and 2. Acute cholecystitis may lead to intraoperative pericholecystic inflammation, which is associated with difficulty in identifying Calot's triangle [12].

Lee et al. found PGS grades to be useful for discriminating between the severity of acute cholecystitis, while another study found that the incidence of acute cholecystitis increased with the severity of gallbladder disease using the PGS [8, 13].

The current study found the overall conversion rate to open cholecystectomy to be <1.5%, which is less than the reported conversion rates to open cholecystectomy in the literature, which varies between 1.8% and 27.7% [14, 15]. Interestingly, the conversion rate to open cholecystectomy was higher in patients with PGS grades 4 and 5 than in patients with PGS grades 1, 2, and 3. Our results are in line with those of recent studies that reported the conversion rate to open cholecystectomy to be highest in PGS grades 4 and 5 compared to PGS grades 1, 2, and 3 [7, 8]. In the present study, two cases of cholecystoduodenal fistula (PGS grade 5) were converted to open cholecystectomy. Cholecystoduodenal fistula is found a risk factor for conversion to open surgery [16]. Other intra-operative findings, such as severe inflammation and adhesion as well as altered anatomy (PGS grades 4 and 5), were also found to be risk factors for conversion to open cholecystectomy [6].

The overall number of perioperative complications in our study increased with the severity of gallbladder disease. The incidence of bile duct injury was less than 0.1%, which is low compared with the incidence reported in the current literature, which varies between 0.3% and 0.5% [3]. The incidence of bile duct injury was highest in PGS grade 4 compared with other PGS grades. In the present study, there were only three patients with PGS grade 5. Therefore, no clear conclusion could be drawn when looking at the perioperative complications in PGS grade 5 in our study. Two recent studies reported bile duct leakage to be highest in PGS grade 5 compared with other PGS grades [7, 8]. However, bile duct leakage does not necessarily imply that there is leakage coming from the bile duct itself, as this could also be due to leakage deriving from the duct of Lushka or the loss of clips positioned around the cystic duct.

The incidence of seroma and wound infections was highest in PGS grade 4 compared to other PGS grades. In our study, no retrieval bags were used due to the limited resource availability of laparoscopy in Iraqi-Kurdistan. The majority of wound infections occurred in PGS grade 4, which is associated with severe inflammation of the gallbladder. This finding could explain the higher wound infection rate in this group of patients. However, a recent meta-analysis of three studies found no statistically significant benefit of retrieval bags in reducing wound infections [17]. It should be noted that the results of this meta-analysis were not stratified for the severity of gallbladder disease.

The incidence of incisional hernia, DVT, and other uncommon complications of laparoscopic cholecystectomy was slightly higher in PGS grades 1, 2, and 3 than in PGS grades 4 and 5. A possible explanation for the higher incidence of incisional hernia in PGS grades 1, 2, and 3 could be that less difficult laparoscopic cholecystectomies were performed by a senior resident surgeon under the direct supervision of the author. Usually, in these expected less difficult

cases, the open technique instead of the closed technique for primary port insertion is performed for teaching purposes, and suture closure of the fascia is performed by the same resident or the assisting scrub nurse. While the evidence is not robust, a systematic review by Buntik et al. suggested that there was no difference in open and closed techniques about incisional hernia when both fasciae are sutured [18]. However, a poor closure technique is found to be a risk factor for incisional hernia [19].

To the best of our knowledge, this study with 710 patients is the largest study to describe PGS grade concerning pre-operative findings, diagnoses, conversion rates, and perioperative complications. A few limitations exist within our study. First, the PGS grades in the current study were extracted from the operation notes, which could be a source of bias. However, all the operation notes were reviewed by two reviewers, and records were excluded when the PGS grades could not be established from the operation notes. Second, only three patients had PGS grade 5. Therefore, larger studies are required to study the outcomes of this study about PGS grade 5. Third, there was a possibility of selection bias due to the retrospective nature of the current study: patients who initially underwent open cholecystectomy were excluded. One of the reasons for initially performing open cholecystectomy instead of laparoscopic cholecystectomy was the expected difficult operation, which could have been the case for patients with PGS grade 5.

In conclusion, a statistically significant increase in the conversion rate and the number of perioperative complications was found in this study with an increase in the severity of gallbladder disease when intra-operatively assessed with the PGS. Therefore, the PGS is a valuable tool to evaluate the severity of gallbladder disease and assess the difficulty of laparoscopic cholecystectomy, conversion rate, and perioperative complications.

Conflict of interest

M.I. Rashaan has no conflict of interest to report.

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