Preoperative indicators of technically difficult laparoscopic cholecystectomy using clinical and ultrasonographic parameters

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Background
Laparoscopic cholecystectomy (LC) has rapidly become the operation of choice for routine gallbladder (GB) removal. The purpose of this study is to provide preoperative indicators of a technically difficult LC based on various preoperative clinical and ultrasonographic predictors.

Patients and methods
This study was conducted in the General Surgery Department, Ohud General Hospital, Al Madinah Al Munawarah, Saudi Arabia, for 280 patients with diagnosis of gallstones confirmed by abdominal ultrasonography and subjected to LC. The technical difficulty of the surgical procedure was assessed postoperatively (either easy, difficult, or very difficult) based on operative time (min), spillage of bile and/or stones, bile duct injury, and the need for conversion to open surgery.

Results
The present study found that old age; male sex; previous history of acute cholecystitis or acute pancreatitis; history of previous abdominal surgery; urgent surgery after 72 h of the onset of symptoms in acute cholecystitis; morbid obesity; ultrasonographic findings including increased of GB wall thickness, impacted stones, sonographic Murphy's sign, and pericholecystic fluid collection; and palpable GB increase the technical difficulty of LC. Conversion to open cholecystectomy was seen in only one patient.

Conclusion
Clinical and radiological patient characteristics are good preoperative predictors for the technical difficulty of LC and can help the surgeon to anticipate the risk for intraoperative complications and the possible need for conversion to open cholecystectomy.

Keywords:
laparoscopic cholecystectomy, prediction, technical difficulty

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Introduction

Laparoscopic cholecystectomy (LC) has become the operation of choice for routine gallbladder (GB) removal and is the most commonly performed major abdominal operation in western states [1].

LC can be difficult in certain patients, owing to either difficult dissection; severe inflammation; obscure anatomy; common bile duct (CBD) problems with abnormal laparoscopic intraoperative cholangiography; complications including bleeding, duodenal injury, and respiratory acidosis; or miscellaneous factors, including inability to secure cystic duct, equipment problems; and unsuspected pathology [2].

The purpose of this study was to provide preoperative indicators of a technically difficult LC based on preoperative clinical and ultrasonographic predictors to minimize complications.

Patients and methods

Patients

A total of 280 patients subjected to LC in General Surgery Department, Ohud General Hospital, Al Madinah Al Munawarah, Saudi Arabia, were enrolled in this prospective study during the period from May 2018 till October 2018.

Ethical approval

This prospective research was done after approval of the institutional board of ethics numbered RAD201801. Fully informed consents were taken from the patients after simplifying the operative technique for them and explaining in detail the

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benefits likely to be achieved from surgery and the risk of conversion to open surgery.

Methods

Detailed clinical history was obtained, including demographic data, history of previous abdominal surgery, and previous hospitalization for acute cholecystitis or acute pancreatitis. Details of clinical examination of all cases were recorded, including BMI, abdominal scars of previous operations, and whether GB is palpable or not.

Full routine laboratory investigations were done for all cases including liver function tests, renal function tests, complete blood count, blood sugar, coagulation, and lipid profiles. Other laboratory investigations including serum amylase, lipase, and alanine aminotransferase were done in cases with suspected diagnosis of acute pancreatitis.

Abdominal ultrasound (AUS) was done in all cases using GE LOGIQ_E9 Ultrasound Machine (GE) for confirmation of cholecystolithiasis, assessment of GB wall thickness, positive ultrasound Murphy's sign (tenderness in the exact area of the GB provoked by either the transducer or the sonographer's palpation under guidance), and the presence or absence of pericholecystic fluid collection. Contrast-enhanced computed tomography scan of the abdomen (oral/intravenous contrast) was requested for one case with severe acute pancreatitis.

Patients with acute symptoms were diagnosed to have acute calcular cholecystitis by clinical (acute upper right hypochondrial pain, right hypochondrial tenderness), laboratory (leukocytosis), and sonographic findings such as distended GB containing stones, thickened more than 4 mm edematous GB wall, positive sonographic Murphy's sign, and pericholecystic fluid collection.

Diagnosis of acute biliary pancreatitis (ABP) was made by clinical examination, with serum amylase level of more than two times the normal, increase in alanine aminotransferase to more than or equal to three times the normal, and ultrasound appearance of pancreatic edema and GB stones with or without the CBD stones. Severity was then graded according to Glasgow-Ranson's criteria, and patients with less than 5 score were considered mild ABP and were managed conservatively till recovery of the acute attack, and then LC was done during the same admission for initial treatment. Patients with more than 5 score were graded as severe and were treated conservatively till improvement of the clinical condition and preparation for elective LC was done [3,4].

LC were performed by experienced surgeons. Interpretive events were recorded, including operative time (min), intraoperative adhesions, the difficulty of dissection of Calot's triangle, state of GB wall, abnormal cystic duct, bile/stone spillage, bile duct injury, cystic artery injury, the need for conversion to open procedure, and the need for intraperitoneal drain.

Surgical procedures were categorized postoperatively into easy, difficult, and very difficult procedures based on operative time, bile/stone spillage, bile duct injury and the need for conversion to open cholecystectomy according to the criteria for the LC based on the scoring system described by Randhawa and Pujahari [5]. Standard postoperative care was given to all cases.

Statistical analysis

Data were analyzed using IBM SPSS software (release 21) (Windows Microsoft; SPSS Inc., USA). Statistical methods included descriptive analysis, such as mean ±SD, percentage, and frequencies.

Results

This study included 280 patients who underwent LC; 40 (14.3%) were males and 240 (85.7%) were females. Their ages ranged from 20 to 70 years, with mean age of 42.8±9.7 years. Overall, 17 (6.1%) patients were older than 60 years; of these 17 patients, 11 were males and six were females.

A total of 159 (56.8%) patients were admitted from the outpatient clinic by chronic calcular cholecystitis and subjected to elective LC, and the remaining 121 (43.2%) patients were admitted from the Emergency Room. Of them, 87 (31.1%) patients were presented by acute calcular cholecystitis, 24 (8.6%) patients with persistent biliary colic, and 10 (3.6%) patients with ABP.

Of the 87 patients admitted by acute calcular cholecystitis, 42 cases were subjected to early LC within 72 h from the onset of pain; 40 patients were treated conservatively, discharged, and an appointment for elective LC was scheduled; and the remaining five cases were subjected to LC after 72 h from the onset of pain (urgent LC).

Ten cases were admitted with symptoms of ABP with no evidence of biliary obstruction. According to

Glasgow-Ranson's criteria [3], nine of these 10 cases were diagnosed as mild attacks and were managed conservatively till recovery of the acute attack, and then LC was done during the same admission for the initial treatment. The remaining case had severe ABP and were treated conservatively, improved, and discharged with an appointment for elective LC.

The procedure was converted to open cholecystectomy in only one patient. This patient was categorized into very difficult LC group owing to the presence of GB phlegmon, dense intraoperative adhesions, along with high BMI (38 kg/m^2).

Fifty (17.9%) cases had a history of previous abdominal surgery; previous cesarean section in 30 (10.7%) patients; laparoscopic sleeve gastrectomy in 13 (4.6%) patients, and open appendectomy in seven (2.5%) patients.

BMI for the patients was in the range of 18.5–24.9 kg/m^2 in 20 (7.1%) patients, 25–29.9 in 202 (72.1%) patients, 30–34.9 in 38 (13.6%) patients, and 35–39.9 in 20 (7.1%) patients. GB was palpable in only 29 (10.4%) patients.

Preoperative ultrasonography of studied cases revealed normal GB wall thickness (≤3 mm) in 215 (76.8%) patients and increased wall thickness more than 3 mm in 65 (23.2%) patients (Fig. 1b and c), impacted stone in the neck of GB in 31 (11.1%) patients (Fig. 1a and c), pericholecystic fluid collection in 27 (9.6%) patients, and positive ultrasonographic Murphy's sign in 49 (17.5%) patients (Table 1).

This study revealed that combination of more than one positive ultrasonographic finding is a significant indicator of a technically difficult LC and was seen in 76 patients: 11 cases in the group of easy LC, 52 cases in difficult LC, and 13 cases in the very difficult LC group.

This study identified some statistically significant preoperative clinical indicators of a technically difficult LC such as male sex, old age more than or equal to 60 years, previous hospitalization by acute cholecystitis, persistent biliary colic or ABP, history of previous abdominal surgery, high BMI, and palpable GB (Table 2).

This study also identified some statistically significant intraoperative data that can attribute to a technically difficult and very difficult LC including intraoperative adhesions at or near the triangle of Calot, GB phlegmon, thick edematous GB wall, distended GB that is not easily grasped and tends to slip from the grasper and so requiring decompression, difficult Calot's triangle dissection, wide cystic duct, and the presence of stone in the cystic duct during dissection (Table 3).

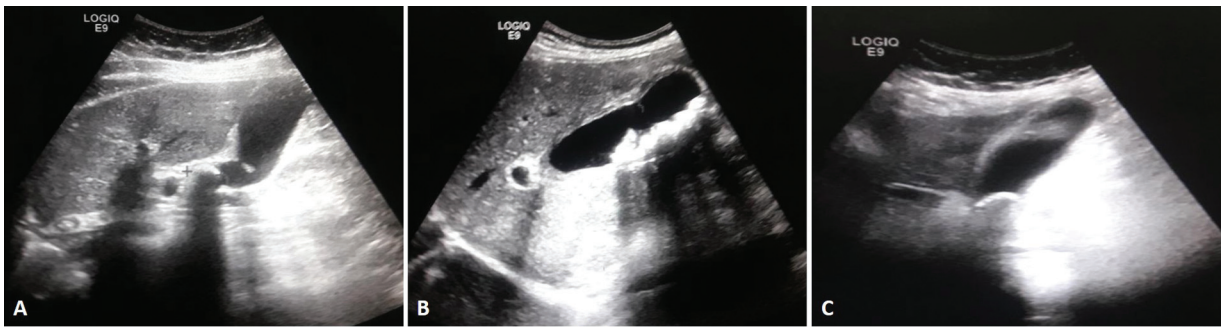
Discussion

In this study, patients' age ranged from 20 to 70 years, with mean age of 42.8±9.7 years, and 17 (6.1%) patients were older than 60 years. The mean age of patients in the group of very difficult LC was 57.2 years in comparison with the mean patients' age in the groups of easy and difficult LC, which was 41.1 and 44.9 years, respectively, and these results matched with

Table 1 Preoperative ultrasonographic findings of patients

Abdominal ultrasonographic findings	Number of cases [*n* (%)]
Normal wall thickness (≤3 mm)	215 (76.8)
Increased wall thickness (>3 mm)	65 (23.2)
Impacted stone	31 (11.1)
Pericholecystic fluid collection	27 (9.6)
Positive sonographic Murphy's sign	49 (17.5)

Figure 1



(a) Distended partially septate GB with thick wall and a single intraluminal 1.8 cm stone impacted near the neck of GB. (b) Distended GB with thick edematous wall and multiple intraluminal stones denoting acute calcular cholecystitis. (c) Thick GB wall (about 9 mm) with a single intraluminal 1.6 cm stone impacted near the neck of GB denoting acute calcular cholecystitis. GB, gallbladder.

Table 2 Clinical data of the patients of easy, difficult, and very difficult groups

Preoperative clinical indicators of a technically difficult LC	Easy LC (*N*=198)	Difficult LC (*N*=69)	Very difficult (*N*=13)	Total (*N*=280)
Acute cholecystitis for elective LC	29	7	4	40
Acute cholecystitis for early LC	2	37	3	42
Acute cholecystitis for urgent LC	0	1	4	5
Persistent biliary colic	20	3	1	24
Acute biliary pancreatitis	4	5	1	10
History of previous abdominal surgery	32	18	0	50
BMI (km/m^2)				
18.5–24.9 (normal weight)	10	10	0	20
25–29.9 (overweight)	138	57	7	202
30–34.9 (class I morbid obesity)	30	2	6	38
35–39.9 (class II morbid obesity)	20	0	0	20
Palpable GB	7	13	9	29

GB, gallbladder; LC, laparoscopic cholecystectomy.

Table 3 Intraoperative data of the patients of easy, difficult, and very difficult groups

	Easy LC (*N*=198)	Difficult LC (*N*=69)	Very difficult LC (*N*=13)	Total number (*N*=280)
Intraoperative adhesions	0	57	12	69
GB phlegmon	0	0	3	3
Thick/edematous GB wall	2	47	11	60
Distended GB requiring decompression	5	14	8	27
Difficult Calot's triangle dissection	0	60	13	73
Wide cystic duct	5	6	5	16
Stone in cystic duct	0	5	0	5
Bile spillage	0	15	0	15
Stone spillage	0	10	0	10
Injury of bile ducts	0	0	0	0
Injury of cystic artery	0	0	0	0
Conversion to open surgery	0	0	1	1
Need for drain insertion	10	54	13	77
Mean operative time (min)	40.9 ±4.6	87.6 ±13.3	149.5 ±13.3	

GB, gallbladder; LC, laparoscopic cholecystectomy.

the previous studies that stated increasing age was an important risk factor for increased operative complications during LC and conversions to laparotomy [6,7].

Females represented most of the studied cases, 240/280 (85.7%); this coincided with the results of Shaffer [8], who reported women to be almost twice as likely as men to form gallstones.

Male sex in this study was a statistically significant indicator of a technically difficult LC, a result that is supported by the results of Yol *et al.* [9] which found that men with symptomatic GB stones are more liable to inflammation and fibrosis with the same disease magnitude, thus leading to difficulty in dissection.

Acute calcular cholecystitis was a significant predictable factor for difficult LC; 11 cases of 13 cases of the very difficult LC group were admitted for LC after a history of acute calcular cholecystitis. In agreement with these results, Lee *et al.* [10], reported that surgeons regularly have trouble during LC for acute cholecystitis by reason of severe local inflammation, which can increase the percentage of postoperative complications, such as bile leakage, CBD injury, and bowel injury, and a study by Le *et al.* [11], reported that 2.6% of the studied patients required conversion to open cholecystectomy and the diagnosis of acute cholecystitis was more common among converted cases.

The study by Schachter *et al.* [12], mentioned that ABP can be considered as a significant risk factor for difficult LC owing to the difficulty in laparoscopic dissection of adhesions present around the GB area, difficult Calot's triangle dissection, and intraoperative bleeding. In this study, 10 cases had a history of hospital admission with ABP. A study by Alimoglu *et al.* [13], mentioned that it is surely well admitted that cholecystectomy is essential after an incident of ABP and that lag in cholecystectomy boosts the danger of recurrence of pancreatitis. Nine out of these 10 cases were admitted with mild ABP, treated conservatively, and LC was planned during the same admission after recovery of the clinical manifestations of ABP. Our plan was in concurrence with the results of da Costa *et al.* [14], who stated that in mild ABP, same-admission cholecystectomy was more powerful and less costly than interval cholecystectomy. The remaining case had severe ABP, treated conservatively, improved, and discharged with an appointment for elective LC.

In this study, 50 cases had a history of previous abdominal surgery, that is, previous cesarean section, laparoscopic sleeve gastrectomy, and open appendectomy, and a significant relation between previous surgery and difficulty of LC was found especially in umbilical port placement. These results

matched with results of Akyurek *et al.* [15], who found an association between previous abdominal surgery with difficult umbilical port entry, intraoperative bleeding, and abnormal ductal or arterial anomalies, and a study by Botaitis *et al.* [16], who stated that history of previous surgery especially upper abdominal may pose difficulty owing to unwanted adhesion around the umbilicus and peri-GB area.

Results of this study proved a significant association between obesity and difficult LC, where 53.9% of patients in the very difficult LC group were overweight (i.e. BMI between 25 and 29.9 km/m^2) and the remaining patients in the same group were morbidly obese with BMI between 30 and 34.9 km/m^2. This association was supported by the results of Nachnani and Supe [17], and Hussien *et al.* [18], who found BMI greater than 30 to be significantly associated with difficulty in umbilical port entry and creating pneumoperitoneum.

In this study, GB was clinically palpable in 69.2 and 18.8% of patients in the very difficult and difficult LC groups, respectively. Increased GB wall thickness was detected by ultrasound in 100% of patients in the very difficult LC group and 69.6% of patients in the difficult LC groups; both palpable GB and increased GB wall thickness on AUS were significant factors for difficult LC in this study. According to the Randhawa and Pujahari [5], prior hospitalization, BMI more than 27.5, palpable GB, and thick GB wall were significant predictors of difficult LC. These results were matched with multiple previous studies who described increased GB wall thickness on abdominal ultrasound (ABU) examination as a significant predictor of difficult LC [19–21].

This study revealed that a combination of more than one ultrasonographic findings of cholecystitis in the same patient as shown in Table 3 was a significant indicator of a technically difficult LC, and it was seen in 65 patients: 52 cases in difficult LC, and 13 cases in the very difficult LC group.

Lal *et al.* [19], mentioned that not only the clinical parameters of GB disease vary with patient cohorts, but surgical findings can be unanticipated, with somewhat unexpected degrees of surgical difficulty or ease. In this study, statistically significant intraoperative factors that can attribute to a technically difficult and very difficult LC included intraoperative adhesions at or near the triangle of Calot, GB phlegmon, thick edematous GB wall, distended GB that is not easily to be grasped so required decompression, difficult Calot's triangle dissection, wide cystic duct, and the presence of stone in the cystic duct during dissection (Table 3). These results were supported by results of Rosen *et al.* [22], which found that dense adhesions at the triangle of Calot were the most common reason for conversion to open surgery; results of Fried *et al.* [23], which found that increased GB wall thickness is associated with difficult dissection of the GB from its bed; and the results of Kuldip and Ashish [24], which found significant association of distended GB and grasping of the GB during operation.

In this study, five patients were found to have cystic duct stones during dissection of the Calot's triangle; preoperative AUS failed to detect this finding as a normal-caliber cystic duct could not be seen. These five cases were classified as difficult LC as the time taken for surgery exceeds 60 min and owing to minor stone spillage. A previous study by Mahmud *et al.* [25], mentioned that cystic duct stones can be encountered during LC and results of the study documented an incidence of cystic duct stones of ~12.3%.In this study, 7.1% of patients had GB content spillage (five patients had bile spillage, and 10 patients had combined bile/stone spillage). This incidence is low in comparison with the studies conducted by Koc *et al.* [26], and Assaff *et al.* [27], which were 34% and 41.3% of patients, respectively. In this study, stone spillage in the studied cases occurred mainly during dissection of an acutely inflamed GB off the liver bed and in one case during extraction of the GB through the port site. Retrieval of all the spilled stones was the rule either by the help of laparoscopic grasper or by thorough peritoneal wash followed by aspiration through a 10-mm suction device.

In this study, LC was converted to open procedure in only one patient, a morbidly obese male admitted for LC 72 h after the onset of acute cholecystitis with GB phlegmon and dense adhesions encountered intraoperatively. This is in accordance with the results of other studies by Ibrahim *et al.* [28], which stated acute cholecystitis as one of the common factors highly predictive of conversion, and the results of Ercan *et al.* [29], Tang and Cuschieri [30], and Helmy *et al.* [31] which showed the male sex to be a risk factor for conversion, probably owing to the more frequent association with severe disease, and presence of more intraabdominal and visceral adipose tissue than women.

Conclusion

Preoperative prediction of a technically difficult LC can be made using clinical (male sex, old age, history of

acute cholecystitis, acute pancreatitis, morbid obesity, previous upper abdominal surgery, and palpable GB) and ultrasonographic findings (thick GB wall, impacted stone in the neck of GB, and positive sonographic Murphy's sign). Preoperative counseling of the patients with these features about the likelihood of conversion to open cholecystectomy seems to be appropriate.

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Conflicts of interest

There are no conflicts of interest.

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