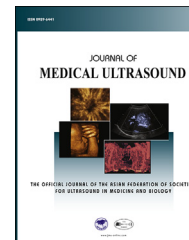


Chinese Taipei Society of
Ultrasound in Medicine

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.jmu-online.com



ORIGINAL ARTICLE

A Standardized Ultrasound Scoring System for Preoperative Prediction of Difficult Laparoscopic Cholecystectomy[☆]



Mohammed Azfar Siddiqui^{1*}, Syed Amjad A. Rizvi²,
Sara Sartaj³, Ibne Ahmad⁴, Syed Wajahat A. Rizvi³

¹ Department of Radiology, Saint Louis University, MO, USA, ² Department of Surgery, Jawaharlal Nehru Medical College, Aligarh, India, ³ Jawaharlal Nehru Medical College, Aligarh, India, and ⁴ Department of Radiodiagnosis, Jawaharlal Nehru Medical College, Aligarh, India

Received 7 March 2017; accepted 5 May 2017

Available online 31 October 2017

KEYWORDS

Ultrasound,
Sonography,
Preoperative
prediction,
Laparoscopic
cholecystectomy,
Open
cholecystectomy

Abstract *Purpose:* Laparoscopic cholecystectomy (LC) has become the treatment of choice for cholelithiasis. Still some patients required conversion to open cholecystectomy (OC). Our aim was to develop a standardized Ultrasound based scoring system for preoperative prediction of difficult LC.

Methods and materials: Ultrasound findings of 300 patients who underwent LC were reviewed retrospectively. Four parameters (time taken, biliary leakage, duct or arterial injury, and conversion) were analyzed to classify LC as easy or difficult. The following ultrasound findings were analyzed: GB wall thickness, pericholecystic collection, distended GB, impacted stones, multiple stones, CBD diameter and liver size. Out of seven parameters, four were statistically significant in our study. A score of 2 was assigned for the presence of each significant finding and a score of 1 was assigned for the remaining parameters to a total score of 11. A cut-off value of 5 was taken to predict easy and difficult LC.

Results: 66 out of 83 cases of difficult LC and 199 out of 217 cases of easy LC were correctly predicted on the basis of scoring system. A score of >5 had sensitivity 80.7% and specificity 91.7% for correctly identifying difficult LC. Prediction came true in 78.8% difficult and 92.6% easy cases. US findings of GB wall thickness, distended GB, impacted stones and dilated CBD were found statistically significant.

Conflicts of interest: None.

[☆] Presented at RSNA 2011, 97th Scientific Assembly and Annual Meeting, 27th November–2nd December, 2011 at Chicago, Illinois.

* Correspondence to: Mohammed Azfar Siddiqui, Department of Radiology, Saint Louis University, 374 S. Grand Blvd, St. Louis, MO 63103, USA.

E-mail address: drazfarsiddiqui@gmail.com (M.A. Siddiqui).

<http://dx.doi.org/10.1016/j.jmu.2017.09.001>

0929-6441/© 2017, Elsevier Taiwan LLC and the Chinese Taipei Society of Ultrasound in Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Conclusion: This indigenous scoring system is effective in predicting conversion risk of LC to OC. Patients having high risk may be informed and scheduled appropriately and decision to convert to OC in case of anticipated difficulty may be taken earlier.

© 2017, Elsevier Taiwan LLC and the Chinese Taipei Society of Ultrasound in Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Laparoscopic cholecystectomy (LC) has gained widespread acceptance as the procedure of choice for management of symptomatic gallbladder (GB) disease [1–3]. Its advantages are well documented like its minimal invasive nature, decreased postoperative pain, better cosmesis, shorter hospitalization, and early recovery [4]. However up to 15% of patients need conversion to open cholecystectomy (OC) for various reasons [5,6]. The degree of difficulty during LC and possibility of conversion is almost impossible to predict clinically.

It would be useful for both patients and surgeons to have some reliable predictive factors. At present there is no ultrasound based scoring system available to predict degree of difficulty during LC and possible conversion. Our aim was to develop a standardized ultrasound based scoring system, which can predict difficulty during LC as well as allow selection of patients who may need conversion to OC.

Materials and methods

Preoperative data of 300 patients who underwent LC between January 2008 and March 2011 by a single experienced surgeon were reviewed retrospectively. All the patients with symptomatic GB stone disease were eligible for entry into our study. We did not include patients where LC was done as emergency surgery or where reason for conversion to OC was equipment failure, anesthetic complications or presence of other co-morbidities. Patients with incomplete data were also excluded from the study. Study was approved by institutional review board.

Sonography was performed by 2 radiologists, using Toshiba NemioXG ultrasound scanner equipped with 3.5-MHz and 5-MHz curved array transducer. After fasting, patients were examined in the supine and the left lateral decubitus positions. The following 7 sonographic findings were analyzed: the thickness of the GB wall, the transverse diameter of the GB, presence of the pericholecystic collection, the number and mobility of stones in the GB, the diameter of the common bile duct (CBD), and the size of the liver (Figs. 1 and 2). A GB stone was considered to be present when a well define intraluminal echogenic lesion with posterior acoustic shadowing was seen in multiple planes. GB wall thickness was calculated by measuring the maximum thickness of the anterior wall adjacent to the liver. A wall thickness equal to or more than 4 mm was evaluated as thick. Diagnosis of a distended GB was made when the organ measured more than 5 cm in transverse diameter. The presence of a fluid collection in the GB fossa

was meticulously recorded. The number of stones was grouped as single or multiple. Stone mobility was assessed by scanning the patient in different positions and if the gallstones moved, they were considered mobile. The largest diameter of the CBD was measured, and it was considered dilated when maximum diameter was greater than 6 mm. A Liver was considered enlarged when its span was greater than 15.5 cm. After sonographic analysis, score of 2 was assigned for presence of each significant finding and a score of 1 was assigned for remaining parameters to a total score of 11 (Table 1). A cut-off value of 5 was taken to



Figure 1 Longitudinal section of gallbladder region reveals multiple stones within gallbladder lumen with thickened (4.2 mm) gallbladder wall.

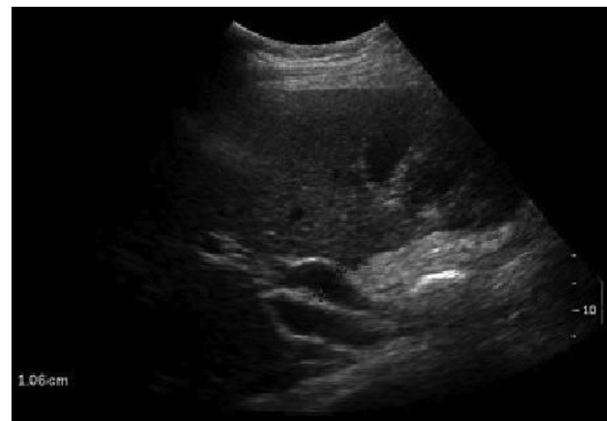


Figure 2 Longitudinal section of common bile duct reveals presence of a dilated duct (10.6 mm).

Table 1 Ultrasound scoring system.

Ultrasound parameters	Score
GB wall thickness ≥ 4 mm	2
Transverse diameter of GB ≥ 5 cm	2
Presence of impacted stones	2
CBD diameter > 6 mm	2
Presence of pericholecystic collection	1
Number of stones > 1	1
Liver size ≥ 15.5 cm	1

predict easy (score of 5 or less) and difficult LC (score more than 5).

All patients underwent surgery between 2 h and 7 days after sonographic examination. Single experienced surgeon performed the surgeries. The LC was performed using a standard four-puncture technique with two 5 mm and two 10 mm ports. Intraoperative cholangiography was also performed selectively in patients with suspicion of a CBD stone, or CBD injury. Drains are not routinely placed. All the patients received standard postoperative care and follow up. Four parameters were analyzed by the surgeon to classify laparoscopic cholecystectomy as easy or difficult (Table 2). Time taken more than 60 min, injury to duct or artery, presence of biliary leakage and conversion to open cholecystectomy because of any cause suggested difficult LC.

Statistical methods

All statistical analyses were performed with the SPSS 15.0 for Windows (SPSS Inc, Chicago, IL) and Microsoft word have been used to generate tables. The two-tailed chi-square test has been used to find the significant association of findings of preoperative ultrasonographic score with per-operative outcome of difficult LC. A p value < 0.05 was considered to be significant. The sensitivity, specificity along with positive predictive values for predicting easy and difficult cases were calculated.

Results

There were 316 cases that underwent LC for symptomatic GB disease. 16 patients who underwent conversion because of equipment failure, anesthetic complications or presence of other co-morbidities, were excluded from this study. So this study was effectively carried out on 300 patients, of

Table 2 Criteria for easy or difficult laparoscopic cholecystectomy.

Easy	Difficult
• Time taken < 60 min	• Time taken > 60 min
• Absence of biliary leakage	• Presence of biliary leakage
• No injury to duct or artery	• Injury to duct or artery
• No conversion to open cholecystectomy	• Conversion to open cholecystectomy

which 22 required conversions to OC with an overall conversion rate of 7.33%. Of the 300 patients, 188 (62.7%) were females and 112 (37.3%) were males. The age ranges from 19 years to 75 years with a mean of 42 years. Maximum cases were in the age group of 40–50 years.

73 (24.3%) patients were scored difficult and 227 (75.7%) patients were scored easy by ultrasound scoring system. 66 out of 83 cases of difficult LC and 199 out of 217 cases of easy LC were correctly predicted (Table 3). A score of > 5 had a sensitivity of 80.7% and specificity of 91.7% for correctly identifying difficult LC with prediction coming true in 78.8% difficult cases and 92.6% easy cases. Ultrasound findings of thickened GB wall, distended GB, impacted stones and dilated CBD were found statistically significant with p-value < 0.05 (Table 4). The sonographic parameters like presence of pericholecystic collection, multiple stones and enlarged liver had higher prevalence in difficult laparoscopic group, but the association was not statistically significant.

Discussion

The advent of laparoscopic surgery has revolutionized the field of general surgery, and no intra-abdominal organ has been spared from its reach. However, its impact is greatest with symptomatic GB disease, and LC is now accepted as the new gold standard totally replacing open surgery [1–3]. Its advantages are well documented like its minimal invasive nature, decreased postoperative pain, shorter hospitalization, earlier return to normal activity, and better

Table 3 Performance of ultrasound scoring system with laparoscopic cholecystectomy as the reference standard.

		Laparoscopic cholecystectomy	
		Difficult	Easy
Ultrasound	Score > 5	66	18
	Score ≤ 5	17	199

Table 4 Analysis of peroperative outcome with ultrasound parameters for statistical significance.

Ultrasound parameters		Difficult LC	Easy LC	p Value
Thickened GB wall	+	14	8	< 0.05
	–	69	209	
Distended GB	+	21	15	< 0.05
	–	62	202	
Impacted stones	+	5	3	< 0.05
	–	78	214	
Dilated CBD	+	35	46	< 0.05
	–	48	171	
Pericholecystic collection	+	1	5	~ 0.54
	–	82	212	
Multiple stones	+	27	65	~ 0.74
	–	56	152	
Enlarged liver	+	18	51	~ 0.67
	–	65	166	

cosmesis [4]. However up to 15% of patients need conversion to OC for various reasons [5,6]. Dense adhesions and aberrant anatomy are few of the unwanted surprises waiting for surgeon during LC making conversion to OC inevitable in some cases. It is very difficult to say preoperatively whether LC is going to be easy or difficult based on clinical history. Identification of the preoperative sonological parameters that could predict the risk for possible conversion would be useful for both patients and surgeons. Our aim was to develop a standardized ultrasound-based scoring system for preoperative prediction of difficult LC.

The role of preoperative ultrasonography in predicting potential intraoperative difficulties and complications has yet to be established [7]. GB wall thickness has been identified as a risk factor for difficult LC in almost all the studies. The critical wall thickness associated with conversion varies from 3 mm to 6 mm in different studies [8–12]. In our study, a GB wall thickness of more than 4 mm was significantly associated with difficulty during LC. In gallstone disease, the most common reason for wall thickening is acute or chronic pericholecystic inflammatory change [13]. An acutely inflamed and edematous GB wall may rupture with spillage of infected bile and stones can further limit visualization of the operative field, resulting in a more difficult operation. Chronic inflammatory changes lead to adhesion formations that frequently impede the detachment of the gallbladder from its bed.

We also found distended GB to be significantly associated with difficult LC, confirming the experience of Cho et al., who also reported that distension of GB lumen was associated with a technically difficult [14].

Randhawa et al. reported absence of statistically significant association between impacted stone and difficulty during LC [15]. But we found that patients with an impacted stone had higher incidence of operative difficulty and the association between the two was statistically significant. We also found that ultrasound finding of dilated CBD is useful for predicting technical difficulties during LC. Similar findings have been reported by Daradkeh et al. and Cho et al. [7,14].

Similar to many of the authors, we also did not find any statistical significance between difficulty during LC and the presence of multiple stones, pericholecystic collection, or enlarged liver [7,10,15,16].

Conversion to OC should not be considered as a failure of LC but a step toward safety of patient in difficult cases. Our scoring system is effective in predicting anticipated difficult LC and risk of conversion. A score of 5 had a sensitivity of 80.7% and specificity of 91.7% for correctly identifying difficult LC with positive predictive value of 78.8%. Based on this scoring system, patients having high risk may be informed and scheduled appropriately. Decision to convert to OC in case of anticipated difficulty may be taken earlier. There is also concern that new surgical trainees learning the procedure have higher complication rates. Our scoring system can be used to select cases to be done by more experienced surgeons.

Although the use of preoperative ultrasound was found to be useful for predicting of intraoperative difficulty, there should be no illusion that our scoring system was a perfect model. This is a small study and further validation of our scoring system through studies with larger sample size is

required. Several authors have also reported usefulness of other non-sonological parameters for predicting operative difficulty during LC. Higher conversion rates and intraoperative difficulty is reported with increasing age, male sex, higher body mass index (BMI), elevated leukocyte count and alkaline phosphatase level, poor diabetic control, and past history of previous upper abdominal surgery [4,6,8,9,16–18]. Thus to improve the predictability of this scoring system, these non-sonological parameters must also be taken into account. Anomalous ducts may be responsible for many conversions to OC [15]. Ultrasound is limited in its ability to detect these anomalous ducts. They are better detected by other imaging modalities such as magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP). So preoperative utilization of these modalities might yield in better results.

Thus we concluded, preoperative ultrasound examination and our scoring system although very useful, but is not the sole predictor for difficulty during LC. Utilization of other non-sonological parameters and advanced imaging modalities may possibly improve the predictability.

Source of funding

None.

References

- [1] Corr P, Tate JJ, Lau WY, et al. Preoperative ultrasound to predict technical difficulties and complications of laparoscopic cholecystectomy. *Am J Surg* 1994 Jul;168(1):54–6.
- [2] Sikora SS, Kumar A, Saxena R, et al. Laparoscopic cholecystectomy—can conversion be predicted? *World J Surg* 1995 Nov–Dec;19(6):858–60.
- [3] Dubois F, Berthelot G, Levard H. Coelioscopic cholecystectomy: experience with 2006 cases. *World J Surg* 1995 Sep–Oct;19(5):748–52.
- [4] Alponat A, Kum CK, Koh BC, et al. Predictive factors for conversion of laparoscopic cholecystectomy. *World J Surg* 1997 Jul–Aug;21(6):629–33.
- [5] Rosen M, Brody F, Ponsky J. Predictive factors for conversion of laparoscopic cholecystectomy. *Am J Surg* 2002 Sep;184(3):254–8.
- [6] Ibrahim S, Hean TK, Ho LS, et al. Risk factors for conversion to open surgery in patients undergoing laparoscopic cholecystectomy. *World J Surg* 2006 Sep;30(9):1698–704.
- [7] Daradkeh SS, Suwan Z, Abu-Khalaf M. Preoperative ultrasonography and prediction of technical difficulties during laparoscopic cholecystectomy. *World J Surg* 1998 Jan;22(1):75–7.
- [8] Kama NA, Kologlu M, Doganay M, et al. A risk score for conversion from laparoscopic to open cholecystectomy. *Am J Surg* 2001 Jun;181(6):520–5.
- [9] Fried GM, Barkun JS, Sigman HH, et al. Factors determining conversion to laparotomy in patients undergoing laparoscopic cholecystectomy. *Am J Surg* 1994 Jan;167(1):35–9. discussion 39–41.
- [10] Jansen S, Jorgensen J, Caplehorn J, et al. Preoperative ultrasound to predict conversion in laparoscopic cholecystectomy. *Surg Laparosc Endosc* 1997 Apr;7(2):121–3.
- [11] Nachnani J, Supe A. Pre-operative prediction of difficult laparoscopic cholecystectomy using clinical and ultrasonographic parameters. *Indian J Gastroenterol* 2005 Jan–Feb;24(1):16–8.

- [12] Parra Blanco JA, Bueno López J, Madrazo Leal C, et al. Laparoscopic cholecystectomy: analysis of risk factors for predicting conversion to open cholecystectomy. *Rev Esp Enferm Dig* 1999 May;91(5):359–64.
- [13] Dinkel HP, Kraus S, Heimbucher J, et al. Sonography for selecting candidates for laparoscopic cholecystectomy: a prospective study. *AJR Am J Roentgenol* 2000 May;174(5):1433–9.
- [14] Cho KS, Baek SY, Kang BC, et al. Evaluation of preoperative sonography in acute cholecystitis to predict technical difficulties during laparoscopic cholecystectomy. *J Clin Ultrasound* 2004 Mar–Apr;32(3):115–22.
- [15] Randhawa JS, Pujahari AK. Preoperative prediction of difficult lap chole: a scoring method. *Indian J Surg* 2009 Jul–Aug;71(4):198–201.
- [16] Hutchinson CH, Traverso LW, Lee FT. Laparoscopic cholecystectomy. Do preoperative factors predict the need to convert to open? *Surg Endosc* 1994 Aug;8(8):875–8. discussion 879–880.
- [17] Kanaan SA, Murayama KM, Merriam LT, et al. Risk factors for conversion of laparoscopic to open cholecystectomy. *J Surg Res* 2002 Jul;106(1):20–4.
- [18] Simopoulos C, Botaitis S, Polychronidis A, et al. Risk factors for conversion of laparoscopic cholecystectomy to open cholecystectomy. *Surg Endosc* 2005 Jul;19(7):905–9.