

## Evaluation of Pre-Operative Ultrasound Findings in Predicting Difficulties in Laparoscopic Cholecystectomy for Acute Cholecystitis

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### Abstract

- Background** Pre-operative prediction of difficulties which may occur during laparoscopic cholecystectomy can help in reduction of operative and postoperative complications.
- Objectives** To study the value of preoperative ultrasound findings for predicting difficulties encountered during laparoscopic cholecystectomy and to assess the usefulness of these findings to identify patients at high risk of conversion from laparoscopic to open cholecystectomy.
- Methods** A prospective study of 200 patients who underwent laparoscopic cholecystectomy for symptomatic cholelithiasis. Pre-operative abdominal ultrasound was done. The diagnosis of gall stones was made and the presence of ancillary findings was recorded. Five ancillary ultrasound findings were assessed. These included; thickened gall bladder wall more than 4mm, presence of pericholecystic fluid, severely contracted gall bladder, empyema, and gall bladder filled with stones. Ultrasound findings were compared with the operative findings.
- Results** In 36 patients who had one or more of these findings laparoscopic Cholecystectomy was difficult in 22(61.1%) of them. Thick wall gall bladder > 4mm has the highest sensitivity (69%) and the presence of pericholecystic fluid has the highest specificity (100%) in predicting difficult laparoscopic cholecystectomy and the presence of more than 2 ancillary findings yielded an accuracy rate of (100%). Conversion to open cholecystectomy was needed in 13.9% of these patients. The rates of difficult laparoscopic cholecystectomy and conversion to laparotomy were much lower in those patients who had no ancillary findings (4.3%) and (1.2%) respectively.
- Conclusion** Preoperative ultrasound findings are of value for predicting difficulties encountered during laparoscopic cholecystectomy which may require conversion to open cholecystectomy.
- Keywords** Laparoscopic surgery, Cholecystectomy, Ancillary ultrasound findings.

### Introduction

Laparoscopic cholecystectomy is now considered the gold standard procedure for symptomatic gallstone disease <sup>(1)</sup> and one of the most frequently performed procedures in surgery. Laparoscopic cholecystectomy has substituted traditional cholecystectomy due to a more comfortable postoperative period than the open approach <sup>(2)</sup>. The increasing experience with laparoscopic cholecystectomy has led to an

expansion of the indications for this procedure, a reduction in contraindications of the procedure, and more complex cases being operated laparoscopically. The definition of difficult laparoscopic cholecystectomy is inconsistent. The term difficult cholecystectomy refers "to multiple" technical intra-operative difficulties that increase the risk for complications and significantly prolong the operating time <sup>(3,4)</sup>. Although most patients will also benefit from the

laparoscopic approach, difficult cases are at a higher risk for conversion and the resulting complications that may overshadow all advantages of the laparoscopic procedure, making this approach unsafe, uneconomic, inefficient, and hence possibly inferior to traditional open cholecystectomy<sup>(5,6)</sup>. Reliable predictive factors for difficult procedures and hence conversion of laparoscopic cholecystectomy would be extremely useful in the preparation and planning of management for patients with symptomatic cholelithiasis<sup>(7-9)</sup>.

### **Methods**

This is a prospective study of 200 consecutive patients who underwent laparoscopic cholecystectomy for symptomatic gall bladder stones during the period from October 2005 to March 2007 in Baghdad Teaching Hospital in Baghdad by two surgeons. Exclusion criteria included patients with suspicion of choledocholithiasis. Preoperative workup included a complete history and physical examination and routine laboratory and radiological tests for all patients. Ultrasound examination for all patients was carried out in Baghdad Teaching Hospital by one sonography expert one day before operation, using a high resolution ultrasound machine (3.5MHz, curvilinear probe, G 50 Siemens). The patients fasted for 6-hours before the examination. The initial scan was performed in the right subcostal region during suspended inspiration. Scans were performed both along the long axis and at right angles to the long axis of the gallbladder. When necessary right lateral intercostal scans were performed along the length of the intercostal spaces. A further alternative approach was to lay the patients completely on their left side and to perform anterior sub costal scans. Care was taken to ensure that the entire volume of the organ is examined and that even a tiny calculus not missed. A special care was given to record any ancillary finding including; thick gall bladder wall, contracted gall bladder, presence of pericholecystic fluid, gall bladder filled with gall stones, and finally if the clinical and ultrasound

findings would suggest empyema of the gall bladder. The study approved by local research ethics committee. Informed consent was taken from the patients. The procedure of laparoscopic cholecystectomy and the risk of conversion were explained to them, with a special emphasis for those patients with a higher risk of conversion. All patients received 1 gm Cefotaxime i.v. at time of induction of anesthesia and another 2 doses at 8 and 16 hours postoperatively. All operations performed under general anesthesia by standard North American laparoscopic technique<sup>(10,11)</sup>. Intra-operative cholangiography was not carried out in any of the procedures. A closed drain was used when indicated. The preoperative ultrasound findings compared with intra-operative findings. The operations which were not converted to open cholecystectomy, graded as difficult or easy operations according to the period between insertion of the ports and clipping of the cystic duct and artery. When this period is less than 30 minutes the operation regarded as easy otherwise it regarded as difficult. The data was collected retrospectively and analyzed to see if the results are statistically significant by applying P-value (if P-value is 5 or less, it will be considered statistically significant)<sup>(12)</sup>.

### **Results**

The study comprised 200 patients. The age ranged between 16 to 79 years (mean was 35). One hundred sixty one patients were females and 39 were males. The male to female ratio was (1:4). There was no mortality in the study. All patients had surgically proven gall stones, thus sensitivity, specificity, and accuracy of ultrasound in diagnosis of gall stones were 100%. Thirty six patients (18%) had additional ultrasound findings that presumed to be of significance in predicting difficult laparoscopic cholecystectomy and conversion to open cholecystectomy. These ancillary findings are shown in table -1. Laparoscopic cholecystectomy was easy in 164 (82%) patients and difficult in 29 (14.5%) patients, while in 7 (3.5%) patients the

procedure had to be converted to open cholecystectomy.

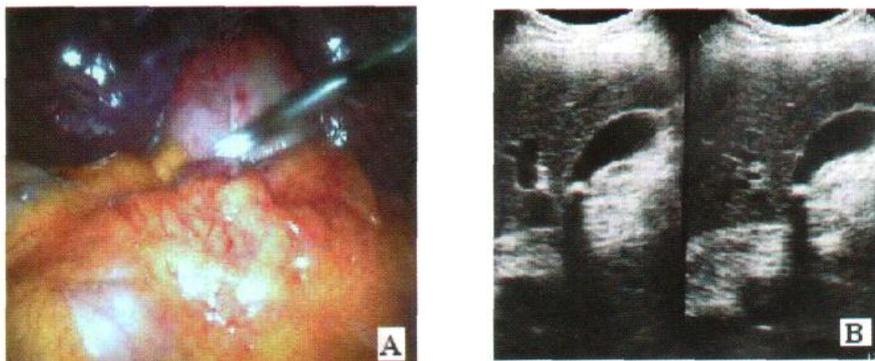
In patients who didn't have ultrasound ancillary findings, the procedure was easy in 155 (94.5%), difficult in only 7 (4.3%) cases, the reasons of difficulty were; severe adhesions (n=3), morbid obesity (n=2), liver cirrhosis (n=1) and

uncontrolled intra-operative bleeding (n=1), while conversion rate was 1.2% i.e. only in two patients and it was because of severe adhesions (Figure 1). Those with no ultrasound findings 162 had Laparoscopic cholecystectomy and 2 ended with open surgery.

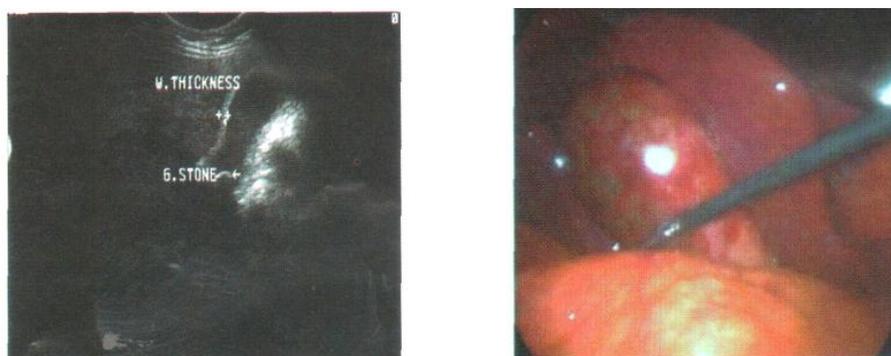
**Table 1. Ancillary ultrasound findings**

| Ancillary findings                | No. of patients |
|-----------------------------------|-----------------|
| Thickened gall bladder wall >4mm  | 26              |
| Presence of pericholecystic fluid | 8               |
| Severely contracted bladder       | 2               |
| Empyema                           | 2               |
| Gall bladder filled with stones   | 8               |

The patients may have > one finding



**Figure 1. A) Laparoscopic photo of a patient who had severe adhesions. B) The preoperative ultrasound of the same patient showed neither, ancillary findings nor any indication of a difficult procedure.**



**Figure 2. (a, and b.) Ultrasound and laparoscopic photo of a patient who had acute cholecystitis with a thick wall gall bladder**

In patients who had ancillary ultrasound findings, the rate of difficult laparoscopic cholecystectomy was 61.1% and conversion rate was 13.9%. These results were much higher and

statistically significant when compared with the results of patients who had no ancillary ultrasound findings ( $P > 0.05$ ) (Table-2).

**Table 2. Ultrasound Findings related to difficult laparoscopic cholecystectomy and rate of conversion to open cholecystectomy.**

| Laparoscopic cholecystectomy       | Without ancillary U/S | With ancillary U/S | Total      |
|------------------------------------|-----------------------|--------------------|------------|
| Easy                               | 155 (94.5%)           | 9 (25%)            | 164 (82%)  |
| Difficult                          | 7 (4.3%)              | 22 (61.1%)         | 29 (14.5%) |
| Conversion to open cholecystectomy | 2 (1.2%)              | 5 (13.9%)          | 7 (3.5%)   |
| Total                              | 164 (82%)             | 36 (18%)           | 200 (100%) |

Gall bladder wall thickness was an important predicting factor of difficult laparoscopic cholecystectomy. Fifteen of 26 patients with wall thickness greater than 4mm had difficult

operation (Figure 2), thus the sensitivity of wall thickness greater than 4mm in predicting difficulty was 69%, and specificity 96.5% (Table 3).

**Table 3. Value of Ultrasound findings in predicting difficult Laparoscopic cholecystectomy**

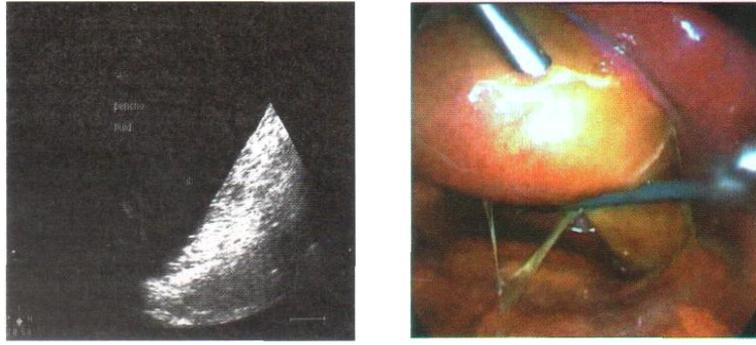
| Procedure                | Ultrasound predictors |                                  |               |                      |         |
|--------------------------|-----------------------|----------------------------------|---------------|----------------------|---------|
|                          | Wall thickness >4mm   | Pericholecystic fluid collection | Contracted GB | GB fluid with stones | Empyema |
| Easy LC                  | 6                     | 0                                | 0             | 3                    | 0       |
| Difficult LC             | 15                    | 3                                | 2             | 5                    | 1       |
| Conversion to laparotomy | 5                     | 5                                | 0             | 0                    | 1       |
| Sensitivity (%)          | 69.0                  | 10.3                             | 6.9           | 17.2                 | 3.4     |
| Specificity (%)          | 96.5                  | 100.0                            | 100.0         | 98.2                 | 99.4    |
| PPV                      | 76.9                  | 100.0                            | 100.0         | 62.5                 | 50.0    |
| NPP                      | 94.8                  | 86.8                             | 86.4          | 87.5                 | 85.9    |
| Accuracy (%)             | 92.5                  | 92.5                             | 86.5          | 86.5                 | 85.5    |
| Total                    | 26                    | 8                                | 2             | 8                    | 2       |

GB = gall bladder, PPV = Positive predictive value (%), NPP = Negative predictive value (%)

Presence of fluid in the pericholecystic area resulted in even more difficult laparoscopic procedure (Figure 3). In all of 8 patients with pericholecystic fluid collection the operation was difficult: sensitivity of pericholecystic fluid for surgical difficulties during laparoscopic cholecystectomy was 10.3%, and specificity 100% (Table 3). Other ancillary ultrasound findings apart from gall stones indicating difficult surgical preparation namely contracted gall bladder and empyema were also observed (Table 3). When the gall bladder was filled with stones (n = 8), difficulty was encountered in 5 patients,

making its sensitivity 17.2%, it's specificity 98.2% (Table 3).

In patients with more than one ancillary finding by ultrasound, laparoscopic cholecystectomy was never easy i.e. specificity and positive predictive value were 100% (Table 3). Laparoscopic cholecystectomy was converted to laparoscopic cholecystectomy whenever it was deemed necessary to avoid exposing patients to unnecessary risks. Conversion rate was higher when there was more than one ancillary ultrasound findings (Table 3).



**Figure 3. Ultrasound and laparoscopic photo of a patient who had acute cholecystitis with pericholecystic fluid.**

### Discussion

The first account of gall stones was given in 1420 by a pathologist Antonio Benevieni, in a woman who died with abdominal pain. With the passage of time, first open cholecystectomy and then, laparoscopic cholecystectomy were established as the standard treatment of gall stones<sup>(13)</sup>. Ultrasound is noninvasive and cost effective, involves no ionizing radiation, and has a reported specificity of 99% for the detection of gall stones<sup>(14,15)</sup>.

In our study its specificity was 100%. It is the cornerstone imaging modality for the diagnosis of gall bladder stones, and it is unlikely to be replaced by other examination methods<sup>(16)</sup>. It is generally accepted as the modality of first choice for the diagnosis of acute cholecystitis<sup>(17,18)</sup>. It has relevance for decision taking, and is an indispensable procedure in the emergency setting<sup>(19)</sup>. In the early years of laparoscopic cholecystectomy, acute cholecystitis was considered a relative contraindication, especially in severe attacks or if the gall bladder wall thickness was more than 4mm<sup>(20)</sup>. Since then, many reports worldwide documented the safety of the procedure in acute cholecystitis<sup>(21)</sup> and the operation is recommended as the treatment of choice for acute cholecystitis<sup>(22)</sup>.

The definition of a difficult laparoscopic cholecystectomy is relative and it is linked to the experience of the surgical team<sup>(23)</sup>. In the present study, difficult laparoscopic cholecystectomy occurred in 14.5% of total

surgical procedures. We evaluated preoperative ultrasound's capacity of predicting technical challenges in laparoscopic cholecystectomy. When there were ancillary ultrasound findings, where difficulty was anticipated, the percentage of difficult laparoscopic cholecystectomy increased significantly to 61%. Our findings suggest that patients with thickened gall bladder wall tend to have technical difficulties during laparoscopic cholecystectomy. Similar findings have been reported by many authors<sup>(24-26)</sup>, in fact it was the most sensitive ultrasound findings that predict a difficult laparoscopic cholecystectomy.

Pericholecystic fluid is another predictor of difficult laparoscopic cholecystectomy. In our study eight patients had pericholecystic fluid and the surgical procedure was difficult in all of them, making the presence of pericholecystic fluid more specific than gall bladder thickness in predicting difficult laparoscopic cholecystectomy. When there were more than 2 ultrasound findings suggesting acute cholecystitis, the specificity of ultrasound in predicting technical difficulty mounted to 100%. Difficult laparoscopic cholecystectomy needs longer time to finish and the preoperative prediction of long operation when patients are listed for laparoscopic cholecystectomy may have several practical applications. In addition to allowing better planning of the operating sessions, both in terms of service provision and training of junior doctors, it may allow a more

efficient selection of patients for ambulatory laparoscopic cholecystectomy. Moreover, additional anesthetic measures may be taken to minimize postoperative emesis and dizziness<sup>(27)</sup>. In a large study involving 6,380 patients Kuldip and Ohri reported an overall conversion rate of 0.42% and a rate of 1.86% in difficult cholecystectomies<sup>(28)</sup>, while Livingston and Rege reported conversion rates ranging on average between 5% and 10% in a nationwide study in the USA<sup>(29)</sup>. Others reported conversion rates of 2.9-10% for elective laparoscopic cholecystectomy and 6-35% for acute cholecystitis<sup>(30-34)</sup>. In our study the conversion rates were 1.2% in patients without ancillary ultrasound findings, 13.9% in patients with ancillary ultrasound findings, and an overall conversion rate of 3.5%. The quest for predicting the probability of conversion of laparoscopic cholecystectomy in unselected patients with calculus gall bladder disease has been extensive<sup>(35,36)</sup>.

Many authors have reached conclusions that preoperative ultrasound examination is useful in selecting patients who are likely to have difficulty and may require conversion from laparoscopic to open surgery. Thickened gall bladder wall<sup>(37,38)</sup>, and the presence of pericholecystic fluid<sup>(39)</sup> being the most strong association with conversion, as seen also in our study. In our study, the conversion rate in patients with no ancillary findings was 1.2%, but it was significantly higher (13.9%) when ultrasound showed findings that might predict conversion from laparoscopic to open approach. Conversion rate was higher when there was more than one ancillary finding. Five patients from those with no ancillary ultrasound findings had difficult laparoscopic cholecystectomy and in two of them the procedure was converted to laparotomy. Ultrasound could not predict difficulty, mostly because the reason for difficulty and conversion was severe adhesions around the gall bladder which is a finding the preoperative ultrasound can not show, but rather it is an intraoperative finding<sup>(40,41)</sup>.

On the other hand 25% of our patients with ancillary ultrasound findings, laparoscopic cholecystectomy was easy, this can be explained partially by the fact that some of these procedures were done at later stages of the study i.e. later stage of the learning curve of the surgeon, and partially by the fact there are other factors which may contribute to the degree of difficulty, like age, sex and obesity<sup>(42-44)</sup>.

Conclude the current study that preoperative ultrasound is able to furnish valuable data in predicting laparoscopic cholecystectomy challenges. On the other hand, a relevant number of cases still exist wherein the concordance between the preoperative ultrasound findings and the surgical findings is unsatisfactory. In this group of patients the surgeon cannot safely rely on ultrasound examination alone and factors with a higher predictive value are obtained only during laparoscopic cholecystectomy. The need to convert can only be assessed during an attempt at laparoscopic cholecystectomy.

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