The Role of Ultrasound in Laparoscopic Cholecystectomy

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Abstract

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KEYWORDS: ultrasound, laparoscopic cholecystectomy
THE ROLE OF PRE-OPERATIVE ULTRASOUND IN LAPAROSCOPIC CHOLECYSTECTOMY

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Abbreviated Title: Ultrasound Value in Lap. Chole.

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KEYWORDS

- ultrasound/laparoscopic/cholecystectomy

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Background to the Topic
Since the first documented laparoscopic cholecystectomy performed by Erich Muhe in Germany in 1985, this procedure has become the gold standard for cholecystectomy. The level of difficulty of the procedure is variable, and there are a number of studies to try and analyze the pre-operative criteria in relation to the difficulty encountered during surgery.

Aims
To evaluate the impact of pre-operative Ultrasound findings of gallbladder wall thickness and number of stones in gallbladder to the level of intra-operative difficulty and post operative complications.

Patients and Methodology
This is a prospective study done in NMC Specialty Hospital, Dubai, UAE in cooperation between Radiology and General Surgery departments between June 2007 to June 2009. Abdominal sonography was performed in 100 consecutive patients before surgery. Surgeon reverified sonographic findings intraoperatively.

Results
Out of 100 patients with cholecystolithiasis on sonography, we encountered straightforward laparoscopic cholecystectomy in 72 (72%), difficult laparoscopic cholecystectomy in 20 (20%) and procedure was converted to open cholecystectomy in 8 (8%). 42 patients had ultrasound revealing gallbladder wall thickness (more than 3mm). The accuracy of sonography for cholecystolithiasis was 99.9%.

Main Conclusions
In our study, increased gallbladder wall thickness is not a good predictor of difficulties during laparoscopic cholecystectomy, though normal gallbladder wall thickness is a good predictor of no difficulties. However interestingly, we found that multiple gall stones is a good predictor that the surgical procedure of laparoscopic cholecystectomy may be difficult.
INTRODUCTION

A number of studies have related gallbladder wall thickness of greater than 3mm as pre operative Ultrasound study to increased difficulties during laparoscopic cholecystectomy. Our study aimed to re-verify impact of pre operative Ultrasound study gallbladder wall thickness on intra operative difficulties and to look if other criteria like the number of stones in the gallbladder will affect the level of difficulties during surgery.

AIMS

To evaluate the impact of gallbladder wall thickness assessed by ultrasound preoperatively on the outcome of laparoscopic cholecystectomy.

PATIENTS AND METHODS

This is a prospective clinical study conducted in combination between Radiology and General Surgery departments in NMC Speciality Hospital Dubai between June 2007 and June 2009. 100 patients with calculus cholecystitis were included in this prospective study ranging from 25 to 55 years old, 74 females and 26 males. Selection criteria were:

1) Sonography done by the same radiologist and within 30 days from surgery.
2) All procedures were performed by the same team.

Exclusion Criteria:

1- Previous abdominal operation.
2- Co-morbid illness which place patient at higher risk for surgery and anesthesia
3- Acute cholecystitis.
4- Cholelithiasis with jaundice.

The laparoscopic system used was Carl Storz. Ultra sound study was performed in all patients before operation and the findings were re-verified by surgeon in the operating room. Diagnostic ultrasound machine used was iu22 Philips model with multiple probes. All patients were examined at least 8 hours after fasting in supine and left decubitus positions. In ultrasound we checked for morphology of the gallbladder, wall thickness, configuration of the liver, intra and extra hepatic ducts diameter, number and location of stones in the gallbladder and presence and absence of pericholecystic edema.

All patients had operation between day 1-30 after the ultrasound. An evaluation questionnaire was sent to the operating room with each patient, and the operating surgeon correlated the data on the checklist with intra operative findings immediately after the operation. Duration of each procedure was recorded just after insertion
of the ports till removal of all the ports i.e. time of insertion ,time of closure were not recorded. Intra operative technical difficulties were defined by a preparation time (the time needed after insertion of all ports to identify all structures in calot’s triangle) of more than 20 minutes.

The procedure was defined to be difficult if:

a- Preparation time (i.e. the time needed after insertion of all ports to identify the anatomy at calot’s triangle) more than twenty minutes.

b- Overall operation time more than two hours.

c- The operation time is from the time of insertion of all ports to the time of removal of ports (note: the closure post sites is not included in the definition of operation time).

d- The operation time may have been prolonged due to:
   1- Difficulty in recognizing anatomy of calot’s triangle.
   2- Preitoneal and perivescicular adhesions.
   3- Excessive and uncontrollable bleeding.

The surgeon makes the decision to convert to open surgery on a case to case basis depending on the level of difficulty and expected complications.

RESULTS

One hundred patients had surgically proven gallbladder stones. In all patients, the prospective diagnosis of cholecystolithiasis was correctly made by ultrasound. Thus sensitivity and specificity of ultrasound with regard to cholelithiasis was 100%. 42 patients had ancillary sonographic findings indicating chronic cholecystitis beyond the presence of cholecystolithiasis including gallbladder wall thickness.
Initially, all patients underwent laparoscopy. Out of 100 patients with cholecystolithiasis on ultrasound we encountered laparoscopic cholecystectomy in 72. There were 52 patients with normal gallbladder wall thickness and 20 patients with thick wall gallbladder. By ultrasound there were 24 gallbladders with single gallstones and 48 with multiple gallstones but following laparoscopic cholecystectomy, on opening the gallbladder only 18 gallbladders harbored single gallstones and 54 had multiple gallstones reflecting on the accuracy of ultrasound in detecting the multiplicity of stones. In other words, while ultrasound is 99.9% accurate in detecting the presence of gallstones it is not as accurate in detecting the number of gallstones.
There were adhesions in 32 patients at surgery but most of them were easy to separate from the gallbladder. We used four ports in order to get a good view at the calot’s triangle and for retraction. Most of the time we had no serious complications. Perforation of the gallbladder happened intra-operatively in 8 patients, 6 of them were iatrogenic (with hook spatula during dissection of the gallbladder from the liver bed) while 2 perforations occurred during extraction of the gallbladder from the epigastric port. It took us an additional 8-10 minutes to extract them all. Six of the perforated gallbladders had normal gallbladder wall thickness and two were thick walled. No postoperative complications were recorded apart from the usual mild abdominal pain mostly at wound sites and occasional postoperative vomiting. A sub-hepatic tube drain was put only in two patients and was removed the next day. The duration of the laparoscopic cholecystectomy ranged from 35-45 minutes.

Out of 100 patients with cholecystolithiasis on ultrasonography we encountered difficulties at laparoscopic preparation in 20, two of whom had normal gallbladder wall thickness while 18 had thick walled gallbladder. Gallstones varied in number in those cases. Preoperative ultrasound examination yielded 4 single and 16 multiple gallstones but direct postoperative inspection proved only 2 gallbladders to harbor a single gallstone and rest 18 contained multiple gallstones. We faced adhesions in all these difficult procedures and they were dense and not easy to separate from the gallbladder and nearby structures and therefore required time for safe dissection to free the operative field. Four gallbladders were perforated intra-operatively, two of which had normal gallbladder wall thickness while the other two were thick walled. No major postoperative complications were recorded apart from mild wound site pain and sometimes vomiting postoperatively. A sub hepatic drain was left in six patients and all removed within 24 hours. The duration of difficult laparoscopic cholecystectomy ranged from 60-90 minutes.

The procedure was converted to open cholecystectomy in 8 patients, four because of difficulty in assessing the anatomy of calot’s triangle and four because of adhesions around the gallbladder that were too dense and consequently hazardous to be dissected laparoscopically. It was due to empyema of gallbladder where radiologist was not able to recognize it by preoperative ultrasound.

Fig (4) Presence of adhesions around gallbladder in different type of operations
Gallbladder wall thickness was normal in four patients and was thick (> 3 mm) in the other four. All eight cases had multiple gallstones on ultrasound that was proved after surgery. Early conversion was performed with an intention to minimize the risk of complications. Consequently one of the patients with empyema gallbladder developed postoperative wound infection (after conversion to open cholecystectomy) and was later treated conservatively and ended with incisional hernia. Time taken to make the decision to convert from laparoscopic to open cholecystectomy ranged from 35 to 55 minutes.

**Fig (5) No. of ports in different type of operations**

**Fig (6) Complications in different type of operations**
Ultrasounds Value in Lap. Chole.

Fig (7) Duration of procedure in different type of operations

Gallbladder wall thickness was an important predictor of difficulties during laparoscopic preparation of the operative field and difficulty in detaching the gallbladder from the liver bed. We encountered such difficulties in 42 out of 100 with gall bladder wall thickness greater than 3mm because of the limits of laparoscopic instruments or visualization of the operative field that lead to conversion in four patients and hence comparison between the three groups of study (laparoscopic cholecystectomy, difficult laparoscopic cholecystectomy and conversion to open cholecystectomy) was statistically significant with p value less than 0.05 with difficult laparoscopic cholecystectomy group carried high percentage of thick wall gallbladder (more than 3mm) which was (90%). All histological examination of the removed gallbladders revealed chronic inflammation and no malignancy.

Table 1 Sonographic Predictors & Value of Findings for Patients Undergoing Laparoscopic Cholecystectomy

<table>
<thead>
<tr>
<th></th>
<th>Number of Patients</th>
<th>Sonographic Predictors</th>
<th>Presence of adhesions around gallbladder</th>
<th>No. of ports</th>
<th>Complications</th>
<th>Presence of tube drain</th>
<th>Duration of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Thickness of gallbladder</td>
<td>Number of gallstones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single</td>
<td>Multiple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laparoscopic cholecystectomy</td>
<td>72 (72%)</td>
<td>26±3 mm (72.2%)</td>
<td>24</td>
<td>48</td>
<td>16→there are adhesions (44%)</td>
<td>3→3 Ports (91.6%)</td>
<td>4 Patients → there are perforation of gallbladder wall (11.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10±3 mm (27.8%)</td>
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<tr>
<td>Difficult laparoscopic cholecystectomy</td>
<td>20 (20%)</td>
<td>1±3 mm (10%)</td>
<td>4</td>
<td>16</td>
<td>There are adhesions in all patients (100%)</td>
<td>2→3 Ports (20%)</td>
<td>2 Patients → there are perforation of gallbladder wall (20%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9±3 mm (90%)</td>
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<tr>
<td>Convert to open cholecystectomy</td>
<td>8 (8%)</td>
<td>2±3 mm (50%)</td>
<td>-</td>
<td>8</td>
<td>2→there are adhesions (50%)</td>
<td>4 Ports &amp; convert</td>
<td>- (0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2±3 mm (50%)</td>
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Table 2 Increased gallbladder wall thickness in predicting difficulties

<table>
<thead>
<tr>
<th></th>
<th>Thick</th>
<th>Not thick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>Not complicated</td>
<td>20</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>72</td>
</tr>
</tbody>
</table>

This gives: sensitivity 22/28=78%, specificity 52/72=72%, positive predictive value 22/42=52%, negative predictive value 52/58=89%

Table 3 Multiple gallstones in predicting difficulties

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Not complicated</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>72</td>
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<tr>
<td></td>
<td>100</td>
<td>72</td>
</tr>
</tbody>
</table>

This gives: sensitivity 24/28=86%, specificity 24/72=33%, positive predictive value 24/28=85%, negative predictive value 24/72=33%

Hence we think that multiple gallstones is a good predictor of difficulties (PPV = 85%), while a normal gallbladder wall thickness is a good predictor of no difficulties (NPV = 89%).

Increased gallbladder wall thickness is not a good predictor of difficulties (PPV= 52% which is like a random guess)

**DISCUSSION**

Preoperative diagnostic procedures are designed to support the decision making process for adequate treatment of patients with gallstone disease. We assessed the value of ultrasound for patients with gallstone disease prior to laparoscopic cholecystectomy. Certain information is required by surgeon to plan the appropriate procedure. The ones we considered included presence of common bile duct stones. Ultrasound is a valuable tool in detecting gallstones, consequently estimating patients surgical risks and suggesting whether further work up of the bile duct is required.

An important question is whether it is possible to assess local operability prospectively. In our study the conversion rate to open surgery 8% was within the range reported by several other studies (0.9-14%). A study by Fuchs et al founded that laparoscopy may be advantageous for patients who are difficult to operate on. Although conversion to laparotomy alone does not worsen the patients outcome, several reasons support the advantage of preoperative assessment of the feasibility of laparoscopy.

It is important to have some idea about the individual patients risk while obtaining informed consent. Identifying difficulties is especially important in specialized hospitals where open cholecystectomy has become a rare procedure and requires the presence of a surgeon who is experienced in this particular approach.

Our findings suggest that patients with excessive gallbladder wall thickening and symptoms of cholecystolithiasis tend to impose technical difficulties during laparoscopic cholecystectomy. In around 87% of the patients with
gallbladder wall thickness (more than 3mm) surgeons encountered surgical difficulties. Gallbladder wall thickness can be assessed with a margin of error ranging from 1 to 1.5 mm. In healthy patients, 97% of individuals have a gallbladder wall thickness less than 2mm. In our study gallbladder wall thickness of more than 3mm was significantly associated with a difficult surgical procedure and the histopathologic report of chronic inflammation. Chronic inflammation may also lead to bleeding that compromises orientation and the visual exposure at surgery forcing surgeons to abandon the laparoscopic access. In patients with chronic inflammation, pericholecystic adhesions frequently impede the separation of gallbladder from its bed. In gallstone disease, the histopathologic substrate for sonographic thickening of the gallbladder is chronic cholecystic inflammation. Gallbladder wall thickening was a sensitive indicator of technical difficulties and the risk of conversion to open cholecystectomy.

However, gallbladder wall thickening may also result from other causes such as hypoalbuminemia, hepatitis, sclerosing cholangitis or AIDS cholangitis, adenomyomatosis, congestive heart failure, portal hypertension and tumors. Therefore, comorbid illnesses like ischemic heart disease, hypertension, diabetes mellitus, sickle cell anaemia, etc. were excluded from our study.

CONCLUSION

An accurate preoperative diagnostic tool is mandatory for planned laparoscopic gallbladder surgery to provide information for the selection of the most appropriate approach and to avoid intra operative difficulties and surprises. We think that sonography should play a central role in surgical planning for laparoscopic cholecystectomy. In our study a checklist helped us to convey it to the surgeon. It appears that gallbladder wall thickening is not a good predictor of difficulties. However, further studies are needed to verify if increased number of gallstones is related to increased wall thickness and thereby increased difficulty in surgery or could increase gallstones directly related to increased difficulty.

QUESTIONNAIRE

- Name of the patient
- Age
- Sex
- Date of operation
- Gallbladder wall thickness (mm) by preoperative ultrasound.
- Number of gallstones by preoperative ultrasound and after opening of the gallbladder
- Number of ports
- Presence of adhesions in the gallbladder area.
- Any complications intra or post operatively.
- Presence of sub-hepatic tube drain (Yes/No)
- Conversion to open cholecystectomy Yes/No (reason)
- Duration of laparoscopic cholecystectomy.
REFERENCES


