Can ultrasound common bile duct diameter predict common bile duct stones in the setting of acute cholecystitis?

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KEYWORDS:
Acute cholecystitis; Common bile duct diameter; Choledocholithiasis; Ultrasound; Endoscopic retrograde cholangiopancreatography; Magnetic resonance cholangiopancreatography

Abstract
BACKGROUND: Our aim is assessment of ultrasound (US) common bile duct (CBD) diameter to predict the presence of CBD stones in acute cholecystitis (AC).

METHODS: A retrospective review from 2007 to 2011 with codes for ultrasound, magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography, and AC was conducted.

RESULTS: The incidence of CBD stones was 1.8%. Two hundred forty eight individuals had US, MRCP, ERCP, and AC, of which 48 had CBD stones and 200 did not have CBD stones. US CBD diameter range was 3.6 to 19 mm. Ninety percent of MRCPs were negative, and it delayed care by 2.9 days. Mean CBD diameter was narrower in those negative for CBD stones (5.8 vs 7.08; P = .0043). Groups based on diameter ranges, 6, 6 to 9.9, and ≥10 mm demonstrated 14%, 14%, and 39% CBD stones, respectively.

CONCLUSIONS: US CBD diameter is not sufficient to identify patients at significant risk for CBD stones. MRCP delayed care by 2.9 days. Intraoperative cholangiography may be more effective, based on the low risk of CBD stones in AC.

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Because the right upper quadrant abdominal ultrasound (US) is commonly the first diagnostic imaging tool for patients presenting with signs and symptoms of acute cholecystitis (AC), it is essential to understand the diagnostic limitations to the study in the acute setting. The incidence of common bile duct (CBD) stones in patients undergoing cholecystectomy has been reported as 3% to 18%.1,2 Although abdominal US can frequently provide data regarding the CBD diameter, the accurate visualization of CBD stones can be impacted by both patient factors and the technical skill of the ultrasonographer. Reliance on CBD diameter as a surrogate for cholelithiasis is associated with a sensitivity ranging from 50% to 90% with a CBD diameter <6 mm using abdominal US.3,4 The majority of the available studies have been predominantly based on elective surgical populations with limited percentages of AC patients.5 The associated risk of abdominal distention and the degree of associated inflammation in the area could impact the accuracy of US.

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It is essential to identify the AC patient at risk for cholecystolithiasis because a decision will need to be made regarding the approach to both the gallbladder and the potential clearance of the CBD. The options have differing cost and risk and include the following: (1) laparoscopic cholecystectomy; intraoperative cholangiogram, directed open/laparoscopic CBD exploration; (2) laparoscopic cholecystectomy; intraoperative cholangiogram, postoperative endoscopic retrograde cholangiopancreatography (ERCP); (3) magnetic resonance cholangiopancreatography (MRCP); directed ERCP if stone seen, same admission laparoscopic cholecystectomy; or (4) ERCP based on US suspicion, same admission laparoscopic cholecystectomy. Therefore, accurate prediction of CBD stones in AC avoids the well-documented increased time to surgery, operative complications, morbidity, length of hospital stay, and increased overall cost associated with additional imaging studies beyond US.\textsuperscript{6} The aim of this study is to determine the impact of abdominal US diameter on the prediction of CBD stones in patients with AC.

**Methods**

All charts of the patients who were seen at Los Angeles County–University of Southern California Hospital from 2007 to 2011 with diagnostic codes including AC (474.00 to 575.12) and procedure codes for preoperative MRCP and preoperative ERCP were reviewed retrospectively. Institutional Review Board approval was obtained from the University of Southern California. Data were extracted from electronic medical records and entered in a protected fashion in Microsoft Excel 2007 (Microsoft Corporation, Redmond, Washington). All patients underwent US at the time of diagnosis. The decision to proceed with additional imaging versus initial laparoscopic cholecystectomy with or without intraoperative cholangiogram (IOC) was at the discretion of the treating surgical team. The decision to perform additional imaging was based on either chemistries or suspicion on US. All measurements of CBD diameter were taken from sonograms performed at the time of admission and recorded in millimeters. Preoperative MRCP and ERCP were classified as positive, negative, or equivocal for CBD stones based on staff radiologist reads and/or endoscopy report. All statistical analyses were carried out using SPSS version 20 (SPSS IBM, New York, NY). Comparison of means among groups was performed using independent samples $t$ test, while comparisons of categorical variables was performed using the chi-square test. A $P$ value of $<.05$ was considered significant.

**Results**

The total number of individuals with AC was 2,588. Thirty-four percent (890/2,588) of patients were men and 66% (1,696/2,588) were women. The average age of the AC population was 42 years (Table 1).

There were 248 individuals with AC and suspected CBD stones who underwent preoperative MRCP, ERCP, or both. The male population comprised 31.5% (78/248) of patients with an average age of 43 years. The female population comprised 68.5% (170/248) of patients with an average age of 40 years. The overall age range for this group was 16 to 89 years (Table 1). Forty-eight of 248 individuals (19%) were found using abdominal US, MRCP, or ERCP to have CBD stones and AC. The overall incidence of cholecystolithiasis in our population of AC was 48/2,588 (1.8%). The diagnosis of cholecystolithiasis based on abdominal US was 10/248 (4%) with 8/10 having documented stones at ERCP. There were 226 MRCPs performed based on clinical suspicion or US diameter and 22/226 (9.7%) were positive for CBD stones and 14/22 had documented CBD stones using ERCP. Importantly, the liberal use of MRCP was associated with a negative result in 204/226 (90.3%).

There were 19 clinically directed initial ERCPs performed and 15/19 (78%) were positive. Eight patients were performed for cholecystolithiasis found using abdominal US. Three ERCPs were performed based on elevated total bilirubin tests/liver function tests (LFT) and CBD diameter $>6$ mm. Four ERCPs were performed based on elevated total bilirubin tests/LFT, 2 were performed for CBD diameter enlargement (8.3 and 9 mm) and 1 ERCP was because of cholecystolithiasis found using computed tomography scan.

**Abdominal ultrasound common bile duct diameter assessment**

The mean CBD diameter in individuals with no CBD stones was significantly narrower compared to AC patients with documented CBD stones (5.8 ± 2.3 vs 7.08 ± 3.4 mm; $P = .0043$, 95% confidence interval (CI) 2.02 to .38). In the population of patients who did not have cholecystolithiasis diagnosed using US, the distribution of CBD diameter groups of patients and the incidence of ERCP or IOC confirmed that CBD stones were $<6$ (9%), 6 to 9.9 (13%), and $\geq 10$ mm (38%) within the population, and $<6$ (69%), 6 to 9.9 (69%) and $\geq 10$ mm (86%) for the

| Table 1 | Study population demographics |
| --- | --- | --- |
| Category | AC | AC + MRCP/ERCP |
| Individuals ($n$) | 2,588 | 248 |
| Men | 890 (34%) | 78 (31.50%) |
| Women | 1,696 (66%) | 170 (68.50%) |
| Average age (y) | 42 ± 14.3 | 41 ± 14.5 |
| Age range (y) | 15–97 | 16–89 |
| Average age of men (y) | 44 ± 14 | 43 ± 13.4 |
| Average age of women (y) | 41 ± 14.3 | 40 ± 14.8 |

Data are expressed as number (percentage). AC = acute cholecystitis; ERCP = endoscopic retrograde cholangiopancreatography; MRCP = magnetic resonance cholangiopancreatography.
An aggregate total of US, MRCP, or ERCP choledocholithiasis for US CBD diameter ranges showed <6 (14%), 6 to 9.9 (14%) and ≥10 mm (39%; Table 2). An insignificant odds ratio of 1.05 (95% CI 0.83 to 1.32, $P = .68$) was found on logistic regression for US CBD diameter and positive CBD stones.

After excluding patients with suspected CBD stones using initial US, analysis of the frequency of subsequently documented stones using ERCP by distribution of duct size was <6 (9%), 6 to 9.9 (9%), and ≥10 mm (27%). Assessment of the clinically directed MRCP patients demonstrated no significant difference in mean US CBD diameter for patients undergoing MRCP with or without confirmed choledocholithiasis (6.2 ± 3.4 vs 7.4 ± 3.6 mm; $P = .3$; 95% CI 3.5 to 1.2) or after excluding patients diagnosed with choledocholithiasis using abdominal US. A positive MRCP was identified in 22 patients. Thirteen patients had the CBD cleared by preoperative ERCP, 5 were confirmed by IOC and cleared operatively, 1 ERCP was aborted secondary to inability to intubate the papilla and 3 patients were discharged home after medical management and lost to follow-up. There were 4 equivocal MRCPs with 3 patients positive for choledocholithiasis and cleared using ERCP and 1 patient was found at IOC and cleared operatively. There were 4 patients with choledocholithiasis diagnosed primarily on IOC. Two patients were found after negative MRCPs, 1 after an equivocal MRCP, and 1 was found after clinically directed IOC.

There were 21 patients who underwent IOC. Fifty percent (11/21) of patients were positive for choledocholithiasis. Similarly, although there was a trend toward a larger duct diameter, there was no significant difference in US CBD diameter for those with or without choledocholithiasis (5.9 ± 2.5 vs 8.5 ± 3.7 mm; $P = .095$). The 11 IOCs that were positive were performed for: a positive MRCP without ERCP (4), with failed ERCP (1), after successful ERCP and persistent-elevated LFT (1), a positive CBD stone on US (2), and persistently elevated total bilirubin and LFT (3). The 10 IOCs that were negative were performed for: a positive MRCP without ERCP (1), with failed ERCP (1), after successful ERCP and persistent-elevated LFT (4), and persistently elevated total bilirubin and LFT (4).

The average length of admission in the general AC population was 6.8 ± 4.13 days, which is significantly longer than that found in the general AC population treated without advanced biliary imaging ($P < 0.01$). The average length of time from admission to MRCP was 2.9 ± 2.0 days and it was 4.3 ± 2.7 days for ERCP.

### Comments

The diagnosis and management of AC is one of the most common acute surgical procedures with the vast majority performed laparoscopically. Although the literature suggests that 3% to 10% of the patients undergoing cholecystectomy will have CBD stones, the approach to management of choledocholithiasis has shifted almost entirely to ERCP – a 2-stage approach. During the era of open surgery, the gallbladder and choledocholithiasis could be managed in a 1-stage approach. Although open CBD exploration is the most effective for clearance of CBD stones, it has increased morbidity and increased the length of hospital stay compared to laparoscopic CBD clearance. At this time, a 1-stage laparoscopic CBD stone clearance is as effective as both pre- and postoperative 2-stage ERCP. CBD clearance with similar morbidity and mortality outcomes, but it decreases the utilization of resources.

Although the laparoscopic 1-stage approach is as effective as the 2-stage approach, it is not routinely practiced in the general surgical community because of its higher degree of technical difficulty and availability of resources. In the absence of cholangitis and necrotizing pancreatitis, the clearance of CBD stones routinely by preoperative ERCP can lead to higher resource utilization, a longer hospitalization, and a longer time to surgery without decreasing complication rates when compared to clearing CBD stones found on IOC postoperatively with ERCP. Therefore, it does not appear optimal to delay the operative management of AC in the face of an US nondiagnostic for CBD stones in favor of an MRCP or nondirected ERCP.

We identified a 1.8% rate of CBD stones in our large population of AC patients, which is lower than the frequently referenced 3% to 10% risk when including elective patients. Conversely, in our selected study group we found that the overall 19% incidence of CBD stones was primarily identified by the initial US (17%) or MRCP (45%). Although there was a trend toward larger duct diameter in patients with documented stones (7.1 vs 5.8 mm), the stones were present at similar rates across the 3 groups of ranges in duct size in the absence of US-visualized stones or subsequently based on clinically driven MRCP (Table 2). The clinical uses of preoperative US to assess the presence of CBD stones indirectly by diameter.

### Table 2

Percent CBD stones by groups based on US diameter

<table>
<thead>
<tr>
<th>US CBDD (mm)</th>
<th>&lt;6</th>
<th>6–9.9</th>
<th>≥10</th>
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<tbody>
<tr>
<td>US</td>
<td>2.4</td>
<td>2.9</td>
<td>18.2</td>
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<tr>
<td>MRCP*</td>
<td>9.6</td>
<td>5.3</td>
<td>25</td>
</tr>
<tr>
<td>ERCP+p-†</td>
<td>68.8</td>
<td>69.2</td>
<td>85.7</td>
</tr>
<tr>
<td>Total (n+/n)*</td>
<td>14 (17/120)</td>
<td>14 (14/100)</td>
<td>39 (7/18)</td>
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Percentages of positive CBD stones for individuals who received a given test (US, MRCP, ERCP).

*Excludes individuals with choledocholithiasis diagnosed using ultrasound.
†Includes intraoperative cholangiogram test.
in AC are currently unresolved. Large studies have used CBD diameter cutoffs ranging from 5 to 12 mm,\textsuperscript{11,12} with predictability ranging from 58% to 78% for diameters 5 to 8 mm, and 90% for diameters >12 mm predictive alone and up to 100% predictive in conjunction with other elevated LFT.\textsuperscript{11,12} A limitation to these data is the fact that these studies included a broad range of biliary pathology, and importantly no study included <20% of the population with a diagnosis of AC. We did confirm a higher risk (38.8%) in patients with a CBD $\geq$ 10 mm, which is consistent with Lacaine et al.; however, 9% of stones occurred again in patients with ducts <6 mm in our AC patients.\textsuperscript{3,11,12} US CBD diameter was particularly unhelpful as an indication for MRCP as we found no significant difference in those patients with and without stones (6.9 vs 5.9 mm) and an unacceptably high negative rate for the study of 90%.

In conclusion, our data suggest that in patients with AC, US-reported CBD diameter is a poor discriminator for the prediction of associated choledocholithiasis. We cannot recommend US-based selection of additional preoperative imaging with MRCP because of the high negative rate, significant cost of the study, and the inherent delay (2.9 days) in care that results. Therefore, our data suggest that a better strategy might be to perform IOC on all patients with an US-measured CBD diameter of $\geq$ 10 mm (40% rate of confirmed CBS stones) and those patients with transient increase in transaminases and/or bilirubin, which was the major indication for MRCP in our experience. This would have allowed for either intraoperative clearance of the duct or a directed use of postoperative ERCP. This strategy would have avoided the over 90% negative rate of MRCP and delay in management in our AC population.

References


Discussion

Raymond P. Onders (Cleveland, OH): I think you touch on something that is very important, is that ultrasound in common bile duct measure size has been in the literature and a lot of the data has been talking about the size and the relationships to BMI, age, and, interestingly, in narcotic use, which may be important on your county hospital. And you actually controlled for that and showed that when you adjust for that, you may not see any differences. I have several questions for you, though. Since we as surgeons use all available data, such as our liver enzymes, that’s one aspect you did not touch in your manuscript. Did you have that data? Second, your intraoperative cholangiogram rate is incredibly low for this group, and the group with evidence of some problem with that head MRCP or ERCP, it was only 10%. What is your overall institution cholangiogram rate DR. BOYS: First one, on the liver function tests and the enzymes, there has been many studies about that in the elective population. Most commonly Sheen, et al., they find that an alkaline phosphatase greater than 350 can be used. Some of them found independent predictors, however, in the acute cholecystitis patients, there have only been 2 papers and they didn’t look at CD diameters as well. And, in fact, they actually say that GGT or gamma glutamyl transaminase is actually more predictive than any of our common liver enzymes that we usually pick up. In those 2 studies, too, they found that, one said that bilirubin was predictive and the other said it wasn’t.

Our IOC rate is low in this population. Our institution has established a treatment plan of trying to clear the duct prior to the OR and, hence, you see the large number of ERCP rates and ERCPs. We have been working on that to try and increase our IOC rate. Dr. Zehetner, one of the authors here, is on our quality improvement committee. And so he and I have been talking about this and getting higher use of IOC and getting patients done in an operating room sooner.