The Predictive Value of Specific Emergency Sonographic Signs for Cholecystitis

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To determine the predictive value of emergency, bedside ultrasound (EUS) signs in the detection of acute cholecystitis (AC). This was a secondary analysis of a previously reported prospective study of EUS for AC. Cases done by physicians who met the training guidelines of the American College of Emergency Physicians by performing 25 prior examinations were selected to determine the predictive value of specific EUS signs for AC. The gold standard was surgical pathology obtained within 2 weeks, if available. Otherwise, the discharge diagnosis of AC was used as the criterion standard. A total of 291 patients were studied to evaluate the predictive value of EUS signs in the detection of AC. Gallbladder wall thickening (GBWT) and pericholecystic free fluid (PCFF) were the two most predictive individual signs for AC. The combination of gallstones with GBWT, PCFF, or sludge was also predictive of AC. Biliary ductal dilation and gallstones were the only least predictive signs. The combination of gallstones and GBWT, PCFF, or sludge on emergency ultrasound is predictive of AC.

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Introduction

Acute cholecystitis (AC) is difficult to diagnose because classic signs and laboratory abnormalities can be absent in up to 40% of patients with pathology-confirmed AC [1–4]. Therefore, confirmatory imaging is required in cases of suspected AC [1–3,5]. Although emergency, bedside ultrasound (EUS) can expedite the diagnosis of AC, it may lack the sensitivity to rule out AC [6–8] and the predictive value
of specific EUS signs for AC is unknown. None of the earlier studies have actually assessed the predictive value of specific EUS signs for AC and it may be that the performance characteristics of EUS do not match those of an abdominal ultrasound performed by the department of radiology. Therefore, the purpose of this study was to determine the predictive value of EUS signs for AC.

Methods

Study design

This was a secondary analysis of a previously reported prospective study describing the learning curve of EUS for biliary disease [9]. For the current study, we obtained surgical pathology and discharge diagnoses data to determine the predictive values of EUS signs for AC.

Study setting

This study was conducted at an urban, academic emergency department (ED) with 49,000 annual adult visits and an emergency medicine residency program.

Selection of participants

In the primary study, all patients presenting to the ED with abdominal pain or nausea/vomiting were eligible for participation if they were being evaluated with ultrasound by the department of radiology for suspected biliary disease.

Protocol

We reviewed charts from the initial study for patients evaluated by physicians who met the training guidelines of the American College of Emergency Physicians (ACEP) by performing 25 prior examinations. We did not include charts from those who were performing their 1st–25th examinations because they were still learning how to evaluate the right upper quadrant (RUQ) and would not otherwise be credentialed to perform the examination independently according to the ACEP guidelines. Therefore, we included only those who were properly trained and, thus, were eligible for credentialing according to the ACEP guidelines. These studies were then compared with the final diagnosis of AC.

Study measurements. In the primary study, (1) the presence of cholelithiasis, (2) common bile duct (CBD) dilatation >5 mm (plus 1 mm per decade of life over 50 years of age), (3) gallbladder wall thickening (GBWT) >4 mm, (4) the presence of pericholecystic free fluid (PCFF), and (5) the presence of sludge were recorded on a standardized data sheet.

Criterion standard

The gold standard was surgical pathology interpreted by a board-certified pathologist blinded to the results of the EUS. Otherwise, the hospital discharge diagnoses data of AC (e.g., patients managed with a cholecystostomy tube and antibiotics) were used as the criteria.

Data analysis

Data were collected in an Excel database (Microsoft Excel, Microsoft Corporation, Redmond, WA) and translated into a native SAS format using DBMS/Copy (DataFlux Corporation, Cary, NC). Analyses were conducted using SAS version 9.1 (SAS Institute, Cary, NC) and 95% confidence interval (CI), which assesses both statistical significance and clinical effect.

Results

A total of 1837 cases were included in the primary study [9] of which 291 cases were selected for this secondary analysis. A total of 1546 patients were excluded—26 for incomplete records, 149 for being enrolled a second time in the initial study (i.e., repeat visits >6 months later), and 1371 patients were excluded due to being evaluated by physicians who had not met the ACEP training guidelines. Among the 291 patients, 101 patients had available surgical pathology reports and 190 patients were managed conservatively. A total of 57 patients had AC (20%), 114 had cholelithiasis only (39%), and 120 had nonbiliary diagnoses. Of the 57 patients diagnosed with AC, 46 had confirmatory pathology postcholecystectomy, five had confirmatory bile cultures postcholecystectomy tube placement, three had confirmatory cultures postendoscopic retrograde cholangiopancreatography, and three had confirmation by hepatobiliary iminodiacetic acid scan. No patients were discharged from the ED and subsequently diagnosed with AC within 1 month.

The performance characteristics of the EUS signs for AC are shown in Table 1. PCFF was the single most predictive sign for AC (LR+: 10.7; 95% CI: 4.0–28.7), followed by GBWT (LR+: 7.1; 95% CI: 4.3–11.7). CBD dilation and stones were the only least predictive individual signs for AC. However, the combination of stones with GBWT, PCFF, or sludge was predictive of AC.

Discussion

Earlier studies of RUQ EUS found poor overall predictive value for AC [6–8], but did not assess the predictive value of individual sonographic signs for AC, which is important because patients may not present simultaneously with every sonographic sign of AC [10]. Although AC is an "extended" rather than the primary indication of RUQ EUS [11], it is the most important diagnosis because it is associated with greater morbidity and mortality.

Our data suggest that physicians who meet the ACEP training guidelines can perform EUS for AC and patients with cholelithiasis and GBWT, PCFF, or sludge on EUS are at much higher risk of having AC than those with CBD dilation or only stones. Given the findings of our study, patients with cholelithiasis and GBWT, PCFF, or sludge should be evaluated further for AC before being discharged from the ED. Furthermore, because no EUS sign or composite of signs reached a sensitivity for AC above 90%, it is important to remember that patients with suspected AC should be thoughtfully evaluated considering their entire presentation, including clinical history, results of physical examination, laboratory data, and sonographic findings, with a low threshold for further evaluation with other modalities such as biliary scintigraphy in the appropriate setting.
Therefore, future work should assess the predictive value unaware of any evidence in the literature to that effect.

assessed in this analysis owing to concerns in the initial

vs. AC).

lution of pathology (e.g., symptomatic cholelithiasis

important because ultrasound is known to be operator

was not assessed for any of the sonographic signs, which is

Predictive Value of EUS Cholecystitis

Table 1 Predictive value of various EUS signs for acute cholecystitis in 291 patients with abdominal pain or nausea/vomiting.

<table>
<thead>
<tr>
<th>EUS sign</th>
<th>Sens</th>
<th>Spec</th>
<th>PPV</th>
<th>NPV</th>
<th>LR+</th>
<th>LR−</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBW (n = 49)</td>
<td>54 (41–67)</td>
<td>92 (88–95)</td>
<td>63 (48–76)</td>
<td>89 (84–93)</td>
<td>7.1 (4.3–11.7)</td>
<td>0.5 (0.4–0.7)</td>
</tr>
<tr>
<td>BiliDil (n = 41)</td>
<td>21 (12–34)</td>
<td>88 (83–91)</td>
<td>29 (17–46)</td>
<td>86 (81–90)</td>
<td>1.7 (0.9–3.1)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>GS + sludge (n = 31)</td>
<td>23 (13–36)</td>
<td>92 (88–95)</td>
<td>42 (25–61)</td>
<td>83 (78–87)</td>
<td>3.0 (1.5–5.7)</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GS + PCFF (n = 16)</td>
<td>23 (13–36)</td>
<td>99 (96–100)</td>
<td>81 (75–85)</td>
<td>89 (79–88)</td>
<td>17.8 (5.2–60.3)</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GS + GBWT (n = 47)</td>
<td>54 (41–67)</td>
<td>93 (89–96)</td>
<td>66 (51–79)</td>
<td>89 (85–93)</td>
<td>8.0 (4.7–13.5)</td>
<td>0.5 (0.4–0.7)</td>
</tr>
<tr>
<td>GS + BiliDil (n = 36)</td>
<td>21 (12–34)</td>
<td>89 (85–93)</td>
<td>33 (19–51)</td>
<td>82 (77–87)</td>
<td>2.1 (1.1–3.9)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>GS + sludge + PCFF (n = 6)</td>
<td>11 (4–22)</td>
<td>100 (98–100)</td>
<td>100 (52–100)</td>
<td>82 (77–86)</td>
<td>NA</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>GS + sludge + GBWT (n = 13)</td>
<td>23 (13–36)</td>
<td>100 (98–100)</td>
<td>100 (72–100)</td>
<td>84 (79–88)</td>
<td>NA</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GS + BiliDil (n = 7)</td>
<td>7 (2–18)</td>
<td>99 (96–100)</td>
<td>57 (20–88)</td>
<td>81 (79–88)</td>
<td>NA</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>GS + GBWT + PCFF (n = 9)</td>
<td>16 (8–28)</td>
<td>100 (98–100)</td>
<td>100 (63–100)</td>
<td>83 (73–87)</td>
<td>NA</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GS + GBWT + BiliDil (n = 10)</td>
<td>16 (8–28)</td>
<td>99 (97–100)</td>
<td>90 (54–99)</td>
<td>83 (78–87)</td>
<td>37 (5–286)</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GS + sludge + GBWT</td>
<td>4 (0–13)</td>
<td>100 (97–100)</td>
<td>100 (20–100)</td>
<td>81 (76–85)</td>
<td>NA</td>
<td>0.96 (0.92–1.0)</td>
</tr>
<tr>
<td>GBW + PCFF (n = 9)</td>
<td>16 (8–28)</td>
<td>100 (98–100)</td>
<td>100 (63–100)</td>
<td>83 (78–87)</td>
<td>NA</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GBW + BiliDil (n = 10)</td>
<td>16 (8–28)</td>
<td>99 (97–100)</td>
<td>90 (54–99)</td>
<td>83 (78–87)</td>
<td>37 (5–286)</td>
<td>0.8 (0.7–0.9)</td>
</tr>
<tr>
<td>GBW + sludge (n = 15)</td>
<td>16 (8–28)</td>
<td>97 (94–99)</td>
<td>60 (30–80)</td>
<td>83 (78–87)</td>
<td>6.2 (2.3–16.6)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>PCFF + sludge (n = 6)</td>
<td>11 (4–22)</td>
<td>100 (98–100)</td>
<td>100 (52–100)</td>
<td>82 (77–86)</td>
<td>NA</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>GS + BiliDil + PCFF (n = 5)</td>
<td>5 (1–16)</td>
<td>99 (97–100)</td>
<td>60 (20–90)</td>
<td>81 (76–85)</td>
<td>6.2 (1.1–36.0)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
</tbody>
</table>

BiliDil = common bile duct dilation; EUS = emergency bedside ultrasound; GBW = gallbladder wall thickening; GS = gallstone; LR+ = positive likelihood ratio; LR− = negative likelihood ratio; NPV = negative predictive value; PCFF = pericholecystic free fluid; PPV = positive predictive value; Sens = sensitivity; Spec = specificity.

Limitations

This study had several limitations. First, surgical pathology data were not available for all patients and patients who were not admitted but went on to develop AC >2 weeks later were not included. Therefore, we do not know the predictive value of sonographic signs for those who will go on to develop AC, although we suspect the performance of the signs would be comparable. This should be evaluated in a more comprehensive study.

Second, inter-rater reliability among EP-sonographers was not assessed for any of the sonographic signs, which is important because ultrasound is known to be operator dependent. The reproducibility of these signs between operators would be essential for interpreting repeat examinations in these patients and in monitoring the evolution of pathology (e.g., symptomatic cholelithiasis vs. AC).

Finally, the value of a sonographic Murphy’s sign was not assessed in this analysis owing to concerns in the initial study that administration of narcotics would alter the performance characteristics of the sign. However, we are unaware of any evidence in the literature to that effect. Therefore, future work should assess the predictive value of the sign and whether or not narcotic administration alters its predictive value.

Conclusion

The combination of gallstones and GBW, PCFF, or sludge on emergency ultrasound is predictive of AC.

References