

ASSESSMENT OF THE USABILITY OF ULTRASONOGRAPHY BY EMERGENCY PHYSICIANS IN THE DIAGNOSIS OF ACUTE CHOLECYSTITIS

YAVUZ KATIRCI¹, MURAT SOYUDURU¹, İSA BAŞPINAR¹, MEHMET SERKAN YURDAKUL¹, ERDAL DEMİRTAŞ¹, HAYRI RAMADAN¹, FIGEN COŞKUN²

¹Ankara Training and Research Hospital, Department of Emergency Medicine, Ankara - ²Kirikkale University, Department of Emergency Medicine, Kirikkale, Turkey

ABSTRACT

Background: Early diagnosis of acute stony cholecystitis allows rapid treatment and reduces mortality and morbidity. In this paper, we aimed to assess the competence of emergency medicine physicians in the ultrasonographic diagnosis of gallbladder pathologies in patients presenting at emergency departments with upper right quadrant pain.

Methods: One hundred and sixty-eight patients over the age of 18 years presenting at the Emergency Medicine clinic on January 1 to July 1, 2013, were included in this prospective study. Ultrasonography (USG) of the upper right quadrant was applied to all patients at emergency services and the radiology unit. The results were statistically analyzed with the radiology clinic reports accepted as the gold standard.

Results: With the radiology reports considered to be the gold standard, emergency physicians were able to identify the sonographic Murphy sign with 98.2% accuracy (95% confidence interval [CI] of 96.2–100), positive gallstones at 89.9% (95% CI 85.3–94.4), pericholecystic fluid at 89.3% (95% CI 84.6–94.0), and finally acute stony cholecystitis diagnosis at 98.2% (95% CI 96.2–100).

Conclusion: Emergency medicine physicians may perform gallbladder USG procedures with similar results to those performed by radiology physicians following standardized training. Thus, USG may assume a function similar to the stethoscope as part of physical examination aiming toward clinical decisions with respect to the assessment of gallbladder diseases, and the decision to discharge patients from the emergency service of hospitalization in the clinic.

Key words: Emergency medicine, bedside ultrasonography, gallbladder.

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Introduction

When patient complaints are examined in their presentation to emergency services, abdominal pain is among the most frequent causes of this presentation. Approximately 5-7% of abdominal pains referred to emergency services result from biliary diseases^(1, 2, 3). Nearly 20 million individuals in the United States have gallbladder stones; one million individuals are hospitalized every year and 700 thousand individuals undergo surgery^(4, 5). Clinical studies and autopsy series indicate that 10% of adult population has gallstones in Turkey. Asymptomatic clinical course is seen in 40-60% of people who have gallstones. While gallstones causing symptomatology as an acute cholecystitis in 20% of patients, in 10% of

them develops complicated cholecystitis (jaundice, cholangitis, pancreatitis)⁽⁶⁾. Acute stony cholecystitis (ASC) results from the obstruction of the cystic duct by a stone, as observed in a majority of cases. During physical examination, tenderness in the upper right quadrant, defense, and the presence of the Murphy sign are clues in the diagnosis of ASC. While the white blood cell count is usually high in these cases, it may also be normal. The serum bilirubin and alkaline phosphatase levels may be slightly high⁽⁷⁾. Ultrasonography (USG) is a diagnostic test that is the first preference in the diagnosis of biliary diseases due to its low cost, easy accessibility, and lack of radiation⁽⁸⁾. On USG, gallstones have a mobile appearance, providing a hyperechoic, acoustic shadow. Sonographic Murphy sign (tenderness elicited by

pressing the gallbladder with the ultrasound probe), thickened gallbladder wall (>3 mm; if the patient does not have chronic liver disease and/or ascites or right heart failure), enlarged gallbladder (long axis diameter >8 cm, short axis diameter >4 cm), incarcerated gallstone, debris echo, pericholecystic fluid collection which are observed in acute cholecystitis^(7, 9, 10, 11).

Most of the upper right quadrant procedures at emergency services are carried out by the radiology clinics located outside of the emergency department. This circumstance may delay the early diagnosis and treatment of patients. With good training, however, emergency physicians-as with focused assessment with sonography (FAST) USG-may use the USG device as part of the physical examination in the diagnosis of gallbladder diseases. In this study, we aimed to investigate the usability of USG in emergency services, by comparing the USG procedures performed by emergency physicians trained in our clinic to those performed by radiologists.

Study design and population

This study was performed on 168 patients over 18 years of age who presented at a third-stage city hospital where nearly 250,000 patients are admitted annually. The patients complained of upper right quadrant abdominal pain and presented on January 1 to July 01, 2013. The emergency physicians who conducted the research had attended a certification program including theoretical and practical training to improve their clinical observations and experience with respect to gallbladder USG prior to starting the research. After having received the consent of the patients included in the study, the vital signs and physical examination results of all patients presenting with upper right quadrant pain were recorded. Patients with known cholelithiasis, apparent icterus, previous gallbladder operations, acute hepatitis, and other acute abdominal diseases, patients who were admitted more than once, patients who had been diagnosed with acalculous cholecystitis and those who had eaten during the last one hour, and patients who were not stable were excluded from the study.

The USG procedure was performed on the patients' upper right quadrant using the 3C5A (2.5-6 MHz) probe of the Mindray DC-3 brand USG device available at emergency services, and the results were recorded. The USG findings of acute cholecystitis, sonographic Murphy sign, increase in the bladder's vertical (>8 cm) and horizontal (>4 cm) dimensions,

increase in the bladder wall thickness (>3 mm), presence of pericholecystic fluid, and presence of intraluminal stone providing acoustic shadows were recorded. For the patients on whom USG was performed by the emergency service physician, a second USG procedure was applied by the radiology unit, with the PVT3758T 3.5 Hz probe of the Toshiba Istyle brand USG device. The results were collected independently of one another. In terms of the clinical decisions relating to the patients, the reports by the radiology clinic were deemed valid. During comparison, not only the radiological ability to identify acute cholecystitis, but also similarities between the individual parameters were investigated. The study was conducted in compliance with the latest version of the Helsinki Declaration and the Good Clinical Practices Regulation.

Statistical analyses were performed using the SPSS for Windows Version 18.0 software package. The numeric variables have been summarized by average±standard deviation, minimum and maximum values, and the categorical variables by figures and percentages. Compatibility between emergency and radiological findings (paired findings) was determined by the sensitivity, specificity, positive predictive value, negative predictive value, and accurate classification ratio. The presence of any differences between the two findings was assessed using the McNemar test. Meanwhile, compatibility between the numeric findings has been observed with the Pearson correlation coefficient. The significance value was assumed to be $p < 0.05$.

Results

During the study period, 314 patients presented at emergency services with upper right quadrant pain complaints. While 168 (55.5%) of these patients were included in the study, 70 (22.3%) were excluded because they had eaten within the last one hour, while 35 (11.2%) were excluded due to having known cholelithiasis, 23 (7.3%) due to having previously undergone cholecystectomy surgery, and 18 (5.7%) due to repeated presentation. In this study, 65% (n=109) of the participants were women. The average age of the women was 51.7 ± 19.54 years (min.: 19 years, max.: 99 years, median: 50 years); the average age of men was 56.5 ± 19.39 years (min.: 20 years, max.: 88 years, median: 57 years).

With the bedside USG procedure performed by the emergency physicians, sonographic Murphy sign was detected in 22 (13.1%) patients, gallstones in

102 (60.7%) patients, increase in the gallbladder wall thickness (>3 mm) in 27 (16%) patients, and pericholecystic fluid in 8 (4.8%) patients (Figure 1).

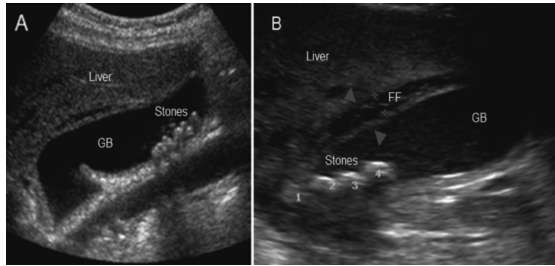


Figure 1, A: Gallbladder with gallstones (Stones). **B:** Thickened gallbladder wall, and pericholecystic fluid (FF).

		Radiology USG		
Sonographic Murphy Sign		Positive (%)	Negative (%)	Total (%)
	Positive (%)	21 (12.5)	1 (0.6)	22 (13.1)
	Negative (%)	2 (1.2)	144 (85.7)	146 (86.9)
	Total (%)	23 (13.7)	145 (86.3)	168 (100)
Gallstone				
	Positive (%)	94 (55.9)	8 (4.8)	102 (60.7)
	Negative (%)	9 (5.4)	57 (33.9)	66 (39.3)
	Total (%)	103 (61.3)	65 (38.7)	168 (100)
Gallbladder Wall Thickening >3mm				
	Positive (%)	19 (11.3)	8 (4.7)	27 (16)
	Negative (%)	11 (6.6)	130 (77.4)	141 (84)
	Total (%)	30 (17.9)	138 (82.1)	168 (100)
Pericholecystic Fluid				
	Positive (%)	8 (4.8)	0	8 (4.8)
	Negative (%)	3 (1.8)	157 (93.4)	160 (95.2)
	Total (%)	11 (6.6)	157 (93.4)	168 (100)

Table 1: Ultrasonography findings. *USG: Ultrasonography*

The average vertical length of the gallbladder was measured as 5.4±2.5 cm (min.: 2, max.: 12), and the average transverse length as 3.3±1.1 cm (min.: 2, max.: 8). On the other hand, in the USGs performed at the radiology clinic, which were accepted as the gold standard in the study, sonographic Murphy sign was found in 23 (13.7%) patients, gallstones in 103 (61.3%) patients, increase in the gallbladder wall thickness (>3 mm) in 30 (17.9%) patients, and pericholecystic fluid in 11 (6.6%) patients. The average vertical length of the gallbladder was reported as

5.4±2.6 cm (min.: 2, max.: 13), and the average transverse length as 3.2±1.1/cm (min.: 2, max.: 7). Both the emergency physicians' reports and the radiology reports diagnosed ASC in 23 (13.7%) patients. The USG results of the emergency physicians and those of the radiology clinic are provided in Table 1.

There was no statistically significant difference between the USGs' sonographic Murphy sign (p=1), positive gallstone (p=1), increase in the gallbladder wall thickness (p=0.815), pericholecystic fluid (p=0.25), or ASC (p=1) diagnoses of emergency physicians and those of the radiology clinic, with the latter assumed to be the gold standard. The vertical (r=0.99) and transverse (r=0.95) gallbladder dimensions measured by bedside USG were correlated with the radiology reports. When the radiology reports were taken as the gold standard, the emergency physicians diagnosed sonographic Murphy sign with 98.2% accuracy (95% confidence interval [CI] 96.2-100), positive gallstones at 89.9% (95% CI 85.3-94.4), pericholecystic fluid at 89.3% (95% CI 84.6-94.0), and finally ASC at 98.2% (95% CI 96.2-100). The diagnostic test results for bedside USG are provided in Table 2.

Limitations

This study aimed to measure the ability of emergency physicians to perform gallbladder USG. Comparison of the evaluation was carried out with results from the radiology clinic, which were assumed to be accurate. For the actual diagnosis, no laboratory findings, biopsy results, or any other radiological diagnostic methods such as tomography were used. We are not claiming that emergency physicians perform better gallbladder USG than radiology physicians; asserting such a claim would be unethical.

Discussion

The idea of having bedside gallbladder USG performed by emergency physicians dates back some time. In 1994, Schlager et al. performed bedside USG prospectively on 65 patients presenting at emergency services with abdominal pain⁽¹²⁾.

The sonographic Murphy sign is accepted as the most sensitive finding by most researchers^(6, 10, 11). Bree et al. (1995) reported that the sonographic Murphy sign has a sensitivity of 86% in the diagnosis of acute cholecystitis⁽¹¹⁾; Kendall et al. (2001) determined the sensitivity to be 75%⁽¹³⁾. Summers et

	Sono Murphy's Sign	(+)Gallstones	Gallbladder Wall thickening >3mm	Pericholecystic fluid	Acute cholecystitis
Sensitivity% (95% CI)	91.3 (73.2-97.6)	91.3 (84.2-95.3)	65.5 (47.4-80.0)	72.7 (43.4-90.3)	91.3 (73.2-97.6)
Specificity% (95% CI)	99.3 (96.2-99.9)	87.7 (77.5-93.6)	94.2 (89.1-97.1)	100 (97.6-100)	99.3 (96.2-99.9)
PPV%, (95% CI)	95.5 (86.8-100)	92.2 (86.9-97.4)	70.4 (53.2-87.6)	(100-100)	95.5 (86.8-100)
NPV%, (95% CI)	98.6 (96.7-100)	86.4 (78.1-94.6)	92.9 (88.7-97.1)	98.1 (96.0-100)	98.6 (96.7-100)
Accuracy% (95% CI)	98.2 (96.2-100)	89.9 (85.3-94.4)	89.3 (84.6-94.0)	98.2 (96.2-100)	98.2 (96.2-100)
LR(+) (95% CI)	132.4 (27.58-2313.64)	7.42 (4.14-15.43)	11.38 (5.75-24.95)	-	132.4 (27.58-2313.64)
LR(-) (95% CI)	0.09 (0.02-0.26)	0.10 (0.05-0.18)	0.37 (0.20-0.56)	0.27 (0.01-0.34)	0.09 (0.02-0.26)
p	1.000	1.000	0.815	0.250	1.000

Table 2: Bedside ultrasonography diagnostic tests results.

PPV: Positive Predictive Value, NPV: Negative Predictive Value, LR+: Likelihood Ratio +, LR-: Likelihood Ratio -

al. (2010) compared the results of bedside USG at emergency services with the USG results of the radiology clinic in the diagnosis of acute cholecystitis, and similar to our study, concluded that there is no difference in detecting the sonographic Murphy sign between the two departments⁽¹⁴⁾.

Taking the USG results of the radiology clinic as reference, Schlager et al. (1994) demonstrated 86% sensitivity and 97% specificity in identifying gallbladder stones with bedside USG in the emergency department, while Kendall et al. (2001) demonstrated 96% sensitivity and 88% specificity^(12, 13). Moreover, Rosen et al. (2001) demonstrated 91% sensitivity and 78% specificity, while Scruggs et al. (2008) showed 88% sensitivity and 87% specificity^(15, 16). The similarity in the ability to identify gallbladder stones with the radiologists in our study is compatible with the results published in the literature.

Kendall et al. (2001) determined the sensitivity and specificity of emergency medicine physicians' detection of gallbladder wall thickness with USG to be as 50% and 92%, respectively, while Summers et al. (2010) reported 65% sensitivity and 91% specificity^(13, 14). The similarity in emergency physician's ability to identify gallbladder wall thickness to that of the radiologists in our study was compatible with the literature.

The presence of pericholecystic fluid is one of the USG criteria of acute cholecystitis. In the literature, only two studies were found where emergency medicine physicians were compared with radiology physicians when it came to identifying the presence of pericholecystic fluid. In the first study, Kendall et al. identified only two patients with pericholecystic

fluid in a study they performed on 109 patients in 2001, and one of these patients represented a false positive. When they compared these results with those of the radiology clinic in identifying pericholecystic fluid, they have determined their sensitivity to be 100%, specificity 99%, positive predictive values (PPV) 50%, and negative predictive value (NPV) as 100%⁽¹³⁾. In the other study, Summers et al. (2010) determined the sensitivity to be 26%, specificity 94%, PPV 43%, and NPV 89% as compared with the radiology clinic when it came to identifying pericholecystic fluid⁽¹⁴⁾. In the study by Kendall et al., pericholecystic fluid was found in only one patient⁽¹³⁾. Summers et al. compared their results with the radiology clinic in their research. However, in this study, the radiology clinic results were not taken as the gold standard. Here, the sensitivity of the radiology clinic in identifying pericholecystic fluid was recorded as 39%, specificity 94%, PPV 64%, and NPV 86%⁽¹⁴⁾. We believe that the differences between the results are based on these primary factors.

Although numerous studies have been carried out by emergency physicians on the diagnosis of cholelithiasis taking the radiology clinic as reference, in the literature, only one study making a similar comparison for acute cholecystitis diagnosis has been encountered. In that study, Summers et al. (2010) compared their values with those of the radiology clinic in the diagnosis of acute cholecystitis; still, the radiology clinic results were not taken as the gold standard in this research. Here, Summers et al. reported their sensitivity as 87%, specificity 82%, PPV 44%, and NPV 97%. Meanwhile, they stated that the sensitivity of the radiology clinic was 83%, specificity 86%, PPV 59%, and NPV 95%. The

results of both clinics were similar, as was also the case in our study⁽¹⁴⁾.

Conclusion

Numerous clinical experiences have been reported in recent years that have demonstrated the benefits of using USG devices in emergency services. Emergency medicine physicians may perform gallbladder USG procedures with similar results to those of radiology physicians, assuming that they have received proper training. Thus, USG may acquire a function that is similar to the stethoscope as a part of the physical examination for clinical decision making with respect to the assessment of gallbladder diseases, and the decision to discharge patients from emergency services or keep them in hospital. This may offer emergency physicians the opportunity to make decisions more rapidly.

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YAVUZ KATIRCI M.D

Ankara Training and Research Hospital, Department of
Emergency Sukriye Mahallesi, Ulucanlar Caddesi No:89
Altındağ,
Ankara
(Turkey)