

EVALUATION OF BEDSIDE ULTRASONOGRAPHY PERFORMED IN THE EMERGENCY DEPARTMENT FOR THE DIAGNOSIS OF ACUTE CHOLECYSTITIS

AKUT KOLESİTİT TANISINDA ACİL SERVİSTE YAPILAN YATAKBAŞI ULTRASONOGRAFİNİN DEĞERLENDİRİLMESİ

Levent ALBAYRAK¹ Caner SAĞLAM²

¹ Department of Emergency Medicine, Yozgat Bozok University Faculty of Medicine, Yozgat, Turkey

² Department of Emergency Medicine, University of Health Sciences, Bozyaka Training and Research Hospital, İzmir, Turkey

Anahtar Sözcükler: Acute cholecystitis, bedside ultrasonography, emergency physician

Keywords: Akut kolesistit, yatak başı ultrasonografi, acil hekimi

Yazının alınma tarihi: 06.06.2022 Yazının kabul tarihi: 30.06.2022 Online basım: 04.10.2022

SUMMARY

Introduction: Acute cholecystitis is one of the common reasons for admission to the emergency department and bedside ultrasonography can assist clinical decision-making in these patients. The aim of this study is to evaluate the test features of bedside ultrasonography performed by emergency physicians in the diagnosis of acute cholecystitis.

Materials and Methods: A single-center, prospective observational study was conducted between 01.02.2021 and 01.02.2022 with patients admitted to the emergency department with a preliminary diagnosis of acute cholecystitis. The results of the ultrasonography performed in the emergency department and radiology departments of the patients suffering from right upper quadrant pain with the suspicion of acute cholecystitis were evaluated and the consistency of the interpretations between the reports was compared.

Results: The mean age of the 152 patients in the study group was 45.8±9 and 73 were male. Sensitivity, specificity, positive and negative likelihood ratios, accuracy, as well as positive and negative predictive values in acute cholecystitis screening of ultrasonography performed in the emergency department are 84.81 (95%CI: 74.97 - 91.9), 94.52 (95%CI: 86.56 - 98.49), 15.48 (95%CI: 5.94 - 40.32), 0.16 (95%CI: 0.09 - 0.27), 89.47 (95%CI: 83.47 - 93.86), 94.37 (95%CI: 86.54 - 97.76), 85.19 (95%CI: 77.3 - 90.66) respectively.

Conclusion: Bedside ultrasonography performed by emergency physicians is reliable for diagnosing cholecystitis. However, further studies are needed to collect sufficient evidence for the transition to clinical practice.

ÖZ

Giriş: Akut kolesistit, acil servise sık başvuru nedenlerinden biridir ve yatak başı ultrasonografi bu hastalarda klinik karar vermede yardımcı olabilir. Bu çalışmanın amacı, akut kolesistit tanısında acil hekimleri tarafından yapılan yatak başı ultrasonografinin test özelliklerini değerlendirmektir.

Gereç ve Yöntem: 01.02.2021-01.02.2022 tarihleri arasında acil servise akut kolesistit ön tanısı ile başvuran hastalarda tek merkezli prospektif gözlemsel çalışma yapılmıştır. Akut kolesistit şüphesi ile sağ üst kadranda ağrısı olan hastaların acil servis ve radyoloji servislerinde yapılan ultrasonografi sonuçları değerlendirildi ve raporlar arasındaki yorumların tutarlılığı karşılaştırıldı.

Bulgular: Çalışma grubundaki 152 hastanın yaş ortalaması 45,8±9 ve 73'ü erkekti. Acil serviste yapılan ultrasonografi akut kolesistit taramasında duyarlılık, özgüllük, pozitif ve negatif olabilirlik oranları, doğruluk, pozitif ve negatif prediktif değerleri sırasıyla 94.52 (%95CI: 86.56 - 98.49), 15.48 (%95CI: 5.94 - 40.32), 0.16 (%95CI: 0.09 - 0.27), 89.47 (%95 CI: 83.47 - 93.86), 94.37 (%95CI: 86.54 - 97.76), 85.19 (%95 CI: 77.3 - 90.66) olarak saptanmıştır.

Sonuç: Acil hekimleri tarafından yapılan yatak başı ultrasonografi kolesistit tanısında güvenilirdir. Bununla birlikte, kliniklerde pratik olarak uygulamak, yeterli kanıt toplamak için daha fazla çalışmaya ihtiyaç vardır.

INTRODUCTION

Abdominal pain is commonly seen in emergency departments (1,2). Early diagnosis is important to reduce mortality and morbidity from etiological causes of abdominal pain. Acute cholecystitis is also one of the most important diseases that cause abdominal pain and cholecystectomy is among the most common operations in general surgery. Early cholecystectomy is known to improve patients quality of life (1,2). Examination methods and laboratory findings alone are not sufficient for the differential diagnosis of acute cholecystitis. Ultrasound, used by radiologists, is a preferred method for detecting gallbladder pathologies (3,4). However, it is not possible to reach a radiologist at any time of the day for ultrasound use in the emergency services. This can disrupt patient care and delay the diagnosis (5).

Bedside ultrasonography is a technique used by emergency physicians, and there are many examples in the literature of applications of bedside ultrasonography in the emergency department (6-9). Bedside ultrasonography is a potential diagnostic tool for diagnosing acute cholecystitis as it is a rapid, reproducible, and inexpensive method for emergency services (7). Although there is increasing evidence of the positive diagnostic performance of bedside bile ultrasound, concerns remain about the need for confirmation based on radiological testing between diagnosis in the emergency department and surgical treatment (10, 11). Therefore, studies in the field of bedside gallbladder pathology ultrasonography will fill this gap in evidence-based practice and contribute to the consensus on the diagnostic accuracy of bedside bile duct ultrasonography. The aim of this study is to evaluate the test characteristics of bedside ultrasonography performed in the emergency department in the diagnosis of acute cholecystitis.

MATERIAL AND METHOD

This study was conducted as a single-center, prospective observational study. Patients admitted to the emergency department of a tertiary hospital between 01.02.2021 and 01.02.2022 with a preliminary diagnosis of acute cholecystitis were included in the study. During the study, the principles of the Declaration of Helsinki were adhered to and written informed consent was obtained from all participants. Before starting the study, approval was obtained from the Ethics Committee of Bozok University Faculty of Medicine with the number of 2017-KAEK-189_2021.01.18_83.

Study population

Patients older than 18 years of age who presented to the emergency department with suspected acute cholecystitis and who required bedside ultrasonography of the right upper quadrant based on their clinical assessment were included. Patients with known biliary tract diseases, pregnant women and patients for whom insufficient data could be obtained during follow-up were excluded from the study.

Study protocol

The patients were selected for participation in the study by the research assistants on duty that day in the emergency department. Ultrasonographic measurements were performed by four emergency specialists and four senior research assistants. Bedside ultrasound practitioners were previously trained in biliary imaging and interpretation. A convex multi-frequency (2-5 MHz) US probe was used to evaluate the gallbladder. US examination was performed with right subcostal oblique and longitudinal scans and intercostal scans to provide the best visualization of the entire gallbladder and its contents. Researchers screened patients for gallbladder wall thickening, pericholecystic fluid,

sonographic Murphy's sign, and cholelithiasis. In patients evaluated for sonographic Murphys sign, thickening of the anterior gallbladder wall greater than 3 mm, and pericholecystic fluid, those with at least two positive findings were scored in favor of acute cholecystitis (Figure 1). Patients with only gallstones in the gallbladder with no other sonographic findings of cholecystic disease were considered to have cholelithiasis. Bedside ultrasonography results were compared with the results of ultrasonography performed in the radiology department as the gold standard. Bedside ultrasonography practitioners were unaware of the results of sonography performed by radiology.

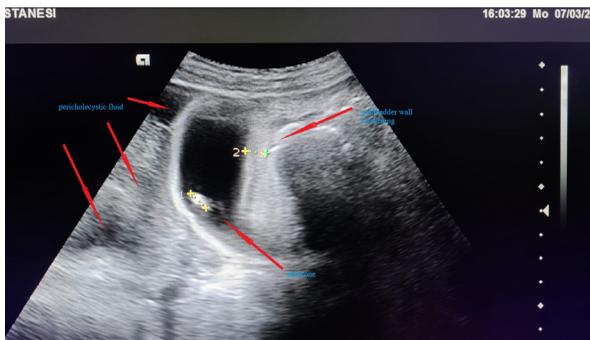


Figure 1. Ultrasonographic view of pericholecystic fluid, gallbladder wall thickening with a gallstone

Statistical Analysis

Statistical analysis was performed using the SPSS® 22.0 (Statistical Package for Social Sciences, IBM Inc., Chicago, IL, USA) package program. The categorical data were presented with numbers and percentages. We calculated the ultrasound performance characteristics including sensitivity, specificity, accuracy, positive and negative predictive values with 95%

confidence intervals. The compatibility between bedside ultrasonography in the emergency room and ultrasonographic applications performed in the radiology department was evaluated with the Kappa test. Cases where the p value was below 0.005 were considered as statistically significant results.

RESULTS

171 patients with ultrasound imaging were included in the study. However, 19 of these patients were excluded from the study because bedside sonography in the emergency department and sonography in the radiology department could not be performed together. The mean age of the remaining 152 patients in the study group was 45.8±9 and 73 were male. The findings of gallbladder ultrasound and the emergency physician and radiologist compliance rates are presented in Table 1. Taking into account the findings of the emergency department and radiology, the highest agreement was observed in the detection of gallstones and the lowest agreement was observed in the determination of the wall thickness of the gallbladder. Sensitivity, specificity, positive and negative likelihood ratios, accuracy, as well as positive and negative predictive values in acute cholecystitis screening of ultrasonography performed in the emergency department are 84.81 (95%CI: 74.97 - 91.9), 94.52 (95%CI: 86.56 - 98.49), 15.48 (95%CI: 5.94 - 40.32), 0.16 (95%CI: 0.09 - 0.27), 89.47 (95 %CI: 83.47 - 93.86), 94.37 (95%CI: 86.54 - 97.76), 85.19 (95%CI: 77.3 - 90.66). Screening performance characteristics of bedside ultrasonography in the emergency department for ultrasonographic findings of acute cholecystitis are presented in Table 2.

Table 1. Frequency and agreement of each ultrasonography report made in the emergency and radiology departments

Findings	Emergency Department Bedside USG (n,%)	Radiology Department USG (n,%)	Kappa	P-value
Gallbladder stone	132 (86.8)	134 (88.2)	0.820	<0.001
Acute cholecystitis	71 (46.7)	79 (52)	0.790	<0.001
Gallbladder wall thickening	48 (31.6)	67 (44.1)	0.463	<0.001
Pericholecystic fluid	47 (30.9)	55 (36.2)	0.794	<0.001
Sonografik murphy	89 (58.6)	86 (56.6)	0.798	<0.001

Table 2. Creening performance characteristics of emergency department bedside sonography for sonographic findings of acute cholecystitis

Characteristics	Gallbladder wall thickening	Pericholecystic fluid	Sonografik murphy	Gallbladder stone
Sensitivity	56.72 (44,04 -68,78)	80 (67,03 -89,57)	93.02 (85.43-97.4)	97 (92,53 - 99,18)
Specificity	88.24 (79,43 -94,21)	96.91 (91,23 - 99,36)	86.36 (75.69-93.57)	88,89 (65,29 - 98,63)
Positive predictive value	79.17 (67,18 -87,58)	93.62 (82,69 - 97,83)	89.89 (82.85-94.24)	98.48 (94,62 - 99,59)
Negative predictive value	72.12 (66,05 -77,47)	89.52 (83,42 - 93,55)	90.48 (81.36-95.39)	80 (60,04 - 91,41)
Accuracy	74.34 (66,63 -81,07)	90.79 (85,03 - 94,87)	90.13 (84.25-94.37)	96.05 (91,61 - 98,54)
Positive likelihood ratio	4.82 (2,6 - 8,95)	25.87 (8,43 - 79,43)	6.82 (3.71-12.55)	8.73 (2,36 - 32,26)
Negative likelihood ratio	0.49 (0,37 - 0,65)	0.21 (0,12 - 0,36)	0.08 (0.04-0.17)	0.03 (0,01 - 0,08)

DISCUSSION

Our study showed that, in terms of the diagnostic test performance of bedside right upper quadrant ultrasound application, positive bedside ultrasound findings in favor of cholecystitis in patients with suspected biliary pathology presenting to the emergency department were similar to ultrasound results performed in the radiology department. In addition, our results predicted that bedside ultrasonography is reliable in detecting gallbladder stones.

Biliary ultrasonography represents the first imaging step of choice in suspected acute cholecystitis, thanks to its non-invasive, radiation-free, high accuracy, and wide availability (12,13). Although contrast-enhanced computed tomography and MRI applications may be preferred to rule out complications, the use of these imaging modalities in various patient populations (pregnancy, renal failure, etc.) is limited due to cost, radiation exposure, and the use of contrast agents (12,14,15). A meta-analysis evaluating the accuracy analysis of ultrasonography, cholescintigraphy, CT, or MR imaging showed that ultrasonography is often used to detect acute cholecystitis in a similar patient population with suspected acute cholecystitis (12).

Studies of bedside ultrasonography for the diagnosis of acute cholecystitis can be found in the literature. However, few studies have been

found on ultrasound performed by non-radiologists for bedside ultrasound examination, particularly in relation to biliary tract pathologies. In one of the studies carried out in this direction, Scruggs et al. in a prospective study comparing the ultrasound findings of emergency physicians and radiologists for the identification of gallstones, found that the sensitivity of ultrasound performed by emergency physicians was 88% and the specificity was 87%, with a positive predictive value of 91% (16). In another study, there was strong agreement in the assessment of gallstones on bedside ultrasound versus radiology [88.4%, kappa 0.77 (95% CI 0.620.92)] (17). Another study found that the sensitivity of emergency physician ultrasonography for detecting gallstones compared to radiology ultrasonography was 94% (ppv: 99%, npv: 73) (18). In our study, data from patients assessed as having cholelithiasis who underwent both bedside and radiological ultrasound examination showed that emergency bedside ultrasound examination is a sensitive and reliable tool for detecting the presence of gallstones, consistent with the literature was.

The sonographic detection of gallstones is easier than the diagnosis of acute cholecystitis. However, there are few studies examining the diagnostic test performance of bedside ultrasonography in acute cholecystitis (19). In recent years, the use of bedside ultrasound as an

integrated physical examination tool in the clinical approach to acute cholecystitis has increased. (20). If there is a clinical suspicion of acute cholecystitis, bedside ultrasound usually clarifies the need for the necessary investigations in the next step, in addition to providing a quick and definitive diagnosis (21). In addition, a prospective observational study showed similar outcomes for cholecystitis detection between emergency bedside ultrasonography for cholecystitis detection and radiological ultrasonography (Bedside US sensitivity 87%, specificity 82%; radiology-ultrasound sensitivity 83%, specificity 86%) (22). In another study, good agreement in the presence and absence of an acute cholecystitis diagnosis was found between sonographic reports found that were made in the emergency room and radiology departments (23). On the other hand, in a study conducted, it was found that the scanning performance characteristics of the ultrasound scan performed by a radiologist were significantly better in detecting gallbladder stones than the ultrasound scan performed by an emergency room attendant and increases gallbladder wall thickness (24). Another study found that bedside ultrasound performed by emergency physicians was less accurate than the presence or absence of gallstones in detecting acute cholecystitis (25). The data obtained in our study were similar to the results of ultrasonography performed by radiologists when diagnosing acute cholecystitis. The difference in the agreement of radiographic and non-radiographic sonographic reports in the diagnosis of an acute cholecystitis in the literature may be due to the practice dependence of sonography. The experience of the ultrasound

practitioner can affect the diagnostic value of acute cholecystitis. In our study, a training plan for the ultrasound practitioners was prepared in advance. Second, the interest of emergency physicians in bedside sonography in other settings in recent years may have increased their sonographic skills and rapid adaptability. This may indicate that more training and practice is needed to improve gallbladder ultrasound screening performance and develop diagnostic skills.

Limitations

The main limitation of our study is the small number of patients included in the study. Another limitation of our study is that the patients body mass index was not measured. Obesity is a technically challenging factor in abdominal ultrasound examinations. This may be a factor in diagnostic discrepancies between cases in bedside sonographers.

CONCLUSION

Bedside ultrasonography, performed by competent emergency physicians with the necessary training, is reliable for identifying gallstones and diagnosing acute cholecystitis. The clinical use of bedside ultrasound as part of the physician's physical examination of patients presenting to the emergency department with right upper quadrant pain can improve the quality of overall patient care. In emergency medical education, training to improve bedside ultrasound skills for gallbladder pathologies should be standardized and encouraged.

REFERENCES

1. Peery AF, Crockett SD, Barritt AS, Dellon ES, Eluri S, Gangarosa LM, et al. Burden of gastrointestinal, liver, and pancreatic diseases in the United States. *Gastroenterology* 2015;149:1731–41.
2. Siddiqui A, MacDonald PS, Chong PS, Jenkins JT, Early versus delayed laparoscopic cholecystectomy for acute cholecystitis: a meta-analysis of randomized clinical trials. *Am J Surg*. 2008;195(1):40–7.
3. Sharif S, Vlahaki D, Skitch S, Truong J, Freeman S, Sidalak D, et al. Evaluating the diagnostic accuracy of point-of-care ultrasound for cholelithiasis and cholecystitis in a canadian emergency department. *CJEM*. 2021;23(5):626–30.
4. Wehrle CJ, Talukder A, Tien L, Parikh S, Devarakonda A, Holsten SB, et al. The Accuracy of Point-of-Care Ultrasound in the Diagnosis of Acute Cholecystitis. *Am Surg*. 2022;88(2):267-72.
5. Stein JC, Jacoby VL, Vittinghoff E, Wang R, Kwan E, Reynolds T, et al. Differential use of diagnostic ultrasound in u.s. Emergency departments by time of day. *West J Emerg Med*. 2011;12(1):90-5.
6. Gökçen E, Savrun A, Kuşdoğan M, Çaltekin İ, Albayrak L, Atik D, et al. Ability of Bedside Ultrasonography to Detect Pediatric Nasal Bone Fractures. *Laryngoscope*. 2021;131(6):1398-1403.

7. Rowland JL, Kuhn M, Bonnin RL, Davey MJ, Langlois SL. Accuracy of emergency department bedside ultrasonography. *Emerg Med.* 2001;13(3):305-13.
8. Chen L, Zhang Z. Bedside ultrasonography for diagnosis of pneumothorax. *Quant Imaging Med Surg.* 2015;5(4):618-23.
9. Rubano E, Mehta N, Caputo W, Paladino L, Sinert R. Systematic review: emergency department bedside ultrasonography for diagnosing suspected abdominal aortic aneurysm. *Acad Emerg Med.* 2013;20(2):128-38.
10. Shah S, Bellows BA, Adedipe AA, Totten JE, Backlund BH, Sajed D. Perceived barriers in the use of ultrasound in developing countries. *Crit Ultrasound J.* 2015;7(1):28.
11. Hansen W, Mitchell CE, Bhattarai B, Ayutyanont N, Stowell JR. Perception of point-of-care ultrasound performed by emergency medicine physicians. *J Clin Ultrasound.* 2017;45(7):408-15.
12. Kiewiet JJ, Leeuwenburgh MM, Bipat S, Bossuyt PM, Stoker J, Boermeester MA. A systematic review and meta-analysis of diagnostic performance of imaging in acute cholecystitis. *Radiology.* 2012;264(3):708-20.
13. Wertz JR, Lopez JM, Olson D, Thompson WM. Comparing the Diagnostic Accuracy of Ultrasound and CT in Evaluating Acute Cholecystitis. *AJR Am J Roentgenol.* 2018;211(2):92-7.
14. Pinto A, Reginelli A, Cagini L, Coppolino F, Stabile Ianora AA, Bracale R, et al. Accuracy of ultrasonography in the diagnosis of acute calculous cholecystitis: review of the literature. *Crit Ultrasound J.* 2013;5 Suppl 1:S11.
15. Fagenholz PJ, Fuentes E, Kaafarani H, Cropano C, King D, de Moya M, et al. Computed Tomography Is More Sensitive than Ultrasound for the Diagnosis of Acute Cholecystitis. *Surg Infect (Larchmt).* 2015;16(5):509-12.
16. Scruggs W, Fox JC, Potts B, Zlidenny A, McDonough J, Anderson CL, et al. Accuracy of ED Bedside Ultrasound for Identification of gallstones: retrospective analysis of 575 studies. *West J Emerg Med.* 2008;9(1):1-5.
17. Graglia S, Shokoohi H, Loesche MA, Yeh DD, Haney RM, Huang CK, et al. Prospective validation of the bedside sonographic acute cholecystitis score in emergency department patients. *Am J Emerg Med.* 2021;42:15-9.
18. Miller AH, Pepe PE, Brockman CR, Delaney KA. ED ultrasound in hepatobiliary disease. *J Emerg Med.* 2006;30(1):69-74.
19. Pereira J, Bass GA, Mariani D, Dumbrava BD, Casamassima A, da Silva AR, et al. Surgeon-performed point-of-care ultrasound for acute cholecystitis: indications and limitations: a European Society for Trauma and Emergency Surgery (ESTES) consensus statement. *Eur J Trauma Emerg Surg.* 2020;46(1):173-83.
20. Zenobii MF, Accogli E, Domanico A, Arienti V. Update on bedside ultrasound (US) diagnosis of acute cholecystitis (AC). *Intern Emerg Med.* 2016;11(2):261-4.
21. Arienti V, Di Giulio R, Cogliati C, Accogli E, Aluigi L, Corazza GR; Ultrasound SIMI Study Group. Bedside ultrasonography (US), Echocopy and US point of care as a new kind of stethoscope for Internal Medicine Departments: the training program of the Italian Internal Medicine Society (SIMI). *Intern Emerg Med.* 2014;9(7):805-14.
22. Summers SM, Scruggs W, Menchine MD, Lahham S, Anderson C, Amr O, et al. A prospective evaluation of emergency department bedside ultrasonography for the detection of acute cholecystitis. *Ann Emerg Med.* 2010;56(2):114-22.
23. Shekarchi B, Hejrjipour Rafsanjani SZ, Shekar Riz Fomani N, Chahardoli M. Emergency Department Bedside Ultrasonography for Diagnosis of Acute Cholecystitis; a Diagnostic Accuracy Study. *Emerg (Tehran).* 2018;6(1):e11.
24. Tootian TJ, Arabikhan HR, Alamdaran A, Zamani MH. Emergency Medicine Resident versus Radiologist in Detecting the Ultrasonographic Signs of Acute Cholecystitis; a Diagnostic Accuracy Study. *Emerg (Tehran).* 2018;6(1):e19.
25. MacDonald AA, Richardson M, Sue L, Hakiwai A, Stephenson G, Harman R, et al. Bedside ultrasonography for acute gallstone disease: a diagnostic accuracy study of surgical registrars and emergency medicine physicians. *ANZ J Surg.* 2020;90(12):2467-71.

Corresponding Author

Levent ALBAYRAK
 Yozgat Bozok University Faculty of Medicine,
 Department of Emergency Medicine, Yozgat, Turkey
 Phone:05324246450
 E mail: drleventalbayrak@yahoo.com
 ORCID: 0000-0002-4288-8170

Caner SAĞLAM (Uzm. Dr.) ORCID: 0000-0002-9967-4456