

ORIGINAL RESEARCH

Emergency Medicine Resident versus Radiologist in Detecting the Ultrasonographic Signs of Acute Cholecystitis; a Diagnostic Accuracy Study

Javad Tootian Tourghabe¹, Hamid Reza Arabikhan², Ali Alamdaran³, Hamid Zamani Moghadam^{2*}

1. Emergency Department, Hasheminajad Hospital, Mashhad University Of Medical Sciences, Mashhad, Iran.

2. Emergency Department, Imam Reza Hospital, Mashhad University Of Medical Sciences, Mashhad, Iran.

3. Radiology Department, Imam Reza Hospital, Mashhad University Of Medical Sciences, Mashhad, Iran.

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Abstract: **Introduction:** Dependence of ultrasonography on the operator's skill plays a major role in the differences between various studies in reporting its diagnostic accuracy. Therefore, the present study was done with the aim of comparing the ultrasonography findings performed by emergency medicine resident and radiologist in evaluation of acute cholecystitis. **Methods:** The present diagnostic accuracy study has been carried out on patients presenting to the emergency department with complaint of pain in the right upper quadrant of abdomen suspected with acute cholecystitis. All the patients underwent gallbladder ultrasonography by a trained emergency medicine resident and a radiologist and their findings were compared with surgical and pathology findings regarding gallstone and increased gallbladder wall thickness. **Results:** 51 patients with the mean age of 42.3 ± 15.8 (17-81) years were analyzed (82.4% female). The overall agreement between emergency medicine resident and radiologist in ultrasonographic diagnosis of cholecystitis was 0.421 (95% CI: 0.118-0.724). Based on the pathology and surgical findings, acute cholecystitis was confirmed for all 51 (100%) patients. Meanwhile, based on the ultrasonographic report of radiologist and emergency medicine resident only 45 (88.2%) and 34 (66.7%) patients, respectively, were diagnosed with cholecystitis. Screening performance characteristics of ultrasonography by radiologist for detection of gallbladder stone ($p = 0.010$) and gallbladder wall thickness ($p < 0.0001$) were significantly better than emergency medicine resident. **Conclusion:** The screening performance characteristics of ultrasonography by radiologist in detection of gallstones and increased wall thickness of gallbladder were significantly better.

Keywords: Gallstones; cholecystitis, acute; diagnostic imaging; ultrasonography

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1. Introduction

One of the most common causes of patients presenting to the emergency department with complaint of abdominal pain is acute cholecystitis. Acute cholecystitis, which is an inflammatory disease of the gallbladder, is mostly due to presence of a stone, ischemia, movement disorders in gallbladder and biliary tracts, and obstruction

of the tracts by a tumor. Statistics have indicated that 3% to 10% of the patients presenting to emergency department with complaint of abdominal pain are affected with acute cholecystitis (1-3).

Along with physical examination and laboratory evaluation, ultrasonography is usually considered the first diagnostic step for patients with suspected acute cholecystitis in the emergency department. Availability, low cost and non-invasiveness of this imaging technique has made it the most commonly used diagnostic method in the emergency department (4-8).

However, dependence of ultrasonography on the operator's skill plays a major role in the differences between various

* **Corresponding Author:** H Zamani Moghadam; Emergency Department, Imam Reza Hospital, Bahar Avenue, Mashhad, Iran. Tel: 09155811238 Email: zamanimh@mums.ac.ir



studies in reporting its diagnostic accuracy. For example, sensitivity and specificity reported for ultrasonography performed by emergency medicine specialist in detection of acute cholecystitis have been reported to be 83%, and 82%, respectively; while, these rates have been 87% and 86%, respectively, for radiologist (9). However, other studies show contradicting results and a sensitivity of 90% to 96% has been estimated for ultrasonography performed by emergency physicians (10, 11). These contradictions in opinion have resulted in inability to accurately decide regarding the diagnostic accuracy of ultrasonography in detection of acute cholecystitis. The present study aims to compare the ultrasonography findings performed by emergency medicine resident and radiologist in evaluation of acute cholecystitis.

2. Methods

2.1. Study design and setting

The present diagnostic accuracy study has been carried out on patients presenting to the emergency department of Imam Reza Hospital, Mashhad, Iran, between November 2015 and January 2017 with complaint of abdominal pain suspected with acute cholecystitis. All the patients underwent gallbladder ultrasonography by an emergency medicine resident and a radiologist and their findings were compared with surgical and pathology findings. Protocol of this study was evaluated in the ethics committee of Mashhad University of Medical Sciences and registered under the code IR.MUMS.fm.REC.1395.597. Before being included in the study, informed consent was obtained from the patients or their relatives and the researchers adhered to the principles of Helsinki Declaration throughout the study period.

2.2. Participants

Patients with acute pain in the right upper quadrant of their abdomen suspected with acute cholecystitis who would finally undergo surgery and the results of their gallbladder pathology was available were included in the study. Exclusion criteria consisted of the patient not cooperating and not giving consent for performance of ultrasonography and the results of pathology of the patients not being available. No age or sex limitation was applied in the present study.

2.3. Procedure

In this study, ultrasonography of the right upper quadrant of the abdomen was performed by an emergency medicine resident and a radiologist independently and separately. Ultrasonography was performed using an HS-2100 model portable ultrasonography device (Honda Company, Japan) using a linear probe with a frequency of 5 to 7MHz. After the initial examination, the emergency medicine resident would perform ultrasonography and then the radiologist would re-

peat this diagnostic modality for the patients using the same ultrasonography device.

Ultrasonographic diagnosis of acute cholecystitis was based on the presence of at least one of the following symptoms in ultrasonography:

Impacted stone in cystic duct of gallbladder neck, sonographic Murphy's sign, thickening of gallbladder wall >3 mm, peri-cholecystic fluid collection. The emergency medicine residents participating in the present study had attended theoretical and practical training courses of ultrasonography performance on patient's bedside for diagnosis of acute cholecystitis. The decision regarding performing surgery on the patients or not was made by the surgeon in charge of the patient and based on a combination of clinical, laboratory, and ultrasonography findings. The gold standard in the present study was considered surgical and pathology findings of the gallbladder.

2.4. Data gathering

A senior emergency medicine resident was in charge of gathering patients' data. The shifts in which this resident was present in the emergency department were planned randomly. To gather data, a pre-designed checklist including demographic data (age, sex), ultrasonographic findings of acute cholecystitis by an emergency medicine resident and a radiologist separately, and findings of gallbladder surgery and pathology was used.

2.5. Statistical Analysis

Considering 95% confidence interval (CI), 90% sensitivity of ultrasonography performed by an emergency medicine specialist, 30% prevalence, and 0.1 error, the minimum required sample size for his study was estimated as 42 patients and by considering missing 15% of the samples, in the end sample size was considered 50 patients (11). Data were analyzed using STATA 14.0 statistical software. Results were expressed as frequency and percentage or mean and standard deviation. Agreement rate of ultrasonography performed by emergency medicine resident and radiologist was reported by calculating Kappa coefficient with 95% CI. Then the true positive, true negative, false positive and false negative results reported by emergency medicine resident and radiologist regarding gallstone and gallbladder wall thickness were calculated by considering the results of surgery and pathology as the standard test. To compare the screening performance characteristics of ultrasonography by radiologist and emergency medicine resident Fisher's exact test was used. Consequently, using Vassarstats medical calculator, screening performance characteristics of gallbladder ultrasonography in detection of stone and gallbladder wall thickness were calculated.



Table 1: Ultrasonographic findings of gallbladder by emergency medicine (EM) resident and radiologist and their agreement rate with 95% confidence interval (CI)

Ultrasonographic finding	EM resident	Radiologist	Agreement (95% CI)
> 3mm thickness	31 (60.8)	42 (82.4)	0.499 (0.271-0.725)
Sonographic Murphy's sign	27 (52.9)	19 (37.3)	0.691 (0.503- 0.877)
Gallstone	14 (27.5)	36 (70.6)	0.272 (0.115- 0.429)
Pericholecystic fluid	2 (3.9)	6 (11.8)	0.469 (0.045-0.892)

Data are shown as frequency (%).

Table 2: Screening performance characteristics of ultrasound performed by radiologist and emergency physician in detection of gallstone

Characteristics	Radiologist	Emergency Physician
True positive	36	14
True negative	14	14
False positive	0	0
False negative	1	23
Sensitivity	97.29 (84.19-99.86)	37.84 (22.94-55.2)
Specificity	100.0 (73.24-100.0)	100.0 (73.24-100.0)
Positive predictive value	100.0 (88.0-100.0)	100.0 (73.24-100.0)
Negative predictive value	93.33 (66.03-99.65)	37.84 (22.94-55.2)
Positive likelihood ratio	NA	NA
Negative likelihood ratio	0.03 (0.004-0.19)	0.62 (0.48-0.80)

NA: Not applicable; data are presented with 95% confidence interval.

Table 3: Screening performance characteristics of ultrasound performed by radiologist and emergency physician in detection of increased gallbladder wall thickness

Characteristics	Radiologist	Emergency Physician
True positive	38	28
True negative	9	10
False positive	4	3
False negative	0	10
Sensitivity	100.0 (88.57-100.0)	73.68 (56.61-86.02)
Specificity	69.23 (38.88-89.64)	76.92 (45.98-93.84)
Positive predictive value	90.0 (76.45-96.90)	90.03 (73.10-97.47)
Negative predictive value	100.0 (62.88-100.0)	50.0 (27.85-72.15)
Positive likelihood ratio	3.25 (1.44-7.34)	3.19 (1.16-8.77)
Negative likelihood ratio	NA	0.34 (0.19-0.61)

NA: Not applicable; data are presented with 95% confidence interval.

3. Results

61 patients were included in the study, but 10 patients were excluded due to unavailability of pathology results. Finally, the data of 51 patients with the mean age of 42.3±15.8 (17-81) years were analyzed (82.4% female). Table 1 shows the ultrasonography findings of gallbladder by emergency medicine resident and radiologist and their agreement rate, separately. The overall agreement between emergency medicine resident and radiologist in ultrasonographic diagnosis of cholecystitis was 0.421 (95% CI: 0.118-0.724).

Based on the pathology and surgical findings, acute cholecystitis was confirmed for all 51 (100%) patients. Meanwhile, based on the ultrasonographic report of radiologist

and emergency medicine resident only 45 (88.2%) and 34 (66.7%) patients, respectively, were diagnosed with cholecystitis. Screening performance characteristics of ultrasonography by emergency medicine resident and radiologist in diagnosis of gallstone and wall thickness have been summarized in tables 2 and 3. Screening performance characteristics of ultrasonography by radiologist for detection of gallstone (p = 0.010) and gallbladder wall thickness (p < 0.0001) were significantly better than emergency medicine resident.

4. Discussion

Based on the results of the present study, it seems that relying solely on ultrasonography for making a decision regard-



ing surgery of patients with pain in the right upper quadrant of their abdomen suspected with cholecystitis is not accurate enough. However, the screening performance characteristics of ultrasonography by radiologist in detection of gallstones and increased thickness of gallbladder wall were significantly better.

Numerous studies have been done on the diagnostic value of ultrasonography in detection of gallbladder problems, which has resulted in performance of many systematic reviews and meta-analyses for this purpose. For example, Kiewiet et al. by evaluating 26 studies showed that sensitivity and specificity of ultrasonography in diagnosis of acute cholecystitis are 82% and 81%, respectively. However, in spite of performing subgroup analyses in the mentioned meta-analysis, no attention was paid to the role of the operator performing ultrasonography (12). Ultrasonography being operator-dependent is a matter that, as clearly confirmed in the present study, affects the diagnostic value of ultrasonography. Overall, much controversy exists between the studies regarding the value of ultrasonography in detection of gallstones. This controversy can be due to many reasons, one of which is dependence of ultrasonography on the operator's skill. In comparison to the present study, the sensitivity of ultrasonography performed by an emergency medicine specialist reported by Shekarchi et al. was higher (89.58% versus 77.08%). The cause of this difference might be the difference in the gold standard of these studies. In the present study, pathologic result was chosen as the gold standard, but in Shekarchi et al. study, the results of ultrasonography performed by radiologist was considered as the gold standard (11).

By assessing 164 patients in their study, Villar et al. showed that diagnosis based on evidence of stone in ultrasonography alone has excellent sensitivity and negative predictive value in diagnosis of acute cholecystitis, even more than when a combination of symptoms is used (13). However, the retrospective nature of Villar et al. study is its most important limitation. Therefore, for answering the question "which symptoms should be used for diagnosis of cholecystitis in ultrasonography?", it is suggested to perform more studies in this regard.

It seems that for improving the screening performance characteristics of gallbladder ultrasonography by emergency medicine residents for detection of stone and increase in its wall thickness more training, practice and repetition is needed for improving their diagnostic skill.

5. Limitation

The most important limitation of the present study is the small number of the patients included (51 patients). This small sample size might have affected the diagnostic value reported. However, considering the surgical and pathology

findings as the gold standard is one of its most important strong points.

6. Conclusion

Based on the results of the present study, it seems that relying solely on ultrasonography for making a decision regarding surgery of patients with pain in the right upper quadrant of their abdomen suspected with cholecystitis is not accurate enough. However, the screening performance characteristics of ultrasonography by radiologist in detection of gallstones and increased thickness of gallbladder wall were significantly better.

7. Appendix

7.1. Acknowledgements

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7.2. Authors' contribution

All the authors of this article met the criteria of authorship based on the recommendations of the international committee of medical journal editors.

7.3. Funding/Support

All the costs of the present study were paid by the researchers.

7.4. Conflict of interest

Hereby, the authors declare that there is no conflict of interest regarding the present study.

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