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ORIGINAL RESEARCH

Accuracy of Surgeon-Performed Gallbladder Ultrasound in Identification of Acute Cholecystitis

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ABSTRACT

Background: Acute cholecystitis is a common cause of emergency hospital admission. Ultrasonography (US) plays a significant role in the prompt diagnosis of this medical condition. However, it is difficult to find a radiologist in attendance for performing gallbladder US “beyond daytime and on weekends.” With this standpoint, we decided to assess prospectively the accuracy of surgeon-performed gallbladder US for identifying acute cholecystitis in patients with cholelithiasis. **Materials and Methods:** Seventy-one consecutive patients awaiting elective or acute gallbladder surgery were included in this study. The US findings of surgeons and radiologists are compared with the histopathology reports. The sensitivity, specificity, accuracy, PPV (positive predictive value), and NPV (negative predictive value) for acute cholecystitis by both surgeon-performed ultrasound (SPUS) and radiologist-performed ultrasound (RPUS) were evaluated. **Results:** Both radiologists and surgeons visualized the gallstones of each patient in all cases. The sensitivity, specificity, accuracy, and NPV for acute cholecystitis by SPUS were 84.2%, 92.1%, 90%, and 94%, respectively, whereas the sensitivity, specificity, accuracy, and NPV for acute cholecystitis by RPUS were 92.3%, 85.9%, 87.1%, and 98%, respectively. **Conclusions:** Both SPUS and RPUS had a high accuracy rate in electing the acute cholecystitis. Our data support the fact that the use of US by general surgeons is effective in the diagnosis of acute cholecystitis.

Keywords cholelithiasis; acute cholecystitis; surgeon; ultrasonography

INTRODUCTION

Gallstone disease is one of the most common problems affecting the digestive tract and is also a common cause for emergency hospital admission. Autopsy reports have shown a prevalence of gallstones from 11% to 36%, and first-degree relatives of patients with gallstones have a twofold greater prevalence [1]. A definitive diagnosis of this medical condition requires the documentation of gallstones by ultrasonography (US) with an appropriate clinical presentation. Nonradiological specialties, such as cardiology, obstetrics, urology, and emergency medicine, already use US in their routine clinical practices [2, 3]. Although US is not a new modality, general surgeons in some developed countries embraced it as a diagnostic tool and an extension of the physical examination only recently [3, 4].

Despite US playing an important role in the diagnosis of acute cholecystitis, especially in the rural regions of developing countries, it is almost always impossible to find a radiologist in attendance for performing gallbladder US on “outside daytime and on weekends.” Starting this standpoint, we decided to assess prospectively the accuracy of surgeon-performed gallbladder US for identifying acute cholecystitis in patients with cholelithiasis.

MATERIALS AND METHODS

Seventy-one consecutive patients awaiting elective or acute gallbladder surgery in our General Surgery Department were included in this study. This study was approved by the ethics committee of the

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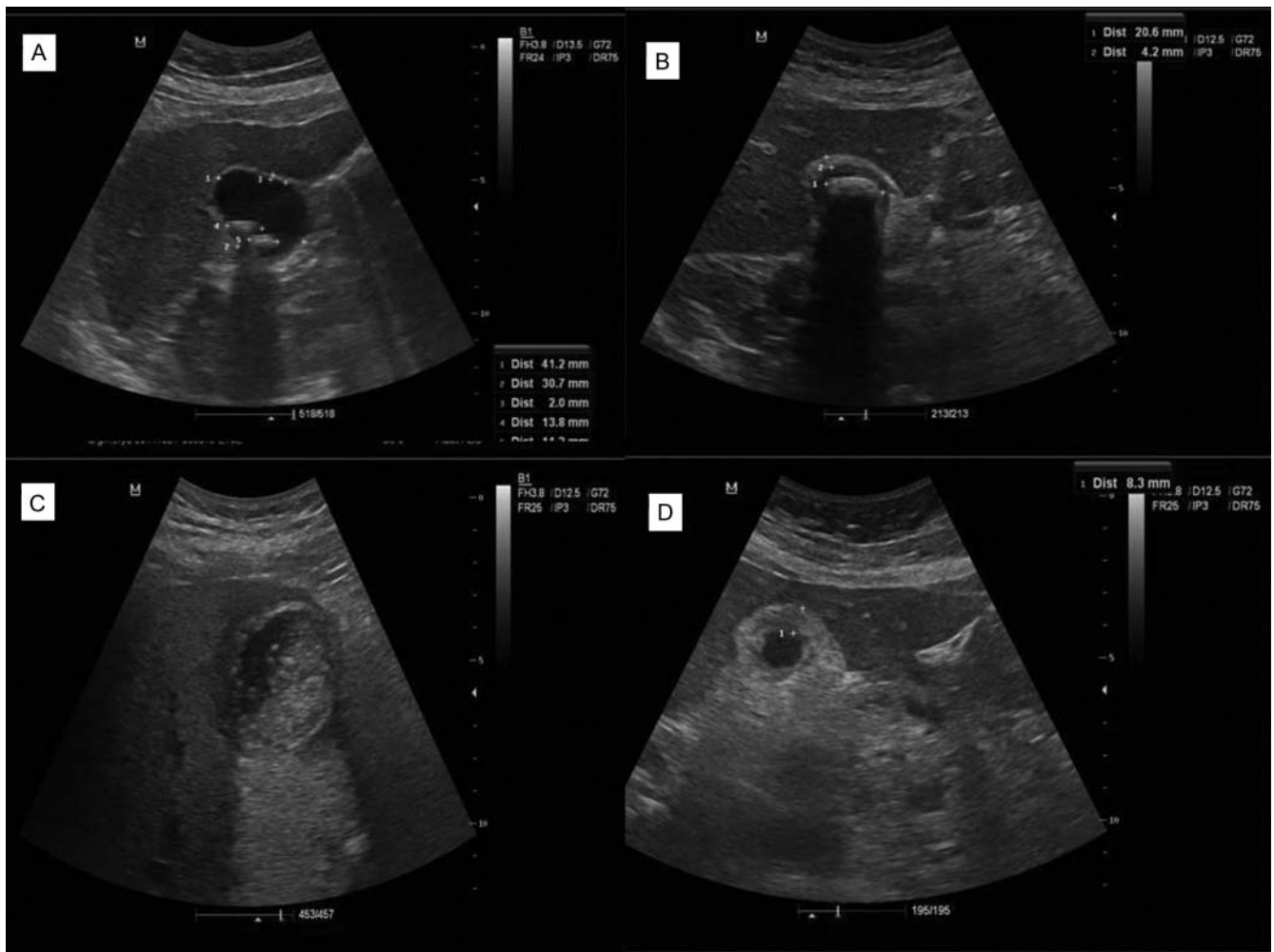


FIGURE 1. (a) The gallbladder filled with multiple stones. (b) An echogenic big stone in the gallbladder. (c) Acute cholecystitis with echogenic sludge and pericholecystic fluid. (d) Acute cholecystitis with gallbladder wall thickening.

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Study Design

Two general surgeons, each given half-a-day tuition during one week in basic landmarks in gallbladder US by a consultant radiologist, were included in the study. After the completion of informed consent, the patients underwent a US study conducted by one of the surgical investigators. SPUS was performed by using a 2–5 MHz curved broadband transducer (Maryland, DC-7, China). The presence or absence of gallstones or sludge was recorded. In addition, the ultrasonographic signs of acute cholecystitis were also recorded if visualized. Incidental findings on US were also noted. A standardized data collection sheet was used for data recording. The US images were printed when necessary and recorded on a database on US. All the investigators were blinded to any previous laboratory and US findings. All the patients were also evalu-

ated by a routine independent radiologist in our radiology department. The same trademark US was used in the radiology department. The reports of radiologists, histopathology reports, and the operation notes of the patients were also recorded.

Ultrasonographic Criteria

The ultrasonographic criterion for gallstone recognition was a mobile hyperechoic focus with posterior shadowing seen within the gallbladder. Gallbladder wall thickness greater than 3 mm, fluid in the pericholecystic space, edema within the gallbladder, and sonographic Murphy's sign were accepted as sonographic criteria for acute cholecystitis [4] (Figure 1).

End Points

The histopathology reports of all the patients regarded as endpoint and RPUS and SPUS were compared

according to these reports. The operation notes were also evaluated. Results were further grouped as follows: (a) the accuracy of surgeon-performed US in identifying acute cholecystitis among the patients who have cholelithiasis, and (b) surgeon-performed US was misleading.

STATISTICAL ANALYSIS

For statistical analysis, Pearson chi square test and Fisher's exact test were used. p values of .05 or less were considered significant. Sensitivity, specificity, diagnostic accuracy, positive predictive value (PPV), and negative predictive value (NPV) were assessed for both SPUS and RPUS. These are defined as sensitivity (true positives/true positives + false negatives), specificity (true negatives/true negatives + false positives), accuracy (true positives + true negatives/true positives + true negatives + false positives + false negatives), PPV (true positives/true positives + false positives), and NPV (true negatives/true negatives + false negatives).

RESULTS

Seventy-one consecutive patients with a mean age of 49.8 years (range 19–77) were included in the study. Female: male ratio was 53/18. SPUS and RPUS agreed with the histopathology for visualization of gallstone in all the patients, but in 1 of 71 patients, in addition to gallstone, a gallbladder adenocarcinoma focus was detected at histopathological evaluation. Both RPUS and SPUS failed to detect gallbladder cancer in this patient. At histopathological evaluation, the diagnosis of 20 cases of acute cholecystitis was made: SPUS identified 16 of these patients, whereas RPUS identified 12. In addition, histopathologically, four nonacute patients who had undergone SPUS and eight patients who had undergone RPUS were misdiagnosed as having acute cholecystitis. There was no statistical significance between SPUS and RPUS for the diagnosis of acute cholecystitis ($p = .301$). On the other hand, at histopathological evaluation, 3 of 50 patients (6%) who were reported as nonacute on SPUS and one patient (2%) who had undergone RPUS were diagnosed as having acute cholecystitis at histopathological evaluation (Table 1). The diagnosis rate for nonacute condition was similar in both SPUS and RPUS ($p = .617$). The sensitivity, specificity, accuracy, PPV, and NPV for acute cholecystitis by SPUS were 84.2%, 92.1%, 90%, 80%, and 94%, respectively, whereas the sensitivity, specificity, accuracy, PPV, and NPV for acute cholecystitis by RPUS were 92.3%, 85.9%, 87.1%, 60%, and 98%, respectively (Table 2).

TABLE 1 Validation of both surgeon performed ultrasonography and radiologist performed ultrasonography

	SPUS (<i>n</i>)	RPUS (<i>n</i>)
True positives	16	12
False positives	4	8
True negatives	47	49
False negatives	3	1

SPUS, surgeon-performed ultrasonography; RPUS, radiologist-performed ultrasonography.

DISCUSSION

During the last 40 years, the ultrasound has become an important diagnostic modality and is widely used in the investigation of abdominal symptoms [5]. Its increasing popularity among clinicians may lead to pressure on radiological services, delay, and prolonged hospital stay [6]. Although obstetricians were among the first nonradiologists who performed and interpreted US examinations, other specialists also quickly recognized the relevance of this modality to their practices [7, 8]. In this study, we assessed the accuracy and value of gallbladder US in patients with acute cholecystitis when the procedure was carried out by general surgeons. Our results suggest that for the visualization of gallstones, SPUS findings were correlated with RPUS, pathologic diagnoses, and operation notes. Both SPUS and RPUS visualized gallbladder stones in 100% of patients with cholelithiasis. On the other hand, the accuracy of SPUS for identifying the patients with acute cholecystitis among the patients with only cholelithiasis is another significant point. In this study, the sensitivity, specificity, accuracy, PPV, and NPV for acute cholecystitis by SPUS were 84.2%, 92.1%, 90%, 80%, and 94%, respectively, whereas the sensitivity, specificity, accuracy, PPV, and NPV for acute cholecystitis by RPUS were 92.3%, 85.9%, 87.1%, 60%, and 98%, respectively. Although this study was not conducted to find out the measurement differences between the surgeon and radiologist, there was a similarity for detecting pericholecystic fluid between the surgeon and radiologist (3 to 4, respectively) and for detecting hydrops of the gallbladder (7 to 7, respectively). On the other

TABLE 2 Correlation of surgeon-performed and radiologist-performed ultrasonography

	SPUS (%)	RPUS (%)
Sensitivity	84.2	92.3
Specificity	92.1	85.9
Accuracy	90	87.1
PPV	80	60
NPV	94	98

SPUS, surgeon-performed ultrasonography; RPUS, radiologist-performed ultrasonography; PPV, positive predictive value; NPV, negative predictive value.

hand, surgeons detected gallbladder wall thickening in 14 of the patients with acute cholecystitis, whereas radiologist detected such thickening in 9.

Both SPUS and RPUS had a high accuracy rate in identifying the patients with acute cholecystitis. In addition, the results of this study showed that both SPUS and RPUS had high NPV, specificity, and sensitivity rates in identifying acute cholecystitis in patients with cholelithiasis. On the other hand, PPV for RPUS was lower than that for SPUS (80% versus 60%). The causes of this result may be as follows: (1) surgeons may be more effective in recognizing the ultrasonographic Murphy sign, which is very important in diagnosing acute cholecystitis that needs a technique that is parallel with physical examination. Prompt identification of localized pain is an important aspect of differentiating the positive Murphy sign. We hypothesized that sometimes, generalized abdominal pain may be falsely interpreted as a positive sonographic Murphy sign by radiologists. On the other hand, surgeons who are familiar with the clinical positive Murphy sign will be able to make a prompt differentiation between localized and generalized pain. (2) Because the surgeons perform operations, they may accept the feedback of surgical operations for every ultrasonographic finding. These feedbacks improve the surgeons' effectivity on US to a great extent. (3) Surgeons may be more familiar with acute abdominal diseases, such as acute cholecystitis, than radiologists are. (4) Surgeons may add their clinical experience to ultrasonographic signs when they comment on ultrasonographic images.

A surgeon performing gallbladder US offers several benefits, especially in acute settings. It acts as an extension of the physical examination, thereby allowing prompt clinical decision making by the surgeon who knows the anatomy and the pathology [3–8]. In this study, the accuracy of SPUS for visualization of gallstones was 100%, and that for diagnosis of acute cholecystitis was 90%. SP gallbladder US in the acute setting may allow for further interventions with less delay, whereas the evaluation of an alternative diagnosis begins earlier for negative examinations.

Rozycki and Ballard *et al.* reported that because the gallbladder is relatively easy to scan, it makes a useful educational target for the novice sonographer. Surgeons are not specialists in sonography, but they use it as an adjunct to their surgical practice. Ultrasound technology is no longer department specific [3, 8, 9]. Considering our findings, especially in developing countries, it may be anticipated that the US may be incorporated into the surgical resident's curriculum. In this study, although a one-week training seemed to be enough for surgeons to perform gallbladder US, for evaluating the whole abdomen, a longer training time may be necessary in patients with acute abdominal pain with an unknown etiology. Our findings should

not be interpreted as that sonography is easy to learn and enthusiastically taken up by every physician.

Although the working times of radiologists may vary between institutions, a service is not always available outside daytime working hours. General surgery practices in urban and rural areas are believed to be markedly different. In a recent study, Vanbibber *et al.* reported that operations on the bowel, appendix, and gallbladder constitute 61% of the general surgical inpatient procedures in rural hospitals, compared with 46% in urban hospitals [10]. Especially in rural regions of developing countries, it is almost always impossible to find a radiologist in attendance on "outside daytime and on weekends." In this situation, the surgeon performing gallbladder US might therefore facilitate early diagnosis and treatment.

CONCLUSION

This study has demonstrated that a general surgeon can perform a US for acute cholecystitis with a high degree of accuracy. Although surgeons are not specialists in sonography, they may use it as an adjunct to their surgical practice in acute cholecystitis.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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