Brief Report

Contrast-enhanced ultrasonography to diagnose gallbladder perforation

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A R T I C L E  I N F O

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A B S T R A C T

Aim: The purpose of this study was to evaluate contrast-enhanced ultrasonography (CEUS) as a modality for diagnosing perforation of the gallbladder (GB) and pericholecystic hepatic abscess.

Methods: This retrospective study comprised 6 patients with acute cholecystitis and GB perforation plus pericholecystic hepatic abscess who underwent conventional US and CEUS imaging. The following sonographic features were examined: GB contour, defect in the GB wall, and pericholecystic hepatic mass. The findings of conventional US and CEUS were compared.

Results: Conventional US revealed a defect in the GB wall in 2 patients and partially obscured GB wall in 4 patients. Pericholecystic masses were visualized as isohypoechoic masses in 3 and mixed cystic-solid masses in 3 patients. Contrast-enhanced US revealed hyperenhancement of the GB wall during the early arterial phase, and a defect was seen in every patient. The pericholecystic masses showed heterogeneous enhancement with a honeycomb-like appearance during the arterial phase—interpreted abscesses.

Conclusion: Contrast-enhanced US clearly visualized defects in the GB wall and pericholecystic abscesses in patients with GB perforation. The results indicate that CEUS is a useful modality for the diagnosis of GB perforation.

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1. Introduction

Gallbladder (GB) perforation is a rare complication of acute cholecystitis and has high morbidity and mortality rates. Early diagnosis and immediate surgical therapy are usually needed to reduce the risk of death. However, the symptoms of GB perforation are usually nonspecific. Although ultrasonography (US) is considered to be the best modality for the diagnosis of GB disease with high sensitivity, the US findings of GB perforation are different because the site of perforation, size of the defect, and duration of disease differ. Therefore, the preoperative diagnosis of GB perforation can often be difficult. Contrast-enhanced ultrasonography (CEUS) is a new technique that has been reported to be useful for differentiating between malignant and benign disease of the GB [1]. Here, we report on 6 patients with GB perforation confirmed by surgery for whom CEUS clearly revealed the site of perforation and the pericholecystic hepatic abscess. To the best of our knowledge, this is the first report on the utility of CEUS for the diagnosis of GB perforation with pericholecystic hepatic abscess.

2. Materials and methods

2.1. Patients

From March 2008 to May 2010, 134 patients with GB disease underwent conventional ultrasonography, color Doppler ultrasonography (CDUS), and CEUS examinations. Six of these patients were ultimately confirmed by surgery to have GB perforation complicated with adjacent liver abscess. Four patients were women and 2 were men, with a mean age of 60.3 years (range, 56-65 years). They presented to the emergency department of our hospital with acute right upper quadrant abdominal pain. Four patients had a history of cholecystolithiasis, 2 patients had fever, and every patient had an elevated white blood cell count. The study was approved by the Ethics Committee of our hospital, and written informed consent was obtained from all patients before CEUS.

2.2. US and CEUS

Ultrasonographic and CEUS examinations were performed using a GE LOGIQ-9 ultrasonography system and Toshiba APLIO ultrasonography system, which were equipped with harmonic contrast pulse sequencing technology and a corresponding C2-4 transducer. SonoVue (Bracco SpA, Milan, Italy) was used as the contrast agent; 2.4 mL of SonoVue was administered as a bolus injection via an antecubital vein, immediately followed by a 5-mL bolus of saline solution. Because
the GB is only supplied by the cystic artery, the enhancement process was divided into an arterial phase (0 to 30 seconds after contrast agent injection) and venous phase (starting 31 seconds after contrast agent injection) [2]. Each patient underwent an examination of the GB and the adjacent liver under conventional US in the advance of CEUS. The procedures were conducted by 2 investigators both with at least 5 years of experience in performing US examinations and 2 years of CEUS examinations. They were unaware of the clinical dates and other imaging findings when they did the US examination.

2.3. Image analysis

Conventional US included the following: determining GB contour and wall thickness, and whether there was a defect in the GB wall, cholelithiasis, collection of pericholecystic fluid, or pericholecystic hepatic mass. A pericholecystic mass was further assessed for heterogeneity or homogeneity and for blood flow within the mass using CDUS.

Contrast-enhanced US determined the enhancement time of the GB wall and whether the GB wall was intact or contained a defect. The enhancement of any pericholecystic hepatic mass was compared with the enhancement of normal adjacent hepatic parenchyma and classified as hyper-, iso-, hypo-, or nonenhancement. The mass was further assessed for heterogeneity or homogeneity.

3. Results

3.1. Conventional US findings

Conventional ultrasonography revealed an irregular, thickened GB wall, ranging in thickness from 0.40 to 0.60 cm, in 6 patients. Two patients had defects in the GB wall, located in the fundus of 1 patient and in the GB body of the other. The GB walls in the other 4 patients were partially obscured. A heterogeneous mass adjacent to the GB bed was seen in all 6 patients. The pericholecystic mass appeared as a mixed iso-hypoechoic mass in 3 patients and a mixed cystic-solid mass in 3 patients, and the margins of all masses were obscured. None of the masses were found to have blood flow on CDUS. The mean maximal diameter of the masses was 4.02 ± 1.24 cm (range, 3.4-6.5 cm). Five patients had cholecystolithiasis, and 3 patients had a collection of pericholecystic fluid, ranging in diameter from 2.9 to 3.6 cm. On conventional US, 2 patients were diagnosed with GB perforation, 2 patients were suspected of having GB perforation, and 2 patients were indefinite for GB perforation and malignancy could not be excluded.

3.2. CEUS findings

All 6 patients underwent CEUS examination to confirm the diagnosis. Enhancement of the GB wall began at 13 to 18 seconds. A hyperenhanced “hyperechoic line” appeared during the early arterial phase before enhancement of the hepatic parenchyma. In every patient, the “hyperechoic line,” which was considered to be the wall of the GB, became discontinuous during the arterial phase, indicating a defect in the wall (Fig. 1). In 4 patients, the defects were located in the fundus; and in 2 patients, the defects were at the former wall. The sizes of the defects ranged from 0.4 to 0.8 cm. The pericholecystic masses appeared heterogeneous, with mild hyperenhancement and some areas of nonenhancement during the arterial phase, resulting in a honeycomb-like pattern (Fig. 2). Each mass appeared continuous with the GB through the defect in the wall. All the 6 patients were finally diagnosed as having perforation, and the malignant tumors were excluded by CEUS. Instant emergency operations were performed on all the 6 patients.

3.3. Pathological findings

Every patient underwent cholecystectomy with subsequent confirmation of GB perforation plus hepatic abscess.

4. Discussion

Gallbladder perforation is rare; most often, it is associated with acute cholecystitis and cholelithiasis. Two percent to 15% of patients with acute cholecystitis develop GB necrosis or perforation, which is attributed to bacterial infection, obstruction of the cystic duct, or
characteristic conventional US findings associated with these categories include the following: type I appears as a defect or “hole sign” in the GB wall, with pericholecystic effusion; type II appears as partially obscured GB wall and a pericholecystic mass; and type III appears as an intracholecystic gas echo. The definitive diagnosis of GB perforation is observation of a defect or “hole sign” in the GB wall; however, computed tomography and US have detected GB wall defects in less than 70% of cases [3,8]. Thus, the value of preoperative US for diagnosis is limited, especially when perforation is accompanied by a secondary hepatic abscess. Ultrasoundography reveals a heterogeneous pericholecystic mass, which is hard to distinguish from hepatic lesions. Therefore, the diagnosis of GB perforation is most often suspected from indirect imaging findings, such as thickening of the GB wall and a collection of pericholecystic fluid. Accurate diagnosis of a defect in the GB wall thus remains challenging.

Contrast-enhancement agents are administered intravascularly. Contrast-enhanced US is the only imaging technique that allows continuous, dynamic, real-time observations and accurate identification of blood flow to an organ or tumor. Because CEUS allows visualization of the feeding vessels to lesions and perfusion of blood, it overcomes the shortcomings of CDUS, which cannot depict tiny blood vessels and low-velocity flow. Because CEUS can distinguish tumor from sludge, it has recently been used to evaluate cholecystic disease [1,9,10].

In most patients with GB perforation, because of the adhesion of the omentum to tissue surrounding the GB, the walls appeared vague; and the locations and sizes of the perforations were difficult to identify on conventional US. However, with CEUS, the GB wall in the early arterial phase appeared hyperenhanced, as a “hyperechoic line,” compared with the surrounding hepatic parenchyma. Therefore, the GB wall could be seen in a higher proportion of patients. In this study, the GB wall defect was detected by CEUS in all 6 patients, whereas conventional US detected it in 2 patients. Contrast-enhanced US was therefore more accurate for the diagnosis of GB perforation than conventional US.

Type II GB perforation is the most common perforation [11,12]. The US findings of pericholecystic abscess have been reported to be nonspecific, often appearing as a hypoechoic or mixed echoic mass on US. Definitive diagnosis is usually difficult because the imaging findings can be undistinguishable from liver or GB tumors. Along with contrast-enhanced computed tomography and enhanced magnetic resonance imaging, CEUS can display blood perfusion and the vessels of the lesion and can be used to distinguish malignant from benign lesions.

In several reports [13-16], liver abscesses had characteristic features on CEUS; during the arterial phase, they had a honeycomb-like appearance with heterogeneous enhancement and multiple septa and a few areas of nonenhancement. This pattern of enhancement was seen to occur in approximately 94% of patients with liver abscess, but could not be detected on routine US.

The internal pathologic changes of liver abscesses were more clearly displayed after injection of a contrast agent. Contrast-enhanced US could clearly show the margin of a liver abscess, along with internal necrosis, which is difficult to identify on conventional US if the necrotic area is not completely liquefied. In this study, CEUS showed 3 of 6 pericholecystic masses appearing as mixed cystic-solid echoic masses and 3 as solid echoic masses; and all 6 masses had areas of cystic necrosis.

In conclusion, the contrast agent of ultrasonography is a blood-pool contrast agent that is excreted respiratorily and does no harm to the liver and kidney. The allergy test is not required. Contrast-enhanced US can be easily performed at the bedside in the emergency department and be repeated without exposure to radiation. Because CEUS clearly depicts disruption of the GB wall at the site of perforation, in addition to any accompanying pericholecystic hepatic abscess, it may be more accurate than conventional US for the
diagnosis of GB perforation. Therefore, CEUS may be the preferable imaging option for the initial evaluation of patients suspected to have GB perforation. However, our study has some limitations; the sample size was small and did not compare with GB malignancy and other imaging diagnoses. Because this is a preliminary study of CEUS in diagnosing the GB perforation, the findings of malignant and other benign GB diseases on CEUS were not described. In addition, a prospective study is needed to testify CEUS accuracy for the diagnosis of GB perforation.

References


