

The combined role of intravenous contrast enhanced ultrasound (CEUS) and computed tomography (CT) in liver abscess diagnosis

D. Feier¹, M. Socaciu¹, O. Anton², N. Al Hajjar³, R. Badea¹

¹Ultrasound Department, "Octavian Fodor" Regional Institute of Gastroenterology and Hepatology, "Iuliu Hațieganu"

²Radiology Department, "Octavian Fodor" Regional Institute of Gastroenterology and Hepatology, "Iuliu Hațieganu"

³Surgery Department, "Octavian Fodor" Regional Institute of Gastroenterology and Hepatology, "Iuliu Hațieganu"
University of Medicine and Pharmacy, Cluj-Napoca, Romania

Rezumat

Rolul ultrasonografiei optimizate cu contrast intravenos (CEUS) combinat cu examenul computer-tomografic (CT) în diagnosticul abceselor hepatice

Scopul studiului: Prin intermediul acestui studiu dorim o trecere în revistă a principalelor aspecte ultrasonografice (CEUS) și CT utilizând substanța de contrast, urmărind suprapunerea experienței noastre cu datele din literatură.

Material și Metodă: În perioada iunie 2008 – decembrie 2010 am evaluat în departamentul nostru o serie consecutivă de 11 pacienți cu abcese hepatice (7 de sex masculin, 63.63%), cu vârste cuprinse între 45 și 74 de ani, cu un tablou clinic și biologic sugestiv pentru un proces inflamator. Diagnosticul imagistic s-a stabilit în urma examinării CEUS și confruntarea imaginilor cu computer-tomografia.

Rezultate: Pacienții incluși în studiu au prezentat o vârstă medie de 54.8 ani (Interval de confidență, IC:46-70). La zece dintre cei 11 pacienți incluși în studiu am evaluat un număr de 14 abcese hepatice. Un singur pacient a prezentat leziuni diseminate în ambii lobi hepatici, fiind evaluate ca microabcese hepatice. Trei pacienți au prezentat leziuni multiple la nivelul lobului drept, 7 pacienți au prezentat leziuni unice iar un pacient a prezentat leziuni diseminate în ambii lobi. Am examinat 6 abcese mature, 4 leziuni în curs de formare și 4

leziuni imature. Toate leziunile au fost depistate atât CT cât și CEUS cu aceeași acuratețe.

Concluzii: Este realizată o clasificare a abceselor hepatice folosind tehnica CEUS care ar putea avea utilitate în selecția tipului de terapie.

Cuvinte cheie: abces hepatic, ultrasonografie, computer-tomografie, contrast

Abstract

Background and aims: Through this study, we intend to review the main aspects regarding the contrast enhanced ultrasound evaluation of liver abscesses, pursuing a comparative analysis between the medical literature and our own experience.

Material and Methods: From June 2008 until December 2010 we have evaluated in our department a consecutive series of 11 patients with liver abscesses (7 males, 63.63%) all between the ages of 45 and 74. All the patients displayed a clinical and biological picture leading to an inflammatory process. The imaging diagnosis was made after confronting the results of the contrast enhanced ultrasound with those of the computed tomography.

Results: In 10 out of 11 patients that were part of the study, we have assessed 14 liver abscesses. A single patient showed spread lesions inside both liver lobes, and they were assessed as hepatic micro abscesses. Three of the patients showed multiple right lobe lesions, 7 patients showed single lesions and one patient showed disseminated lesions within both lobes. We examined six mature lesions, 4 lesions with incomplete necrosis and 4 immature lesions, with no necrosis. The particular aspect of mycotic microabscesses is mentioned at the conventional ultrasound and at the CEUS as well.

Corresponding author:

Radu Badea, M.D.
Ultrasound Department
"Octavian Fodor" Regional Institute
of Gastroenterology and Hepatology
Croitorilor street 19-21, 400.162, Cluj-Napoca
România
E-mail: rbadea@umfcluj.ro

Conclusion: Various types of hepatic abscesses have different imaging findings, and typical CT and CEUS findings can suggest the diagnosis.

Key words: liver abscesses, ultrasound, computer-tomography, contrast-enhanced

Introduction

Liver abscesses are a severe, progressive entity, with a high risk of developing into sepsis and liver failure, described as single or multiple circumscribed lesions, most commonly placed inside the right lobe and caused by various germs, mainly bacteria, but also fungi (1,2).

During the past few decades, the newly discovered diagnosis and treatment methods have changed both the evolution, as well as the consequences of this illness, which still continues to pose a threat, even though significant progresses have been made (3).

Ultrasound (US) and computed tomography (CT) are used as first intention diagnosis methods when patients with this pathology are concerned (4). Computed tomography is a great accuracy diagnosis method, due to the high resolution obtained after intravenously injecting the contrast, but at the same time it is not recommended when the patient has an allergy to iodine containing substances or renal insufficiency (5). When there is a significant acoustic impedance difference from the surrounding hepatic parenchyma, the conventional ultrasound can find mm 20 abscesses or bigger (6). Optimising the conventional ultrasound using contrast agents (CEUS) will increase the efficiency of the conventional ultrasound, giving a real-time evaluation of the abscess's architecture, detecting the possible septum and collections, aspects that will be fundamental to the therapeutic conduct (surgical drainage versus antibiotic treatment) (7). CEUS has also proven to be useful for diagnosing smaller abscesses, which conventional ultrasound could not find (8).

Through this study, we intend to review the main aspects regarding the contrast enhanced ultrasound, pursuing a comparative analysis between the medical literature and our own experience.

Subjects and Method

From June 2008 until December 2010 we have evaluated in our department a consecutive series of 11 patients with liver abscesses. Seven of these patients were male, and four of them were female, all between the ages of 45 and 74. All the patients displayed a clinical and biological picture leading to an inflammatory process. The imaging diagnosis was made after confronting the results of the contrast enhanced ultrasound with those of the computed tomography. At the same time, we have been monitoring the presence of surrounding inflammatory phenomena, peritoneal collections, or angiocholitis. Ten of the patients (90.9%) had curative surgeries, and

one patient had a percutaneous drainage because of the spread micro abscesses, with antibiotic monitoring.

Ultrasound examination

The ultrasound examination was performed by two experienced examiners. It was performed on a GE Logiq 7 ultrasound system, using the 1.5-5 Mhz transducer. CEUS investigation was made at a low acoustic power (mechanical index < 0.12), after injecting a second generation contrast agent, SonoVue (Bracco, Milano, Italy). We injected 1.6 ml contrast agent, and afterwards a 10 ml saline solution. During the examination we used GE Logiq 7's contrast software, in Pulse-inversion mode. The examination was dynamic, monitoring the hepatic area of interest in arterial, portal and late, parenchymal phases. The information was saved as video clips, which allowed subsequent image analysis and post-processing. The main ultrasound features, both in grey scale, as well as post-contrast, were reviewed according to the EFSUMB handbook (8).

CT Examination

In order to perform CT examinations of the liver abscesses, we used spiral native and post-contrast scans on a 16 detectors multi-slice system (Siemens Somatom Emotion 16). Therefore, we obtained for interpretation 3 mm axial slices and we made pre and post-contrast coronal and sagittal reconstructions. There has also been an automated injection of 1.5 mg/kg non-ionic iodinated contrast agent (Optiray), and we made acquisitions in both arterial and venous phases, with timing adjustments in accordance with the abdominal aorta filling time.

The diagnosis criteria for liver abscesses were the presence of single or multiple focal lesions, heterodense both native, but especially post-contrast, the presence of gas within, the hidroaeric or liquid-liquid, severe peripheral levels of iodide in arterial phase, associated or not with hepatic circulation adjustments and early contrast washout in venous phase (10). We measured the lesions and we marked the necrotic areas, as well as the relations with the bile ducts, the vessels or the hepatic capsule.

Results

There were 11 patients who participated in the study, with an average of 54.8 years (Confidence Interval, CI:46-70), who were investigated using ultrasound and CEUS, the diagnosis being completed by computed tomography investigation.

In 10 out of 11 patients that were part of the study, we have assessed 14 liver abscesses. A single patient showed spread lesions inside both liver lobes, and they were assessed as hepatic microabscesses.

On an etiological basis, 6 of the patients were ascendingly contaminated, consequential to an angiocholitis; three of the patients developed abscesses by hematogenous dissemination consequential to a colonic diverticular illness, while two of the patients developed the abscesses consequential to a post-cholecystectomy surgical intervention. Three of the patients

showed multiple right lobe lesions, 7 patients showed single lesions and one patient showed disseminated lesions within both lobes.

The patients showed a suggestive clinical picture in all cases, with inflammatory syndrome, leukocytosis (9 cases), anemia (7 cases), hyperbilirubinemia and increase of the alkaline phosphatase (4 cases), with hepatic tests modifications (11 cases).

The blood cultures could not identify the germ involved in the infectious process. The microbial etiology was relevant just in that one case when the patient had a percutaneous drainage, thus marking out fungal cultures (*Aspergillus*). In all the other cases, the cultures were analyzed after establishing the antibiotic treatment, and the pathological germ could not be marked out.

The main features that described lesions of the patients participating in the study are shown in *Table 1*.

The lesions had various dimensions, from 14.34 mm to 54.4 mm, round or oval shaped and irregular edges. At the conventional ultrasound examination, six lesions showed complete central necrosis, without septum on the inside, being considered mature abscesses. The Doppler examination showed an aggravation of the arterial vascular signal (*Fig. 1A*).

CEUS examination showed perilesional early enhancement in arterial phase, with contrast agent washout in portal and late phase. An intensification of peripheral arterial circulation was highlighted. (*Fig. 1B, Fig. 1C*).

CT confirmed the presence of heterodense both native, but especially post-contrast focal lesions, without gas or hidroaeric level within, with a severe peripheral level of iodide in arterial phase, associated with hepatic circulation adjustments and early contrast washout in venous phase (*Fig. 2A, Fig. 2B, Fig. 2C*).

Regarding the incomplete necrosis abscesses (4 lesions), US revealed an alteration between the areas of liquefaction

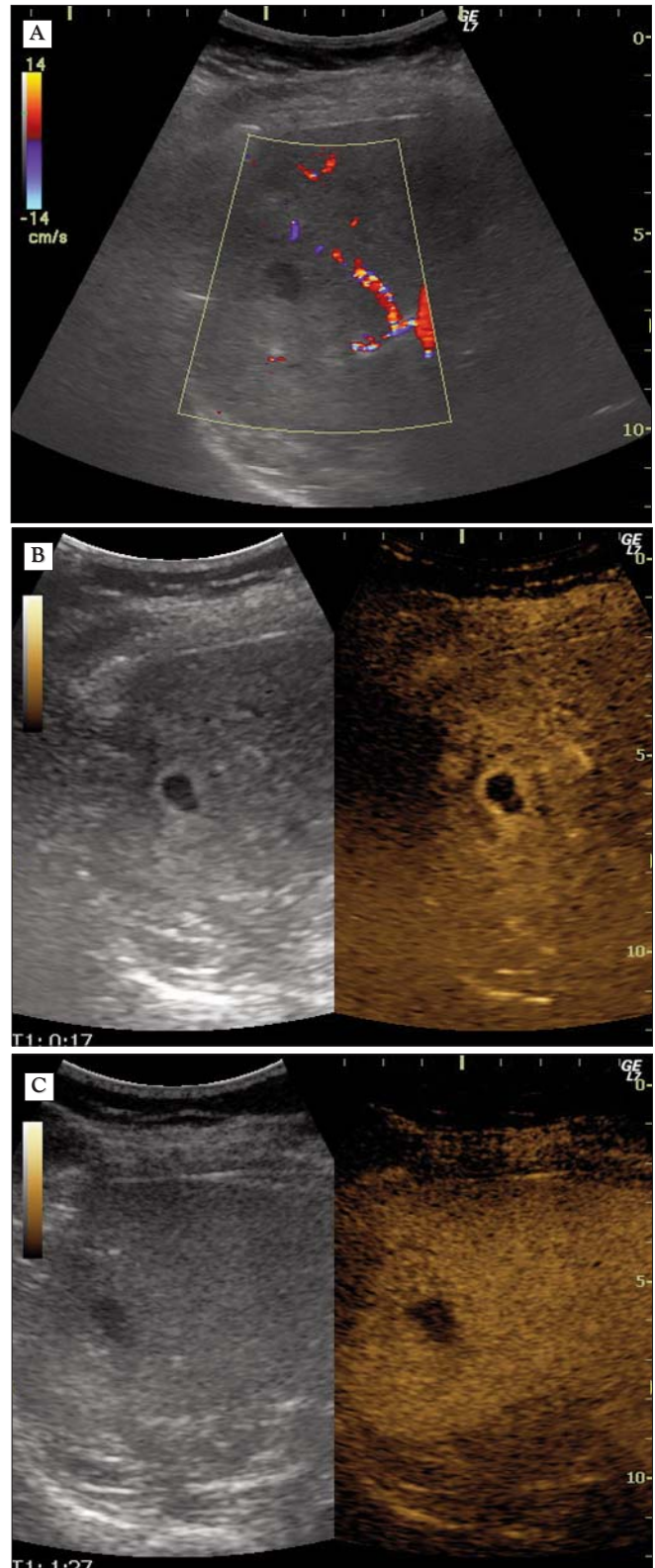


Figure 1. CEUS examination. "Mature" liver abscess. Heterogeneous lesion with exacerbation of Doppler signal on B-mode US (A) with perilesional enhancement at CEUS, no central collection and increased hepatic circulation during arterial phase (B) and early washout in venous phase (C)

Table 1. The main characteristics of liver abscesses included in the study

General characteristics		No of liver abscesses (%)
Location	Right lobe	12 (85.7%)
	Left lobe	1 (7.15%)
	Both lobes	1 (7.15%)
Etiology	Pyogenic	13 (92.5%)
	Mycotic	1 (7.15%)
Abscesses	Single	7 (71.5%)
	Multiple	4 (28.5%)
US characteristics		
Dimensions (Median, CI) (mm)		34.37 (14.34 – 54.4)
Shape	Round	4 (28.5%)
	Oval	10 (71.5%)
Borders	Well defined	8 (57.14%)
	Irregular	6 (42.86%)
Central necrosis		6 (42.86%)
Intralesional septa		4 (28.5%)
Portal vein thrombosis		2 (14.3%)

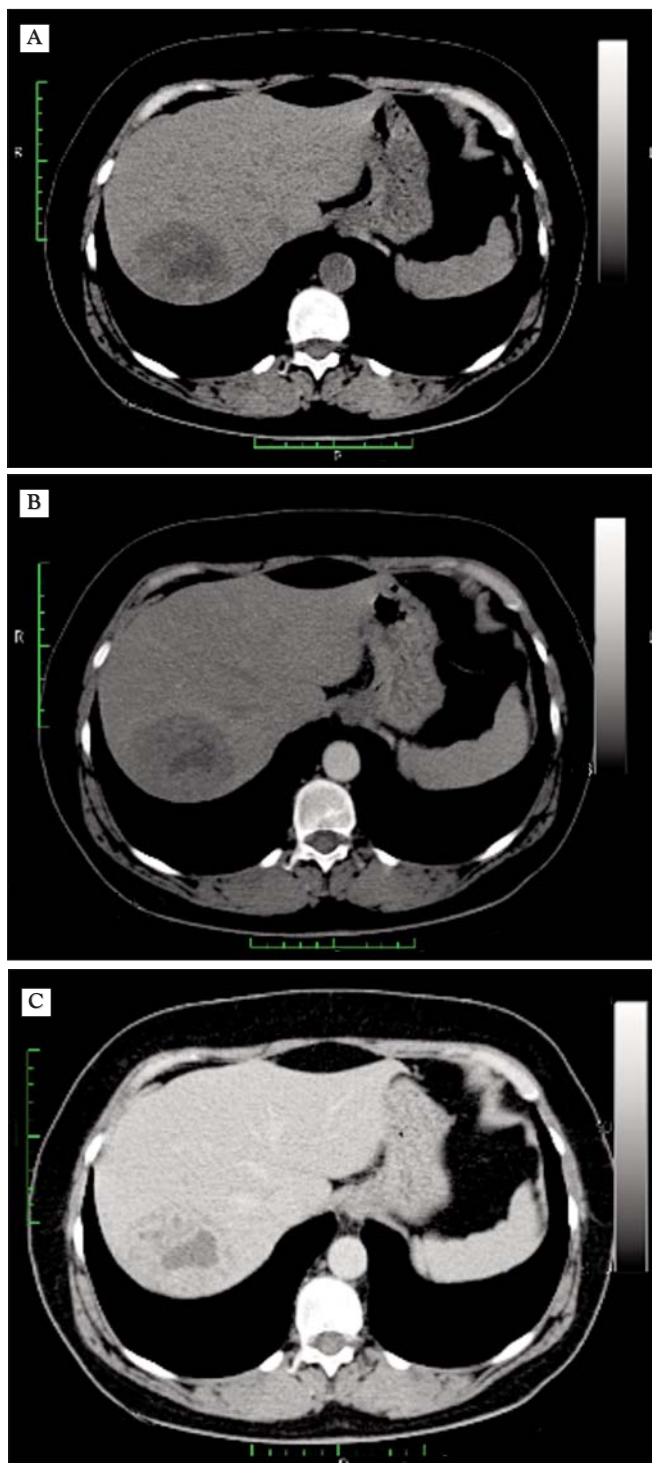


Figure 2. CT examination – axial section. Heterogeneous lesion both native (A) and post contrast, with intense peripheral enhancement in arterial phase (B), changes in hepatic circulation and early washout in venous phase (C)

and the areas of undignified parenchyma with intralesional septum (Fig. 3A).

CEUS showed early perilesional and intra-septal contrast agent intake within arterial phase, with isoechoic septum within the venous and washout phase, and with hypoechoic septum in the late phase (Fig. 3B, Fig. 3C).

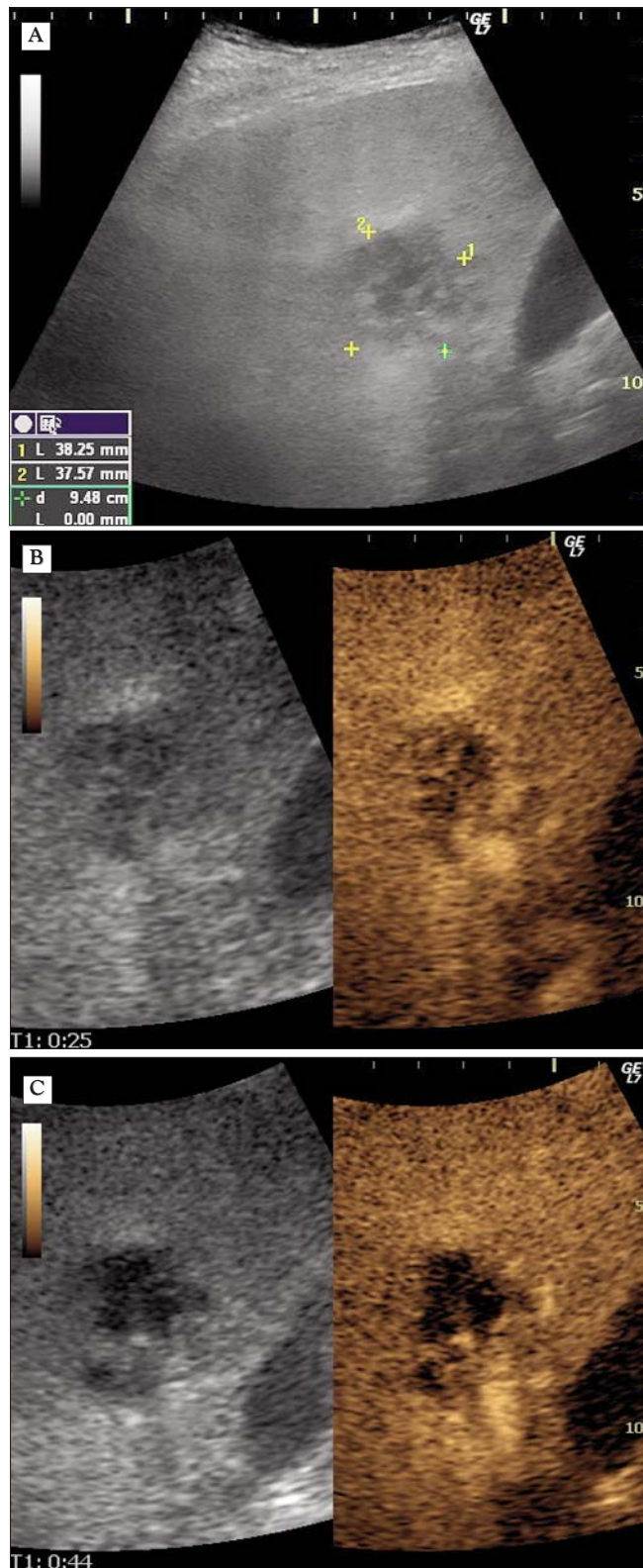


Figure 3. CEUS examination. Liver abscess with incomplete necrosis – round pericolecistic lesion, with multiple septa on B-mode US (A); at CEUS, the arterial phase has mild perilesional and septa enhancement (B) and early intralesional washout in venous phase (C)

As a result of CT examination, during the native phase the heterodense lesions showed an alteration of the hepatic structure, with a suspicion of lesion (Fig. 4A) and a severe peripheral and septal enhancement, with early washout during the venous phase (Fig. 4B).

The lesions without significant liquefaction showed a hypoechogenicic assemblance (Fig. 5A).

The Doppler examination showed an enhancement of the intra and perilesional signal. Using the contrast agent, the ultrasound showed two subcapsular and peri-gallbladder lesions within the right lobe, with early intake during the arterial phase, and with washout starting from the venous phase and continuing until the late, parenchymal phase. CEUS also showed an intensified perilesional parenchyma intake during the arterial phase (Fig. 5B, Fig. 5C). The CT examination revealed heterodense lesions, barely visible with native examination (Fig. 6A), but with peripheral and intralesional intense enhancement during the arterial phase (Fig. 6B), related to changes in hepatic circulation and early emptying of the contrast within the venous phase (Fig. 6C).

The ultrasound aspect of the mycotic abscesses was dominated by hepatomegaly, a non-homogenous echo structure with a nodular aspect and increased echogenity, with a highly increased level of the arterial circulation for the entire parenchyma (Fig. 7A).

CEUS revealed a circumscribed, multicentric form with multiple 2-3 cm nodular formations, spread within both lobes. The lesions that were spread within both lobes of the liver showed intense perilesional parenchyma inhancement during the arterial phase, with early washout during the venous phase (Fig. 7B, Fig. 7C).

Discussions

Liver abscesses represent a small incidence pathology (5 to 13 cases once every 100.000 hospitalized patients) (4), but also with a certain stability when considering large scales. Therefore, in 1938, Ochshner showed an incidence of 8 out of 100.000 hospitalize patients (11), while Rubin showed in 1974 an incidence of 16 out of 100.000 hospitalized patients (12).

Nowadays, the most common cause for liver abscesses (30-50%) is the ascending biliary infection, caused by choledochal obstruction (lithiasic, neoplastic or iatrogenic-obstruction of a biliary – digestive anastomosis) and secondary cholangitis (13, 14). Pathogenically speaking, the current case-studies revealed as main cause the hematogenous ascendant infection, secondary to angiocholitis, or as a consequence of a highly-infected diverticular disease.

The patients that participated in the study showed a clinical picture suggesting a septic state. The infectious pathology was suspected based on the clinical signs and the data from the laboratory, and confirmed by imagistic data.

The role of conventional ultrasound in the diagnosis of focal lesions has been reported on numerous occasions (15, 16). The right diagnosis can be quite a challenge because of the imagistic aspect's variation in time, closely related to the

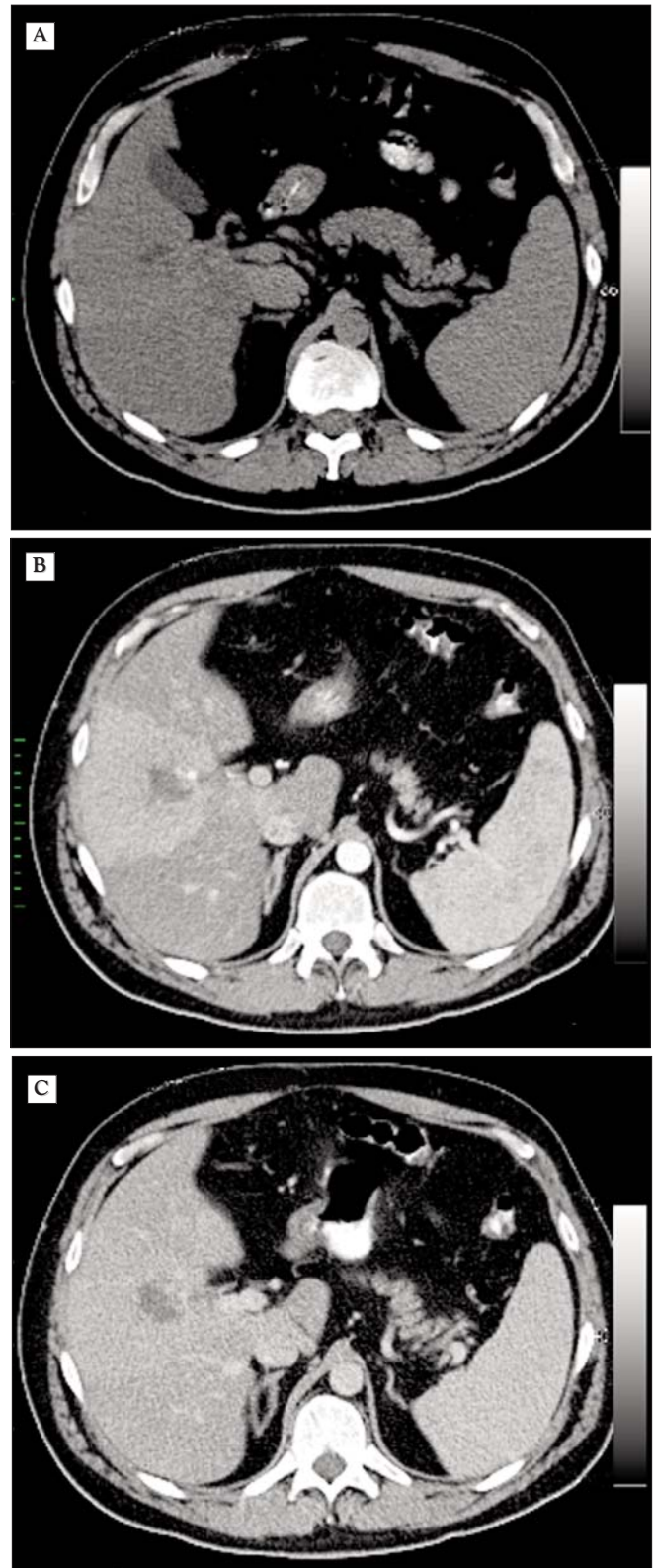


Figure 4. CT examination of a liver abscess with native heterodense lesion (A), with early perilesional and septa enhancement in arterial phase (B) and washout in venous phase (C)

evolution of the abscess and of the accompanying pathologies as well (17,18).

The ultrasound aspect herein described was dependent

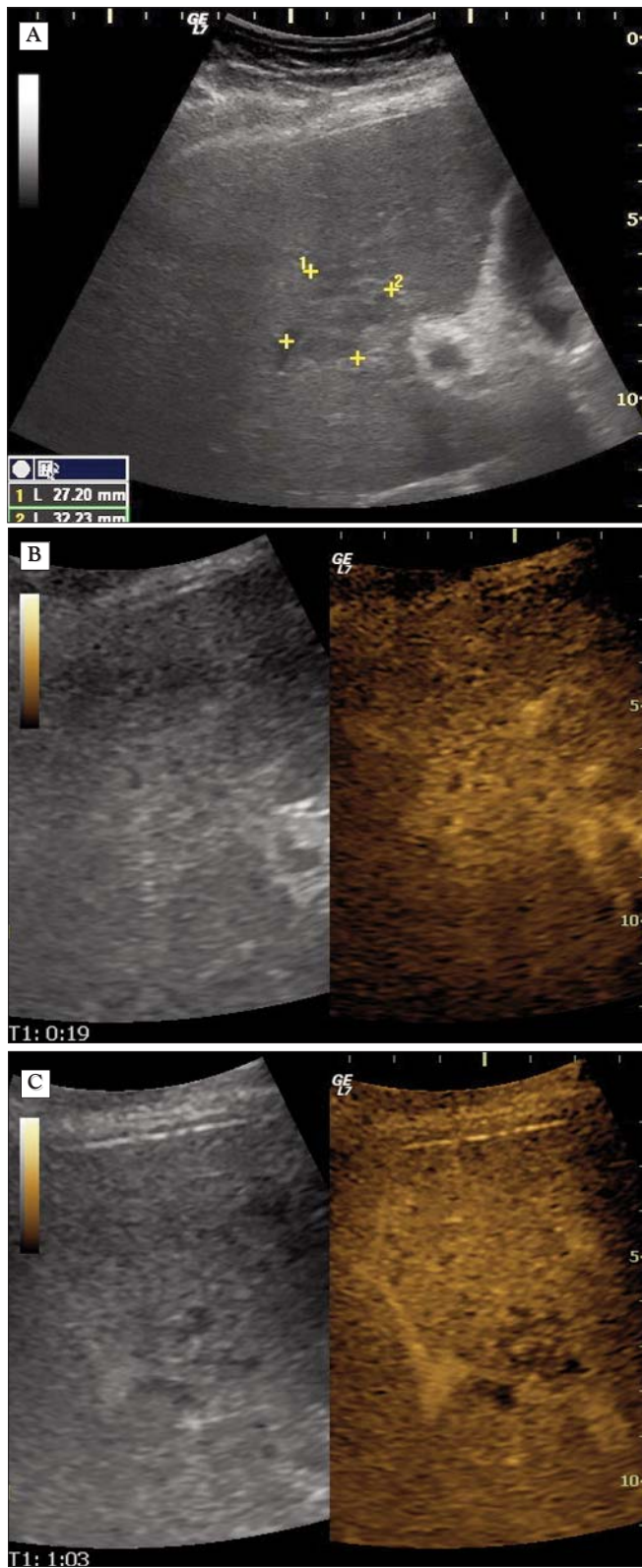


Figure 5. CEUS examination. Liver abscess without areas of central necrosis - hypo echoic lesion on B-mode US (A) with intralesional enhancement and increased arterial vascularisation in arterial phase (B) and venous phase washout (C)

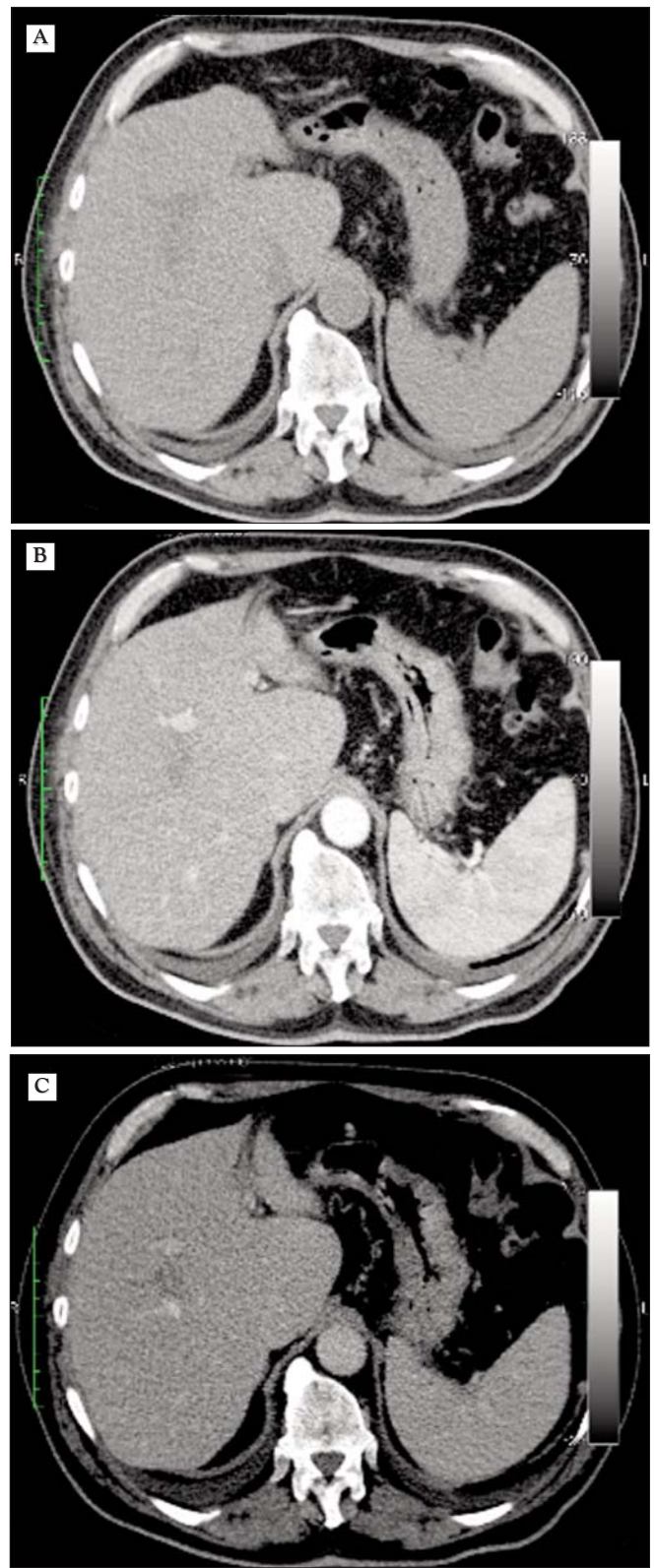


Figure 6. Axial CT sections - heterodense lesion (A) intense intralesional enhancement without areas of necrosis with increased arterial circulation (B) and venous phase washout (C)

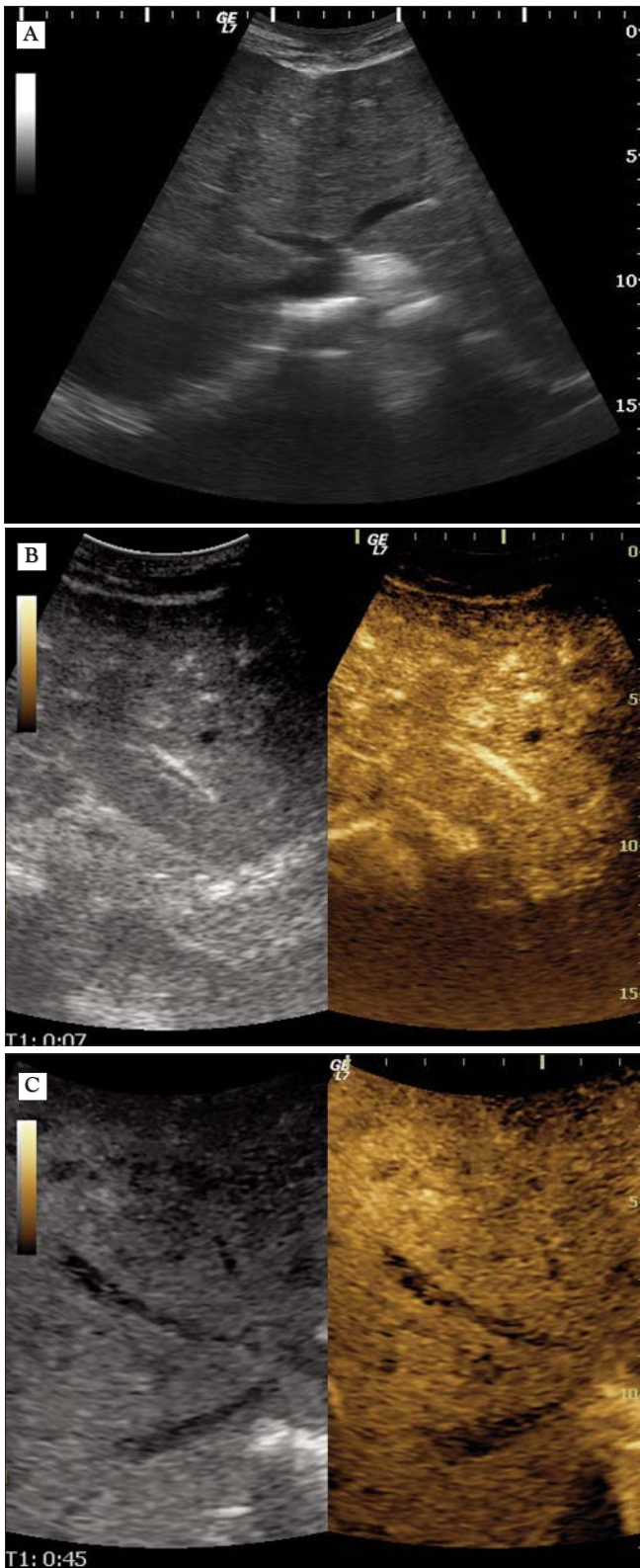


Figure 7. Mycotic abscesses – US examination. (A) B-mode US with a inhomegeus apearence and increased echogenity, with a highly increased level of arterial circulation of the entire parenchyma. CEUS examination with intense perilesional parenchyma enhancement during the arterial phase (B) and early washout during the venous phase (C)

to the nature and evolutionary stage of the abscess. The lesions that we have detected in an early stage displayed a parenchymal area semblance, slightly more echogenous, weakly and irregularly delimited. The vascular signal was highly increased inside as well as in the vicinity of the parenchymal area. Those abscesses that we have detected in a mature phase formed a rather well delimited collection. The content was hypoechogenous or transonic, with an acoustic hardening effect. We performed the next examination using CEUS, and then we had the diagnosis confirmed by the results of the CT examination.

The detection and the quantification of the liver abscesses using CEUS can be done with a high level of diagnosis accuracy (9,19). In order to avoid the destruction of the bubbles, we used a low mechanical index (8), thus making possible the tracking of all vascular phases that the contrast agent went through: from the arterial phase (15-30 seconds after injecting the agent), portal phase (30-120 seconds after injecting the agent) and the late, parenchymal phase (20,21,22).

The nature of the abscess: characterization. The main feature that contributed decisively to the way abscesses were classified, was the intake method: peripheral, central and perilesional (23). When using CEUS, the dominant aspect of the liver abscesses was that of a lesion with partial intake, with perilesional ring and lack of central intake. The most commonly encountered element was that of an arterial perilesional circulation enhancement. The CEUS examination allowed the perilesional hyperaemia diagnosis, aspect that was also shown on the CT images. The CEUS examination allowed the diagnosis of the perilesional hyperaemia, aspect that was also revealed by the CT examination. The medical literature explains the peripheral intake - caused by the extended swelling of the Glisson spaces - by the secondary thrombophlebitis emergent in the compensatory portal and arterial bends (8,10).

Procedural performance. Computed tomography gives a good abscess contrast resolution, due to the lesion hypodensity during the venous phase (8). In our series of patients, the CEUS showed diagnosis performances similar to the CT examination. As a criticism, most likely, on larger scales there would be more differences, such as it is stated in the medical literature (21,22). In our case, the high performances were the result of a mixed - ultrasound, clinical and biological - diagnosis criteria. The contrast-specific images showed a lesion well defined from the surrounding undignified parenchyma, with septum well emphasized. This can also be a result of arterial vascular enhancement - both perilesional, as well as intra-septal - within the acute process.

Originality of the research consists in elaborating an abscess classification in accordance with the ultrasound criteria, with great value in therapy coordination. Classifying the abscesses according to the architectural evolution allowed an appropriate decision regarding the therapeutic conduct: broad-spectrum antibiotics treatment, aspiration, percutaneous or surgical drainage, similar to the therapeutic conduct described in the medical literature (24,25). In our patients'

cases, although diagnosed at different moments, the number and location of the lesions lead to surgical drainage; all but one patient, who developed post-cholecystectomy mycotic liver abscesses. This patient had percutaneous drainage for therapeutic and diagnosis purposes, with antibiotic treatment under supervision.

Features. The mycotic microabscesses developed after a surgical intervention for angiocholitis. Liver abscesses with mycotic etiology are rarely described in medical literature (26,27). The medical literature explains their appearance as a complication during the evolution of immune depression syndromes (chymiotherapy, immunodepression, operatory stress, myeloproliferative syndromes) (28,29). Their particular aspect is mentioned at the conventional ultrasound and at the CEUS as well (6). In our patient's case the ultrasound aspect was uncharacteristic, the inhomogeneous echo structure and the clinical picture raised suspicions regarding space replacement lesions with the hepatic parenchyma. The CEUS showed multiple hypoechogenous lesions, without contrast agent intake, suggesting intralesional necrosis and perilesional intake enhancement that indicates the accompanying inflammatory process. The aspect, such as it was described, lead to biopsy percutaneous drainage, which confirmed the liver microabscesses diagnosis.

An initial imagistic evaluation may show an uncharacteristic aspect for any type of abscess, and it may be very similar to hepatic cysts or necrotizing tumors (30).

The differential diagnosis of liver abscesses is to be made first of all with hepatic metastases, and most of the times an ultrasound directed puncture is needed. CEUS has a Sensitivity (Se %) and a Specificity (Sp %) varying between 80-100 % (31), and at the same time, it has a diagnosis value comparable to that of the computed tomography (Se%= 100, Sp%=100) (10).

The features revealed by CEUS were similar to the ones formerly described in the medical literature, as results of ultrasound (28) and computed tomography as well, using liver-specific contrast agents (6).

Our experience, as we have herein analyzed and exemplified, shows a real incidence of liver abscesses in accordance with the medical literature, even though it is based on a smaller number of patients. The confrontation between the results of the ultrasound and those of CEUS allowed a complete evaluation of the patients and also explains the data obtained using CEUS.

Conclusions

The results of the CEUS examination regarding the aspects of the pyogenic abscesses are typical, similar to the results of the CT examination. These contribute to the diagnosis and ascertainment of future therapeutic conduct. The imaging aspects may show specificities, in accordance with the abscess' stage of evolution, liquefaction or etiological level (bacterial or fungi).

We performed a clasification of liver abscesses using CEUS used as a tool in selecting the right therapeutic approach of patients.

Various types of hepatic abscesses have different imaging findings, and typical CT and CEUS findings can suggest the diagnosis.

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