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ORIGINAL ARTICLE

Pitfalls in a Sonographic Diagnosis of Liver Abscess in Children

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Key Words
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Background: The purpose of this article is to identify the pitfalls of sonography in the diagnosis of liver abscesses, hematomas, and hepatic tumors, which appear similar and therefore are difficult to differentiate from each other.
Methods: Cases were collected at the China Medical University Hospital between January 2008 and January 2010. Liver abscesses were initially diagnosed by sonograph in selected patients who were younger than 18 years.
Results: There were 15 patients in whom a liver mass was diagnosed by ultrasound, but 6 of them were excluded from further study because of failure to meet any of the screening criteria. Nine patients with a mean age of 11.3 years (range 5-17 years) were initially suspected to have liver abscesses by ultrasound and were enrolled in the study. These nine patients were identified as follows: five with liver abscess, one with liver hematoma, one with hepatic lymphoma, one with perihepatic abscess, and one with undifferentiated liver sarcoma. Ultrasonography alone was sufficient for diagnosis in five patients. Four patients required abdominal CT scanning to confirm final diagnosis.
Conclusion: Different liver lesions may present sonographic images similar to those of liver abscesses. Therefore, it is suggested that patients in whom liver abscesses were diagnosed by ultrasound undergo further evaluation if the clinical condition is less likely.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; CRP, C-reactive protein; ERCP, endoscopic retrograde cholangiopancreatography; PCD, percutaneous catheter drainage; RUQ, right upper quadrant.

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1. Introduction

Abdominal ultrasound is a common medical procedure to locate abdominal lesions and evaluate gastrointestinal function. Additionally, the procedure will show clear images of the liver. Abdominal ultrasound is used on patients who are clinically suspected of having a liver abscess. The ultrasonic appearance of a typical liver abscess has been described as having the following criteria: acoustic enhancement, abscess wall, peripheral halo, septation, and internal debris.[1,2] However, some intrahepatic lesions, such as a necrotic hepatic tumor or hematoma, could present with a sonographic appearance similar to that of liver abscess. For this reason, we reviewed nine patients' sonographies with presentations similar to that of liver abscess and attempted to identify the pitfalls by any specific features or methods.

2. Materials and Methods

Between January 1, 2008 and January 1, 2010, a retrospective ultrasound-based study of 15 patients younger than 18 years was conducted. These patients were admitted to China Medical University Hospital with an initial diagnosis of liver mass by sonography.

Liver abscess is screened by using the following criteria: acoustic enhancement, abscess wall, peripheral halo, septation, and internal debris.[1,2] Six patients were excluded because of failure to meet any of the screening criteria. Nine of 15 patients, on initial suspicion of liver abscess (meeting at least one of the five criteria), were enrolled in our study. Another imaging study was indicated if the patient's clinical course was not compatible with manifestations of liver abscess (Figure 1). In our study, we chose computed tomography (CT) as the secondary screening tool. However, one of the patients in the unconfirmed liver abscess group had been scheduled for serial ultrasonography instead of CT, because his family informed us of the patient's trauma history in time. The clinical characteristics of these nine patients are recorded in Table 1. Results from their imaging studies, microbiologic and pathologic findings, and blood examinations are presented in Table 2. The mean age was 11.3 years (range 5-17 years). An ultrasound machine (HP Sonos 5500, Stockton, CA, United States) was used with gray-scale ultrasound and 3-5 MHz transducers to examine these patients.

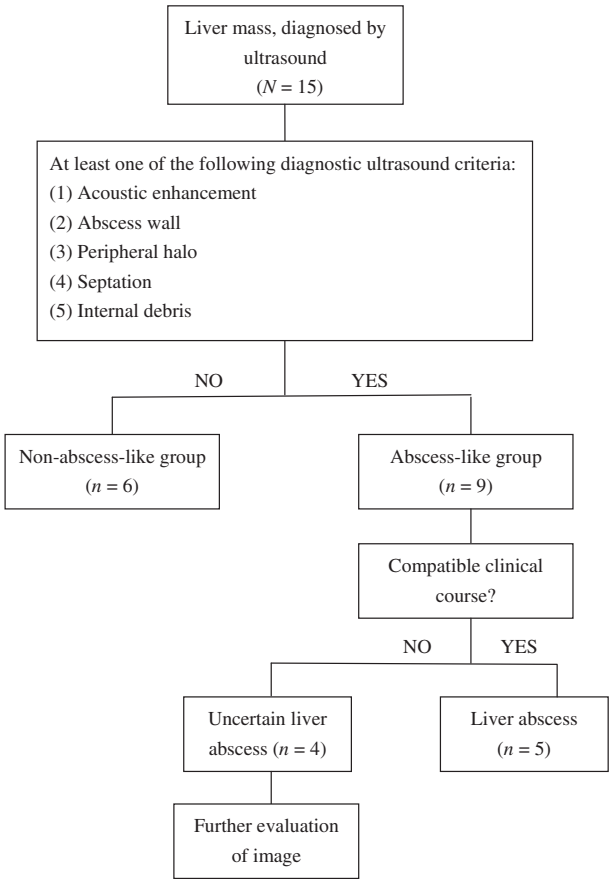

Figure 1 Flowchart for selecting cases.

3. Results

This series comprised five liver abscesses (Figure 2), one liver hematoma, one hepatic lymphoma, one perihepatic abscess, and one undifferentiated liver sarcoma. In all of these cases, sonographic findings demonstrated various degrees of features of liver abscess, as presented in Table 3. Therefore, the tentative diagnosis of liver abscess was made initially. Fever and abdominal pain were the chief complaints (77.8%). Confirmed diagnoses needed to be further proved by CT in cases 5, 6, 7, and 9 due to unusual clinical presentations or imaging findings. Biopsy was performed for cases 6 and 7. The lesion size ranged from 24 mm to 65 mm in diameter on the initial scan. Although diagnostic abdominal CT was not necessary for cases 1, 3, and 4, we still arranged abdominal CT to perform CT-guided percutaneous catheter drainage (PCD).

Hypoechoic masses were present in all nine patients. Four patients revealed homogeneous echogenicity, whereas heterogeneous echogenicity was discovered in five patients. Internal echoes were seen in seven patients; septation was noted in cases 5 and 7.

Six of the nine patients (cases 1, 3, 4, 5, 7, and 9) showed variable degrees of distal acoustic enhancement. Acoustic enhancement was not related to the size or degree of echogenicity of the mass. A sharp echogenic wall was seen in five patients (cases 2, 3, 5, 7, and 9). A peripheral halo was present in cases 2 and 6.

Case 6 was a large B-cell lymphoma with some sonographic characteristics of liver abscess, such as multiple heterogeneous hypoechoic lesions with a peripheral halo (Figure 3A). There was no vascularity noted on color Doppler imaging. According to the patient's history, end-stage renal disease had been diagnosed and the patient had previously received renal transplantation. Because of immunosuppression therapy, which may lead to the possibility of oncogenesis (sirolimus/tacrolimus/mycophenolate: lymphoproliferative disease), abdominal CT (Figure 3B) and biopsy were performed to differentiate diagnosis of hepatic malignancy. The abdominal CT demonstrated multiple hypovascular tumors in the liver and

Table 1 Clinical characteristics of nine patients with suspicion of liver abscess.

Patient/Final diagnosis	Age/sex	Chief complaint
1. Liver abscess	15 y/o M	Fever & RUQ[#] pain for 2 days
2. Liver abscess	15 y/o F	Fever & RUQ[#] pain for 2 weeks
3. Liver abscess	12 y/o F	Fever & RUQ[#] pain for days (AA* s/p BMT[†])
4. Liver abscess	10 y/o M	Fever & RUQ[#] pain for 2 days
5. Liver abscess	11 y/o F	Fever & abdominal pain for 6 days
6. Hepatic lymphoma	11 y/o F	Fever for days (ESRD[§] s/p renal transplant)
7. Liver sarcoma	4 y/o M	Abdominal pain for 2 weeks (TA[‡] 6 months ago)
8. Liver hematoma	7 y/o M	Fever and RUQ[#] pain for 2 days (TA[‡] 3 days ago)
9. Perihepatic abscess	17 y/o M	Fever and epigastralgia for 2 days (CBD[‖] stone s/p ERCP[¶])

*aplastic anemia; [†]bone marrow transplant; [‡]traffic accident; [§]end-stage renal disease; [‖]common bile duct; [¶]endoscopic retrograde cholangiopancreatography; [#]right upper quadrant.

spleen, and the pathologist confirmed the diagnosis of B-cell lymphoma.

Case 7 was a hepatic undifferentiated sarcoma. The sonographic findings included echogenic wall, heterogeneous hypoechoic lesion with septation inside, and acoustic enhancement (Figure 4A). No significant vascularity was seen on color Doppler imaging. These findings were similar to those of a liver abscess. However, persistent abdominal pain and fatigue were noted after days of antibiotic treatment. A final diagnosis of sarcoma was confirmed by pathology. As reviewed, previous trauma history and abscess-like sonography had led to an initial misdiagnosis. However, a normal white blood cell count and C-reactive protein (CRP) level, combined with unusual clinical course refractory to antibiotic treatment, led to doubt of the tentative diagnosis of liver abscess. CT revealed a heterogeneous mass containing multiple cystic spaces separated by hyperdense septations of varying thickness[3] (Figure 4B).

Case 8 was a hematoma, and the sonography was similar to that of a liver abscess initially. Because the patient concealed a traffic accident from us, as many children will do, a liver abscess could not be ruled out initially. In addition, fever, leukocytosis, and abscess-like sonogram were highly compatible with liver abscess presentation. When the family hinted the possibility of trauma, a follow-up abdominal ultrasound on the next day and another 6 days later were performed. Hepatic hematoma was confirmed due to a typical change in the ultrasonic appearance with time (Figure 5).

Case 9 was a perihepatic abscess, probably endoscopic retrograde cholangiopancreatography-related iatrogenic trauma. The lesion was located along the falciform ligament and looked like a liver abscess between the S2 and S4 lobes. While performing CT-guided PCD, we found the abscess located in the perihepatic space (Figure 6A). After PCD, some clear bile-stained fluid was drained and the value of amylase of drainage fluid was low (8U/L). We reviewed the initial sonographic images, which showed a perihepatic lesion communicated with the abscess-like lesion between the S2 and S4 segment (Figure 6B).

4. Discussion

The etiologies of an intrahepatic abscess can have several different causes. The first is intraabdominal sepsis with spread by direct extension and/or portal bacteremia, usually due to appendicitis or diverticulitis. Second, biliary tract disease, such as cholecystitis or ascending cholangitis, can cause intrahepatic abscess. Third, it may be caused by trauma and generalized septicemia with bacterial seeding via the hepatic artery.[4]

Ultrasound imaging is traditionally used as a first-line tool for suspicion of liver abscesses. In addition, it provides the available clinical information in most instances. Ultrasound is the preferred imaging technique for the detection of liver abscess because of its lower cost, noninvasive nature, and availability. Five of the nine patients (55.6%)

Table 2 Laboratory data of nine patients with suspicion of liver abscess.*

Patient	WBC	Neu/Lym	CRP	GOT/GPT	Microbiology	Pathology
1	21,910	85.2/3.9	27.6	32/54	*Streptococcus intermedius*	—
2	12,670	81.7/11	17.9	15/12	Not found	—
3	17,060	90.2/4.3	0.24	24/29	*Aspergillus*	—
4	20,670	73.6/14.8	6.46	62/116	*S. intermedius*	—
5	15,640	72/16.4	18	76/85	*Klebsiella pneumoniae*	—
6	3,470	72.1/16.7	1.02	129/156	—	Large B cell lymphoma
7	5,450	45.7/44	0.22	33/21	—	Undifferentiated sarcoma
8	15,850	59.7/18.4	5.33	65/309	—	—
9	14,720	77.7/12.4	12.51	26/47	*Pseudomonas aeruginosa*	—

CRP = C-reactive protein; GOT/GPT = glutamyl oxaloacetic transaminase/glutamyl pyruvic transaminase; WBC = white blood cell.
* WBC, μl; CRP, mg/dl; GOT/GPT, IU/L.

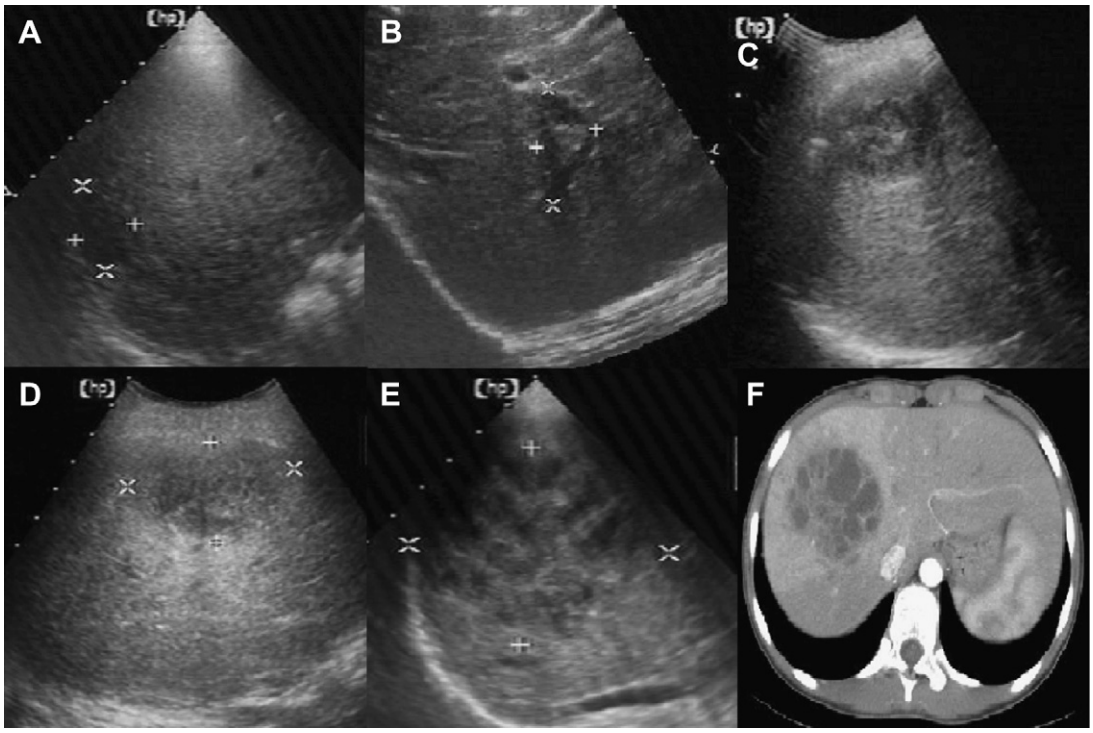

Figure 2 Liver abscesses: (A) Case 1; (B) Case 2; (C) Case 3; (D) Case 4; (E) Case 5; (F) Case 5, CT image.

were correctly identified as having liver abscess initially. The key conditions that must be differentiated from hepatic abscess on ultrasound are necrotic neoplasm, hematoma, and complicated (hemorrhagic or inflammatory) cyst.[5]

The gray scale of sonography in patients with hepatic pyogenic abscess varies with disease progression. During the acute stage, the shape of the lesion is usually irregular. It is composed of an accumulation of neutrophils in an area of liquefaction necrosis of tissues. The echogenicity is variable due to high protein and lipid content or small bubbles of gas. It can be either misdiagnosed as a solid mass or overlooked altogether. During the subacute and chronic stages, extensive fibroblastic proliferation and vascularized connective tissue are present. As abscesses mature, the lesion becomes more rounded and hypoechoic, with debris in the middle and thick walls on the outside. Therefore, wall enhancement usually appears in subacute and chronic abscesses and is generally not visible in the acute inflammatory lesions.[2]

Ultrasonic features of a necrotic hepatic neoplasm, which simulate those of an abscess, include sonolucency, acoustic enhancement (if liquefaction has occurred), and an irregular, echo-poor wall. Moreover, multiple lesions or different echo patterns favor a malignant process.[5]

Case 6 was initially thought to be multiple fungal liver abscess because of sonographic features, which appeared in the form of a multiple bull's eye pattern. According to previous studies,[6,7] lymphomatous involvement of the liver is more often secondary to non-Hodgkin lymphoma, a large B-cell lymphoma in our case, than to Hodgkin lymphoma.[8] The typical sonographic findings of hepatic lymphoma include discrete anechoic or hypoechoic nodules, which were compatible with our case. The peripheral halo is

Table 3 Ultrasound appearances of nine patients with suspicious of liver abscess.

Patient	Size (main part)	Internal echoes	Acoustic enhancement	Wall enhancement	Peripheral halo	Other image study
1	5.01*3.33 cm	—	+	−	−	CT/PCD
2	3.67*2.22 cm	Debris	−	+	+	−
3	4.13*2.85 cm	Debris	+	+	−	CT/PCD
4	5.08*4.32 cm	Debris	+	−	−	CT/PCD
5	6.56*5.08 cm	Septation	+	+	−	CT/PCD
6	2.40 cm	Debris	−	−	+	CT
7	4.93*3.34 cm	Septation	+	+	−	CT
8	6.44*5.13 cm	+	−	−	−	−
9	6.13*4.63 cm	Debris	+	+	−	CT/PCD

CT/PCD = CT-guide percutaneous catheter drainage.

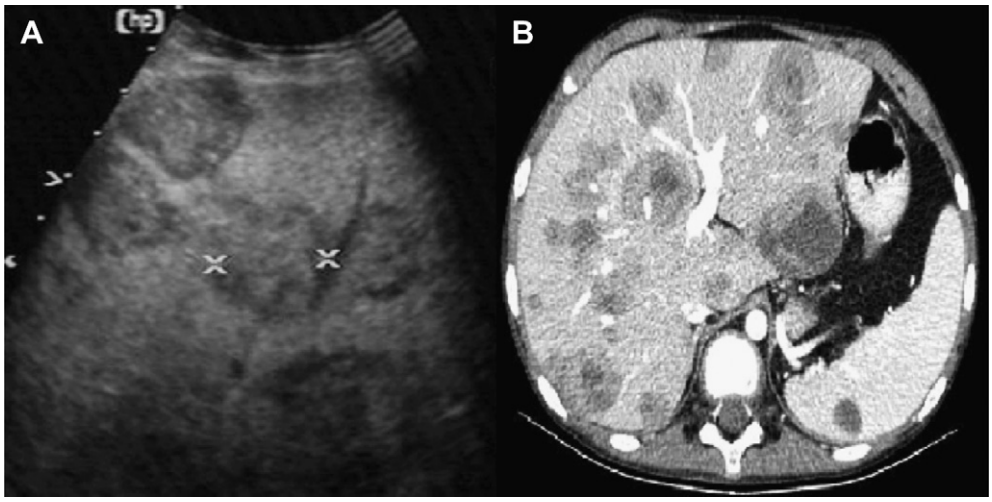

Figure 3 (A) Hepatic lymphoma, case 6: Multiple heterogeneous lesions with peripheral halo and hepatomegaly. (B) CT: Multiple hypoattenuating lesions and rim enhancement.

attributed to an inflammatory reaction and increased blood flow seen in tumors. The thickness of the halos in hepatic abscesses and tumors may be similar.[2] On a sonographic basis alone, it may be difficult to distinguish liver abscesses from lymphomatous metastasis to the liver; therefore, another imaging modality is required.[9,10]

Case 7 showed the typical ultrasound findings of liver abscess, such as internal echoes, acoustic enhancement, and wall enhancement, and confused our tentative diagnosis. In our study, high white blood cell count and elevated CRP were noted in six patients, and one patient had a high white blood cell count without an elevated CRP. Cases 6 and 7 had malignancy without high blood white cell count or elevated CRP. Therefore, whenever abdominal sonography shows liver abscess-like lesions without high white blood cell count or elevated CRP, further evaluations for diagnosis of malignancy should be added.

In case 9, we ruled out the possibility that the intrahepatic abscess had ruptured into the perihepatic area because the drainage fluid is too clear to be like that from an abscess. In this case, we could not differentiate perihepatic fluid from intrahepatic abscess by sonography alone. However, CT more clearly ascertained that the abscess-like lesion was located along with the falciform ligament and communicated with the perihepatic area.

Traditionally the location of hepatic abscess and the patient's cooperation affect the accuracy of ultrasound.[11] However, we cannot be sure that a lesion is an abscess, even when the lesion is compatible with sonographic features of abscess and is located in the S4 or S5 area where there is a relatively easier ultrasound approach. We can find the high sensitivity of ultrasound for diagnosing liver abscesses, and the range is from 66% to 90% in previous reports.[12–14] Similar to other reports, the sensitivity of ultrasound was high (100%) in our study, but the false-positive rate was also rather high (55.6%). According to our experience, ultrasound is suggested to be the first-line diagnostic tool for suspicion of liver abscess because of its

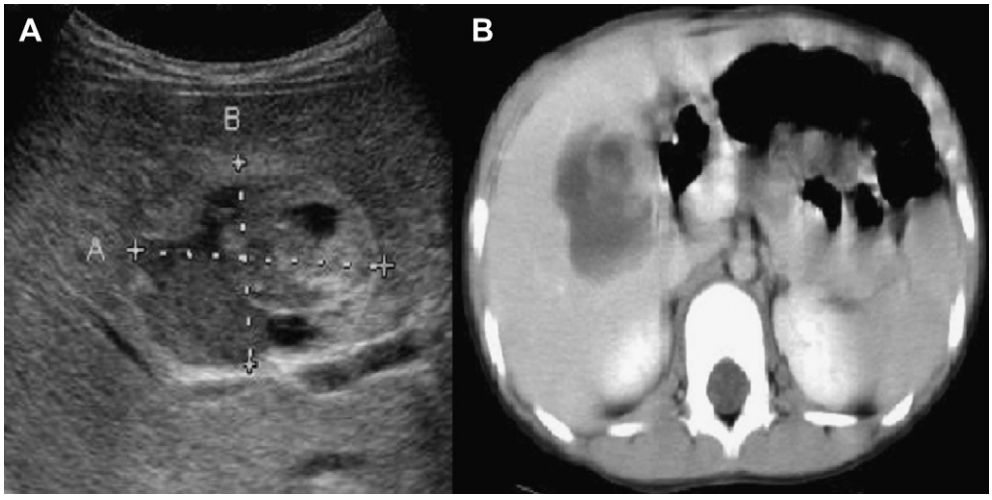

Figure 4 (A) Undifferentiated sarcoma, case 7: Large, heterogeneous cysts were separated by echogenic septation. (B) CT: A huge tumor including solid and cystic parts is located in the right lobe of the liver.

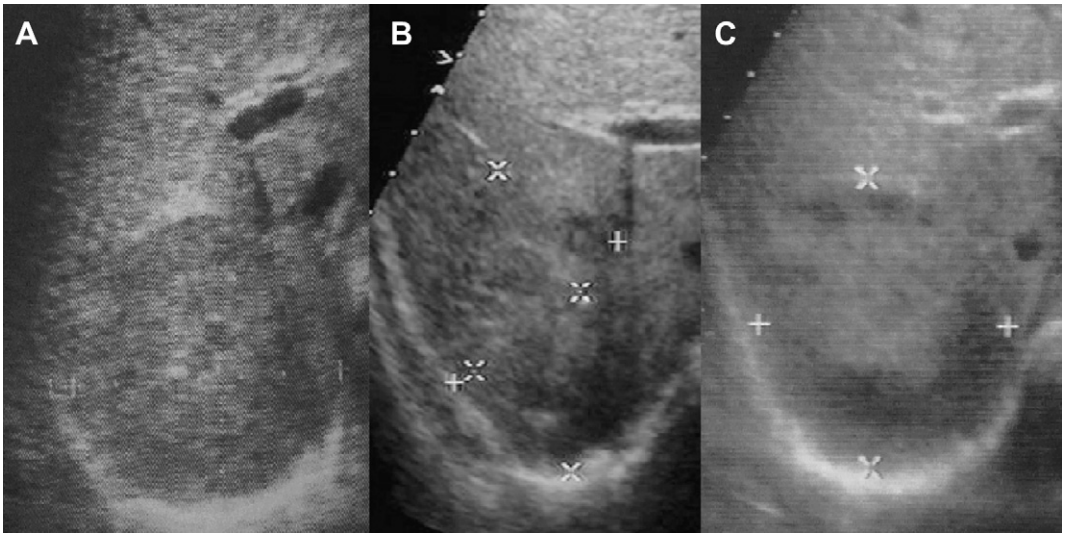

Figure 5 Liver hematoma, case 8: An ill-defined lesion with internal echoes changes in the ultrasonic appearance on (A) the first day, (B) the second day, and (C) the seventh day during admission.

high sensitivity. However, an additional imaging study, such as CT, should be arranged if any of the following conditions exists. First, past history or drug history may induce another liver disease. Second, patients present unusual clinical manifestations or progressive courses. Third, patients' conditions are refractory to adequate treatment. Fourth, the lesion located along the falciform ligament should be evaluated carefully.

Conventional ultrasonography has the advantage of accurately visualizing the biliary tree and distinguishing solid from cystic structures, whereas CT has the advantage of visualizing the posterior and superior aspects of the liver. Although magnetic resonance imaging can detect liver abscesses, it is much less useful because it cannot guide percutaneous aspiration. Contrast-enhanced ultrasound may be used to enhance both the detection and characterization of a pyogenic liver abscess. Relative to conventional ultrasound, contrast-enhanced ultrasound is able to reveal peripheral rim enhancement and central low reflective debris in the arterial phase. It will reveal parenchymal hypoperfusion in the vicinity of the abscess in the venous phase.[15] CT identifies a relatively homogeneous liver abscess better than does conventional ultrasound. However, contrast-specific sonography brings out even more differences.[16]

No matter how experienced an ultrasound operator is, the diagnosis of liver mass will not be complete without additional confirmation study, such as microbiologic confirmation for liver abscess or histology for neoplasm. Unless hematoma is suspected from clinical history and compatible sonographic findings, abscess or neoplasm cannot be diagnosed by ultrasound alone.

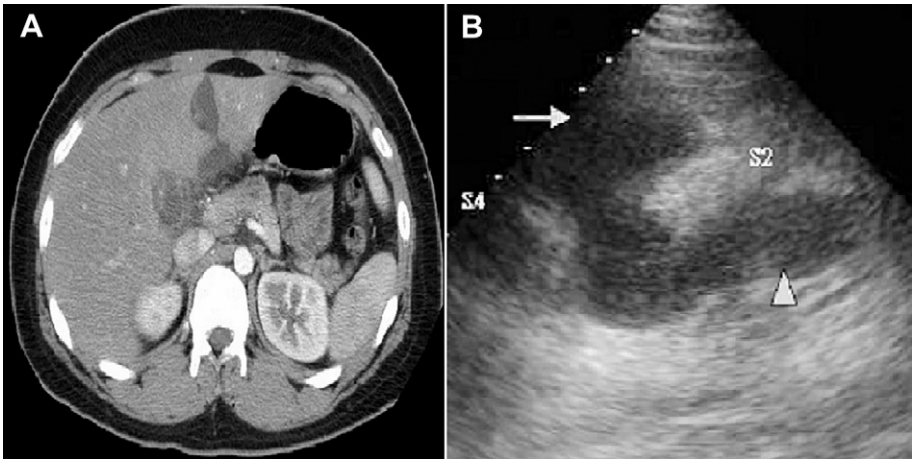

Figure 6 (A) CT: The lesion along with the falciform ligament communicates with the perihepatic area. (B) Perihepatic abscess, case 9: Perihepatic fluid collection (arrowhead); the lesion is in line with the falciform ligament (arrow).

5. Conclusion

Ultrasonography is a useful screening tool when liver abscess is suspected because of its high sensitivity and noninvasive properties. However, it should not be thought of as the gold standard diagnostic tool. Whenever the sonographic diagnosis of liver abscess is doubtful or the clinical presentations are less likely, further evaluation such as CT or even contrast-enhanced ultrasound should be done to confirm the diagnosis.

References

1. Siegel MJ. *Pediatric sonography*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2002, p. 240—2.
2. Subramanyam BR, Balthazar EJ, Raghavendra BN, Horii SC, Hilton S, Naidich DP. Ultrasound analysis of solid-appearing abscesses. *Radiology* 1983;**146**:487—91.
3. De Campo M, De Campo JF. Ultrasound of primary hepatic tumors in childhood. *Pediatr Radiol* 1988;**19**:19—24.
4. Rambo WM, Black HC. Intrahepatic abscess. *Am Surg* 1969;**35**: 144—8.
5. Newlin N, Silver TM, Stuck KJ, Sandler MA. Ultrasonic features of pyogenic liver abscesses. *Radiology* 1981;**139**:155—9.
6. Noronhaa V, Shafib NQ, Obandoc JA, Kummar S. Primary non-Hodgkin's lymphoma of the liver. *Crit Rev Oncol Hematol* 2005;**53**:199—207.
7. Wu MS, Lin JT, Yang PM, Chen YC, Su IJ, Wang TH. Hepatic lymphoma mimicking liver abscess: report of a case and review of the literature. *J Formos Med Assoc* 1993;**92**:263—6.
8. Soyer P, Van Beers B, Teillet-Thiébaud F, et al. Hodgkin's and non-Hodgkin's hepatic lymphoma: sonographic findings. *Abdom Imaging* 1993;**18**:339—43.
9. Wernecke K, Rummeny E, Bongartz G, et al. Detection of hepatic masses in patients with carcinoma: comparative sensitivities of sonography, CT, and MR imaging. *AJR Am J Roentgenol* 1991;**157**:731—9.
10. Noone TC, Semelka RC, Chaney DM, Reinhold C. Abdominal imaging studies: comparison of diagnostic accuracies resulting from ultrasound, computed tomography, and magnetic resonance imaging in the same individual. *Magn Reson Imaging* 2004;**22**:19—24.
11. Lin AC, Yeh DY, Hsu YH, et al. Diagnosis of pyogenic liver abscess by abdominal ultrasonography in the emergency department. *Emerg Med J* 2009;**26**:273—5.
12. Lublin M, Bartlett DL, Danforth DN, et al. Hepatic abscess in patients with chronic granulomatous disease. *Ann Surg* 2002; **235**:381—91.
13. Rintoul R, O'Riordain MG, Laurenson IF, Crosbie JL, Allan PL, Garden OJ. Changing management of pyogenic liver abscess. *Br J Surg* 1996;**83**:1215—8.
14. Branum GD, Tyson GS, Branum MA, Meyers WC. Hepatic abscess. Changes in etiology, diagnosis, and management. *Ann Surg* 1990;**212**:655—62.
15. Morin SH, Lim AK, Cobbold JF, Taylor-Robinson SD. Use of second generation contrast-enhanced ultrasound in the assessment of focal liver lesions. *World J Gastroenterol* 2007; **13**:5963—70.
16. Catalano O, Sandomenico F, Raso MM, Siani A. Low mechanical index contrast-enhanced sonographic findings of pyogenic hepatic abscesses. *Am J Roentgenol* 2004;**182**: 447—50.