

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/radcr

Case Report

Using temporal changes in MR images to determine treatment options for complex liver cysts [☆]

Hiroyuki Maeda, MD^a, Yasuhiko Fujita, MD, PhD^b, Teruyoshi Amagai, MD, PhD^{c,*}

^a Department of Surgery, Kagoshima Tokushukai General Hospital, Kagoshima, Japan

^b Department of Radiology, Kagoshima Tokushukai General Hospital, Kagoshima, Japan

^c Faculty of Health Care Sciences, Department of Clinical Engineering, Jikei University of Health Care Sciences, 1-2-8, Miyahara, Yodogawa-Ku, Osaka, 532-0003, Japan

ARTICLE INFO

Article history:

Received 17 January 2023

Revised 7 May 2023

Accepted 28 May 2023

Keywords:

Hemorrhagic hepatic cyst

Complex hepatic cyst

MR imaging

Prognostic nutritional index

ABSTRACT

The prevalence of hepatic cyst (HC) ranges from 2.5 to 4.7%. Among them, HCs with with symptoms occur in 15%. Extrahepatic rupture of HCs with hemorrhagic shock and death may occur. Early detection of intracystic hemorrhage is necessary to prevent lifethreatening complications. In this case, a 77-year-old woman underwent regular checkups. Her ultrasound (US) showed multiple hepatic cysts (HCs). The largest HC was 80 mm in diameter and located in segment 8 of the right lobe. Her prognostic nutritional index (PNI) was 41.7, indicating high surgical morbidity and mortality after surgery. Multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) were added to identify intra- and extra-cystic anatomy. Compared to MDCT, MRI was able to identify intra-cystic heterogeneous low and high intensity. These findings were interpreted to indicate acute to chronic intra-cystic hemorrhage. As a complication of the rupture and death, an anterior segmentectomy with segmentectomy with cholecystectomy was planned and performed. Her post-operative course was uneventful and she was discharged on day 16. The life-threatening complex HCs include intra-cystic hemorrhage, rupture, hemorrhagic shock and death. To prevent these, we would like to emphasize that MRI appears to be superior to US or CT in providing accurate information on the time course of intra-cystic hemorrhage from hemoglobin to hemosiderin changes to guide urgent surgical intervention of hepatectomy to prevent HC rupture and prevent HC rupture and death.

© 2023 The Authors. Published by Elsevier Inc. on behalf of University of Washington.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

[☆] Competing Interests: All authors have no conflicts of interest to disclose.

* Corresponding author.

E-mail address: amagaipedteruyoshi@gmail.com (T. Amagai).

<https://doi.org/10.1016/j.radcr.2023.05.066>

1930-0433/© 2023 The Authors. Published by Elsevier Inc. on behalf of University of Washington. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

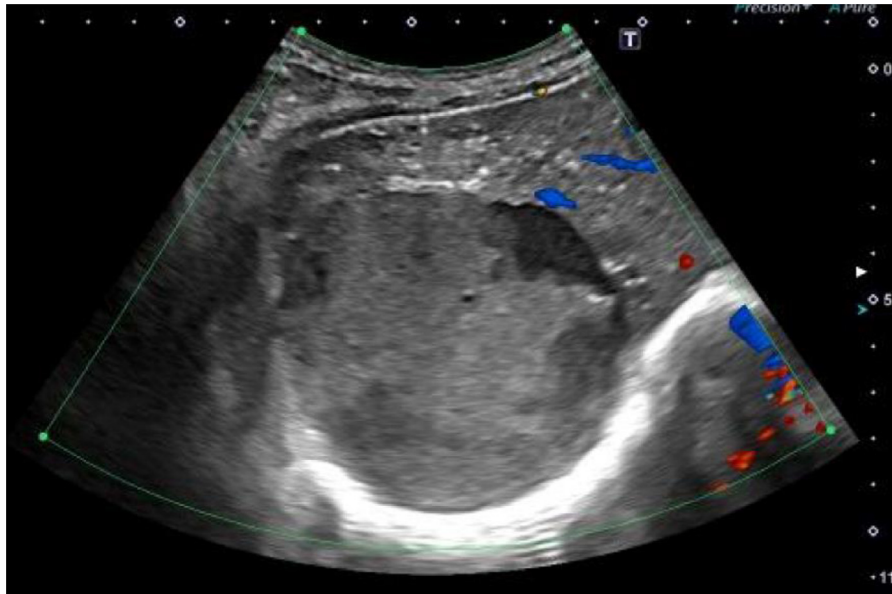


Fig. 1 – The ultrasound sonographic (US) image of the case. This is US view of right upper quadrant transverse dissection. The US showed that the largest hepatic cyst measured 80 × 70 mm in diameter and its internal images seemed heterogeneous mosaic pattern of hyperechoic in central lesion and hypoechoic images in marginal areas.

Introduction

The prevalence of hepatic cysts (HCs) ranges from 2.5% to 4.7% [1]. The majority of HCs are asymptomatic and may become symptomatic as they grow. Of these, 15% are symptomatic HCs [2]. Complications of HCs include intra-cystic hemorrhage in 2%-5% and infection in 1%. Compression of surrounding structures such as biliary, vascular, gastrointestinal and pulmonary tracts occurs in 3%-9% of HCs due to HC growth. In addition, extrahepatic rupture of HCs with hemorrhagic shock and death occurs very rarely [1]. Early detection of intra-cystic hemorrhage is necessary to prevent life-threatening complications. In this case report, we describe a case of hemorrhagic HC with a diameter of 80 mm, and urgent liver resection was performed to prevent rupture and death. To identify hemorrhage in HCs, the question of which radiological modality is most appropriate, including ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI), was discussed.

Case report

A 77-year-old woman was seen for a routine physical examination. Her medical history was significant for cataract and osteoporosis, both of which were treated with medication. Her surgical history was appendectomy 50 years ago. Her most recent past regular examinations of esophago-gastro-duodenoscopic (EGD) study and colonoscopy (CS) examined 3 years ago showed no abnormalities. The ultrasound (US) images performed at the same time as the EGD showed multiple liver cysts. The largest liver cyst was located in the posterior

segment of the right lobe. It measured 80 × 70 mm in diameter, and its internal images appeared heterogeneous mosaic pattern of hyperechoic in the central lesion and hypoechoic images in the marginal areas (Fig. 1). These were the same as the previous US images. When she came to our hospital, she did not complain of abdominal pain. Her temperature was 36.3°C, blood pressure was 154/95 mm Hg, and heart rate was 85 beats per minute. On physical examination, she was not anemic and had no conjunctival jaundice. There was no abdominal mass or rebound tenderness, and a surgical incision was observed in the right lower quadrant. Laboratory examination revealed a white blood cell count of 4450 cells/mm³ (reference range (ref: 3300-8600), neutrophils of 73.1% (ref: 42.0-74.0), lymphocytes of 21.3% (ref: 18.0-50.0), TLC of 947 count/mm³ (ref: < 1500), platelets of 16.2 × 10⁴ count/mm³ (ref: 15.8-34.8 × 10⁴), serum albumin (Alb) of 3.7 g/dL (ref: 4.1-5.1), and C-reactive protein of 0.08 (mg/dL) (ref: 0.00-0.14). Her liver panel was unremarkable, with aspartate aminotransferase (AST), alanine aminotransferase (ALT), and total bilirubin of 23 IU/L (ref: 13-30), 18 IU/L (ref: 7-23), and 0.8 mg/dL (ref: 0.4-1.5), respectively. Her prognostic nutritional index (PNI) was then 41.7 according to the calculation (10 X [Alb] + 0.005 X [TLC]). When the calculated PNI value is < the cut-off point of 51.3, it has been reported to have a high probability of surgical complications [3]. Therefore, their lower PNI value indicated a high probability of postoperative adverse events. To identify the causes of heterogeneity in the US images, multidetector computed tomography (MDCT) showed a well-demarcated round low-density mass with dividing lines of the cyst radiating from central to peripheral areas of high density (Fig. 2). Magnetic resonance images were added to identify the internal images (Fig. 3). T1WI and T2WI both showed a composite of high and low intensity (Figs. 3A and B). Gd-enhanced MRI showed no enhancement effects in the internal and marginal areas

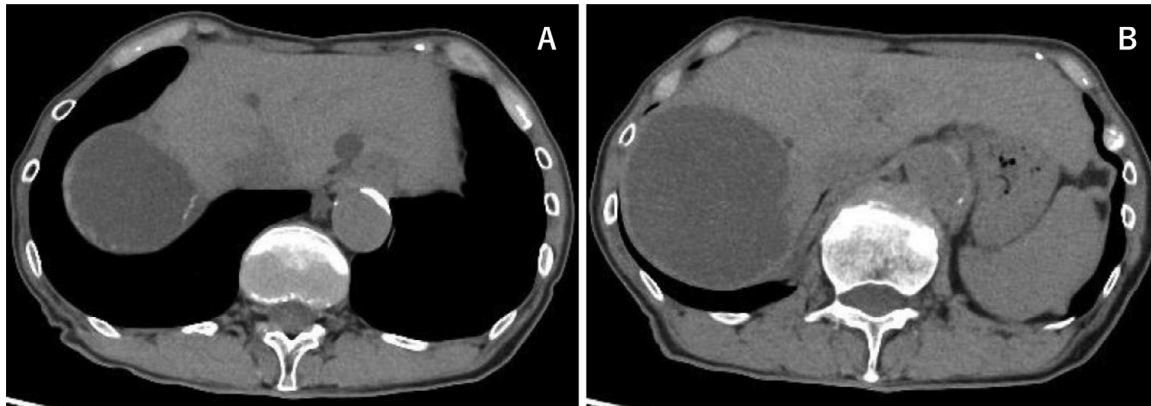


Fig. 2 – The multidetector computed tomography (MDCT) images of the case. This hepatic cyst was located at posterior segment of right lobe and showed well-demarcated round low-density composite with separating lines of the cyst radiating from central to marginal areas of high-density.

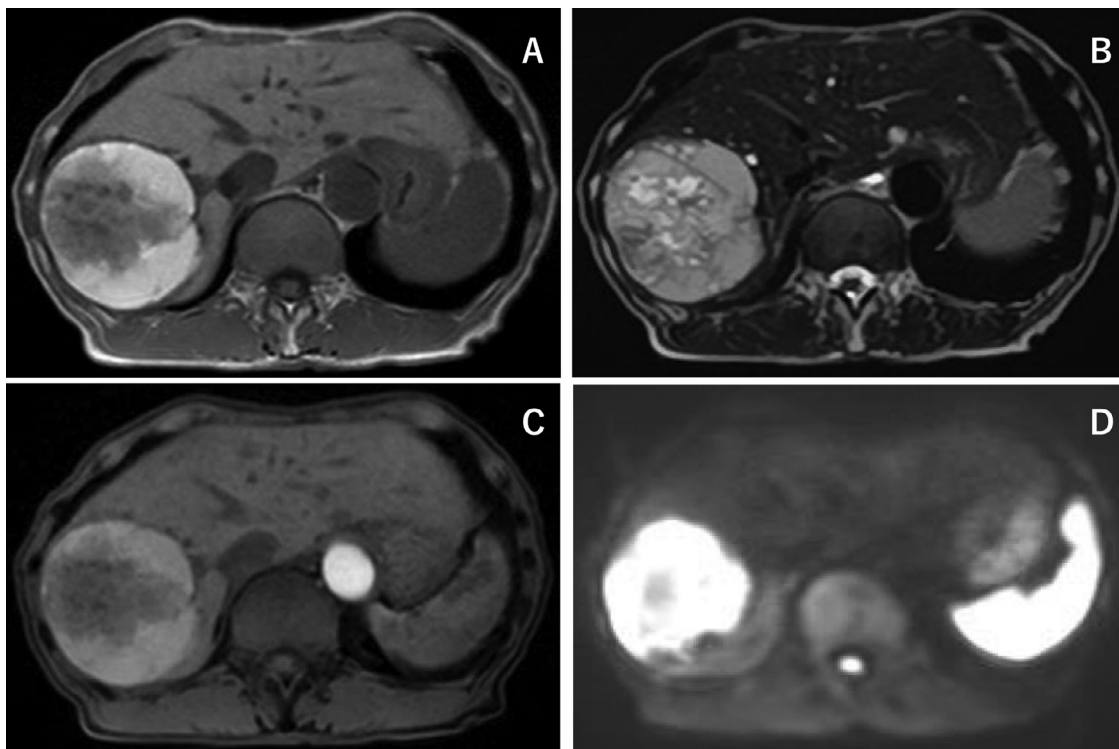


Fig. 3 – The magnetic resonance images (MRIs) of the case. The T1WI (A) and T2WI both showed composite of high- and low-intensity (B). Mainly low-intensity in T2WI is interpreted to coexistence of hemosiderin in hepatic cyst. In addition, Gd-enhanced MRI did not show enhancement effects in internal and marginal area (C), whereas diffusion-weighted MR image showed high-intensity with low-intensity at central 2 areas (D). These findings could be interpreted that hepatic cyst has composite of hemoglobin and hemosiderin together and consistent with heterochronous acute on chronic hemorrhage. (A) T1WI, (B) T2WI, (C) Gd-enhanced MRI, (D) diffusion-weighted MRI. A and B showed composite of high- and low-intensity.

(Fig. 3C), whereas diffusion-weighted MRI showed high intensity with low intensity in the 2 central areas (Fig. 3D). Considering these radiological findings together, heterogeneous, heterochronous hemosiderin deposition due to recurrent intracystic hemorrhage and diagnosis of hemorrhagic complex hepatic giant cyst were made. Then, right hepatic lobectomy was planned and performed uneventfully to prevent abrupt rupture and unpredictable hemorrhagic shock and mortality.

During this operation, 2 units of packed blood cells were transfused for an acceptable intraoperative bleeding of 234 mL. Surgical specimens were sent for pathology, which showed that the cyst walls were lined with hyalinized connective tissue and contained hemosiderin, and no malignancy was found. During in-hospital follow-up, her vital signs were stable and no comorbidities were noted. She was discharged uneventfully on postoperative day 16.

Table 1 – Comparison of radiological modalities to make differential diagnosis of hemorrhagic hepatic cyst (HC) from simple HC. The complex cyst has complex features within a lesion including that multilocular, septal enhancing, debris containing in MDCT, and findings in MRI that high-intensity of margin areas with low-intensity of internal part in diffused weighted, and enhancing effect of wall layer with non-enhancing of internal parts in Gd-enhancing. These MDCT and MRI findings suggest that hemorrhagic HC is useful in differentiating hemorrhagic HC from a simple cyst when hemorrhagic HC is suspected.

Radiology modalities	US	MDCT	MRI		
Simple HC	homogeneous, aseptate, thin, and smooth walls	nonenhancing, hypodense, smooth walls	T1WI, T2WI T1WI: low signal T2WI: high signal	diffused weighted homogeneous high-intensity	Gd-enhancing nonenhancing effect
Hemorrhagic HC	irregular, hyperechoic septations with debris	multilocular, septal enhancing, debris containing	composite of high- and low-intensity in T1WI and T2WI	high-intensity of margin areas with low-intensity of internal parts	enhancing effect of wall layer with nonenhancing of internal parts

Abbreviations; MDCT, multidetector computed tomography; MRI, magnetic resonance images; US, ultrasound sonography.

Table 2 – Comparison of MRI findings of hemorrhagic hepatic cyst according to time line after hemorrhage. This table shows changes in MRI findings corresponding to temporal changes in intracellular and extracellular Hemoglobin in hemorrhagic HC. (1) From Stage 1 to Stage 2 - O-Hb changes to deoxy-Hb, which changes to low intensity on T2WI on MRI, (2) From Stage 2 to Stage 3 - deoxy-Hb changes to intracellular Met-Hb, which changes to high intensity on T1WI on MRI, (3) From Stage 3 to Stage 4 - not only intracellular Met-Hb appears, but also extracellular. On MRI, T2WI changes back to high intensity. These changes in findings according to MRI stage indicate that it is possible to follow the blood age of hemorrhagic HC as well as simply distinguish it from simple HC.

Stage of blood age	days after hemorrhage	blood changes	MRI findings			
			T1WI	T2WI	DWI	ADC
1st	hyperacute (< 1 d)	intracellular oxyhemoglobin (O-Hb)	→	→ ~ ↑	↑	↓
2nd	acute (1-3 d)	intracellular deoxy-hemoglobin (Deoxy-Hb)	→ ~ ↓	↓ (signal intensity drops to become low intensity)	↓	↓
3rd	early subacute (3-7 d)	intracellular methemoglobin (Met-Hb)	↑ (intensity gradually increases to become high-intensity)	↓	↓	↓
4th	late subacute (7 to 14-28 d)	extracellular methemoglobin (Met-Hb)	↑	↑ (signal gradually increases over the next few weeks as cell breakdown and extracellular MetHb increases)	↑	↓
5th	chronic (> 14-28 d) -	extracellular hemochromes : in central regions.	→	↑	↓	↑
	chronic (> 14-28 d) -	intracellular hemosiderin : in periphery regions.	↓	↓		

Discussion

Classification of liver cysts by differences in the internal structure of the cyst

simple or complex

Simple HCs are identified as congenital exclusions of hyperplastic bile duct remnants without connection to the biliary tract [4]. Based on their appearance, HCs are classified into simple and complex types. The simple cyst has thin, smooth walls lined with cuboidal epithelium secreting bile [4]. The complex cyst has complex features within a lesion, includ-

ing septations, wall thickening or nodular lesion, debris, radiologic enhancement, hemorrhage, or proteinaceous content (Table 1). The complex features are due to neoplastic, infectious, traumatic destruction of simple cystic structures resulting in hemorrhagic changes [2].

Temporal changes in hemorrhagic liver cysts on MR images

In hemorrhagic HCs, MRI appears to be superior to US or MDCT because of its ability to identify the composite of high and low, heterogeneous intensity consisting of intracystic hemorrhagic components and septa (Fig. 3). MRI findings of T1WI, T2WI, diffusion-weighted and apparent diffusion coefficient

(ADC) could differentiate time lines of acute, subacute, chronic or composite of acute and chronic according to blood age (Table 2) [5,6]. In Fig. 2, shaded areas are shown as differentiation from the previous stage. These time lines of intracystic hemorrhage of HCs could not be identified in US, CT, but in MRI. From this, we would like to emphasize that MRI could identify not only the growth in size, but also the time course of hemorrhagic HCs. MRI showing a combination of acute and chronic stage with growth could be an alarm to require urgent treatment including hepatectomy to prevent complication of liver rupture and death. [7].

Conclusion

A 77-year-old woman with hemorrhagic HC of 80 mm in diameter was diagnosed by radiological examination using US, CT and MRI. Among these radiological modalities, our case showed that MRI seems to be superior to US or CT to identify the time line of hemorrhagic complication of HC. The acute to chronic time line of hemorrhagic HC identified by MRI requires urgent surgical intervention to prevent rupture and hemorrhagic death.

Patient consent

Informed consent was obtained from the patient for the publication of this case report before her death. This case report

was approved by the hospital ethic committee and the approval number is 23-01.

REFERENCES

- [1] Marion Y, Brevart C, Plard L, Chiche L. Hemorrhagic liver cyst rupture: an unusual life-threatening complication of hepatic cyst and literature review. *Ann Hepatol* 2013;12:336–9.
- [2] Mavilia MG, Pakala T, Molina M, Wu GY. Differentiating cystic liver lesions: a review of imaging modalities, diagnosis and management. *J Clin Transl Hepatol* 2018;6(2):208–16.
- [3] Onodera T, Goseki N, Kosaki G. Prognostic nutritional index in gastrointestinal surgery of malnourished cancer patients. *Nippon Geka Gakkai Zasshi* 1984;85:1001–5.
- [4] Sanfelippo PM, Beahr OH, Weiland LH. Cystic diseases of the liver. *Ann Surg* 1974;179:922–5.
- [5] Bradley MG Jr. MR appearance of hemorrhage in the brain. *Radiology* 1993;189:15–26.
- [6] Gaillard F. Radiopaedia hemorrhage on MRI. last edited on November 10, 2022. <https://radiopaedia.org/articles/haemorrhage-on-mri?lang=us>. [accessed 16.01. 23].
- [7] Marrero JA, Ahn J, Reddy KR, Jorge MA, Joseph A, Rajender R. ACG clinical guideline: the diagnosis and management of focal liver lesions. *AM J Gastroenterol* 2014;109:1328–47.