European Journal of Radiology 81 (2012) 2476–2480

Contents lists available at SciVerse ScienceDirect

European Journal of Radiology

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

Assessment of acute cholangitis by MR imaging

Hyo Won Eun [a], Jung Hoon Kim [b,*], Seong Sook Hong [c], Young Jae Kim [c]

[a] Health Promotion Center, Asan Medical Center, University of Ulsan, 388-1 Poongnap-dong, Songpa-gu, Seoul 138-736, Republic of Korea
[b] Department of Radiology and Institute of Radiation Medicine, Seoul National University College of Medicine, 101 Daehang-no, Chongno-gu, Seoul 110-744, Republic of Korea
[c] Department of Radiology, Soonchunhyang University Hospital, 657 Hannam-Dong, Youngsan-Ku, Seoul 140-743, Republic of Korea

ARTICLE INFO

Article history:
Received 30 August 2011
Received in revised form 18 October 2011
Accepted 19 October 2011

Keywords:
Magnetic resonance imaging
Bile ducts
Cholangitis
Bile duct stones
Gallstones

ABSTRACT

Purpose: The purpose of this study is to assess the common MRI findings of acute cholangitis compared with those of non-acute cholangitis.
Materials and methods: During a 31-month period, we performed MRCP and contrast-enhanced MRI on 173 patients with biliary abnormalities including duct dilatation or stricture. The causes of the biliary abnormalities included biliary stone disease ($n = 85$), cholangiocarcinoma ($n = 47$), periampullary cancer ($n = 20$), GB cancer ($n = 4$), and others ($n = 17$). Among 173 patients, 66 consecutive patients were confirmed with acute cholangitis diagnosed according to the Tokyo guideline, and 107 patients were confirmed as having non-acute cholangitis. Two radiologists retrospectively and independently accessed the MR findings, including the cause of biliary abnormality, increased periductal signal intensity on T2-weighted images, the transient periductal signal difference, and the presence of abscess, thrombosis, and ragged duct. They also measured the dilated duct and the thickened wall. The Student *t*-test and the Pearson chi-square were used. The κ statistics were used to determine interobserver agreement. Logistic regression was used to identify the MR findings that predicted acute cholangitis.
Results: MRI correctly accessed the cause of biliary abnormality in 163 patients (94%). The statistically common findings for acute cholangitis were as follows: increased periductal signal intensity on T2-weighted imaging ($n = 26$, 39%, $p < 0.05$); transient periductal signal difference ($n = 31$, 47%, $p < 0.05$); abscess ($n = 18$, 27%, $p < 0.05$); thrombosis ($n = 12$, 18%, $p < 0.05$); and ragged duct ($n = 11$, 17%, $p < 0.05$). Interobserver agreement was good to excellent for each finding ($\kappa = 0.74$–0.97). The wall thickness showed a statistically significant difference between the acute cholangitis and the non-acute cholangitis group (2.65 mm:2.32 mm, $p < 0.05$), however, there was no significant difference in duct dilatation in the two groups. The periductal transient attenuation difference was an independent predictor of acute cholangitis (Exp (B) = 6.389, $p = 0.018$).
Conclusion: MRI accurately assesses the cause of biliary abnormality in patients with cholangitis. Using statistically common MR findings for acute cholangitis, MR imaging is very successful in predicting acute cholangitis.

1. Introduction

Acute cholangitis is a clinically diagnosed condition caused by partial or complete obstruction of the biliary tree which predisposes patients to ascending infection. Patients with acute cholangitis have a wide spectrum of clinical disease severity ranging from a mild form to a severe form of acute suppurative cholangitis that can be life-threatening. Therefore, prompt diagnosis is important for appropriate treatment [1–3].

The typical clinical symptoms leading to the diagnosis of acute cholangitis include jaundice, abdominal pain, and fever and/or chills are described as Charcot's triad [4]. As the diagnosis of acute cholangitis characteristically depends on the clinical findings, there have been a few published reports in the radiology literature regarding the CT imaging diagnosis of acute cholangitis [5–10]. Although biliary dilatation, transient periductal enhancement, bile duct wall thickening and enhancement, portal vein thrombosis, and liver abscess are characteristic image findings of acute cholangitis, these findings are also detected in biliary diseases other than acute cholangitis [11].

Although the primary imaging modalities for patients with suspected biliary disease are ultrasound and computed tomography, recently the use of MRI and MRCP for evaluation of the liver and biliary tree, has increased substantially [12,13]. Therefore, it is necessary to be familiar with the MR imaging findings of acute cholangitis in order to prevent the delay of diagnosis and to ensure appropriate treatment. To our knowledge, no prior report has

* Corresponding author. Tel.: +82 2 2072 2584; fax: +82 2 743 6385.
E-mail addresses: namsanae@gmail.com (H.W. Eun), jhkim2008@gmail.com (J.H. Kim), hongses@hosp.sch.ac.kr (S.S. Hong), rtwodtwo@hosp.sch.ac.kr (Y.J. Kim).

0720-048X/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ejrad.2011.10.020

Table 1
Tokyo guideline: diagnostic criteria for acute cholangitis.

A. Clinical context and clinical manifestations	1. History of biliary disease 2. Fever and/or chills 3. Jaundice 4. Abdominal pain (RUQ or upper abdominal)
B. Laboratory data	5. Evidence of inflammatory response[a] 6. Abnormal liver function tests[b]
C. Imaging findings	7. Biliary dilatation or evidence of an etiology (stricture, stone, stent, etc.)
Definite diagnosis	(1) Charcot's triad (2 + 3 + 4) (2) Two or more items in A + both items in B and item C

[a] Abnormal WBC count, increase of serum CRP level, and other changes indicating inflammation.
[b] Increased serum ALP, r-GTP (GGT), AST, and ALT levels.

described the MRI appearance of acute cholangitis and comparing it to that of patients with biliary disease without acute cholangitis. The purpose of this study is to determine the characteristic MRI findings of patients with acute cholangitis compared to those with biliary disease without acute cholangitis.

2. Materials and methods

2.1. Patients

Our institutional review board approved this retrospective study and patient informed consent was not required. By a computerized search of the MRI records from January 2007 to July 2009, 226 consecutive patients with biliary abnormalities were identified. The biliary abnormalities included dilatation or stricture of the bile duct. We reviewed the medical records, including the clinical manifestations and initial laboratory data. The 39 patients with cholecystitis and the 14 patients who did not have complete clinical or laboratory data, were excluded from the study. Therefore, 173 patients (97 male and 76 female patients; mean age, 52 years; range, 31–72 years) with biliary abnormalities seen on MRI, were included in the study. The causes of biliary abnormality included biliary stone disease (n = 85), cholangiocarcinoma (n = 47), periampullary cancer (n = 20), GB cancer (n = 4), and others benign cause of the biliary abnormality (n = 17). Among the study patients, 66 consecutive patients were confirmed to have acute cholangitis according to the Tokyo guidelines and 107 patients without acute cholangitis were included in the non-acute group. Table 1 summarizes the Tokyo guidelines [14].

2.2. MR imaging

MRCP and contrast-enhanced MR images were performed on a 1.5-T MR system (Magnetom Sonata Maestro, Siemens Medical Solutions). To localize the biliary and pancreatic ductal system, we performed an axial T2-weighted half-Fourier single-shot TSE sequence (repetition time, 800 ms; echo time, 63 ms; flip angle, 150°; 7-mm slice thickness; 20 slice number) and an axial fat suppression T1-weighted fast low-angle shot (FLASH) sequence (repetition time, 159 ms; echo time, 2.6 ms; flip angle, 120°; 7 mm slice thickness; 20 slice number). The MRCP protocol was composed of a single-slab rapid acquisition with relaxation enhancement (RARE; repetition time,– ms; echo time, 1100 ms; flip angle, 150°; 40–80 mm slice thickness; 6 slice number), multislice half-Fourier single-shot TSE (HASTE; repetition time, 1100 ms; echo time, 87 ms; flip angle, 150°; 4 mm slice thickness; 15 slice number), and free-breathing T2-weighted TSE (FBTSE; repetition time, 1700 ms; echo time, 674 ms; flip angle, 180°; 1.5 mm slice thickness; 40 slice number) sequences with navigator-triggered prospective acquisition correction (PACE). The slabs of a single-shot RARE sequence were obtained at various angles allowing optimal visualization of the bile ducts. Multislice HASTE images and a T2-weighted TSE sequence with navigator-triggered PACE were then obtained in the coronal and oblique planes. Each examination was performed during a single breath-hold. The free-breathing T2-weighted TSE sequence with navigator-triggered PACE was reconstructed using the maximum intensity projection (MIP) algorithm. Contrast-enhanced MR imaging was performed following administration of gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany). A dose of 0.1 mmol/kg gadopentetate dimeglumine was injected using an automatic injector (Spectris MR; Medrad, Germany) at a flow rate of 3 ml/s and was followed by an injection of 20 ml of normal saline at the same flow rate. Determination of the scan delay for image acquisition timing was achieved using the test bolus technique in which 1 ml of gadopentetate dimeglumine was injected along with 20 ml of saline flushing. The breath-hold T1-weighted imaging sequence for arterial phase (20–30 s), portal phase (45–60 s) and equilibrium phase (180 s) imaging was obtained using a 3D volumetric interpolated breath hold examination (VIBE) sequence using the following parameters: TR/TE of 3.4–3.8/1.4–1.8; a flip angle of 12°; bandwidth 490 Hz/Px; a matrix of 256 (read) × 120 (phase) × 64–72 (partition); an effective slice thickness of 2.3 mm; and a field of view of 32–35 cm.

2.3. Imaging interpretation

MRI scans were retrospectively analyzed by two radiologists (KJH, EHW) with nine years of clinical experience in abdominal MR imaging. The reviewers were blinded to patient identification, their clinical histories, final results, and other imaging findings. The two reviewers independently assessed the cause of the biliary abnormality. The following imaging variables were then analyzed: increased periductal signal intensity on T2-weighted images; the transient periductal signal difference on dynamic phases; the presence of abscess; portal vein thrombosis; and ragged duct. The transient periductal signal difference on dynamic phases was defined as transient enhancement surrounding the intrahepatic bile ducts during arterial or portal venous phase. The abscess was diagnosed when the hepatic mass showed multilayered target-like enhancement on dynamic phase or a cluster appearance and central fluid-like space on T2WI or dynamic phase. The ragged duct was diagnosed when there was uneven wall enhancement at the bile duct. When the readers' interpretations differed, a third opinion (H.S.S) was obtained. They also measured the dilated bile duct and thickened bile duct wall.

2.4. Statistical analysis

All MR findings were compared in the acute cholangitis group and the non-acute cholangitis group using the Student t-test and the Pearson chi-square test. A p value less than 0.05 was considered to indicate statistical significance. Statistically significant MR findings associated with acute cholangitis were further analyzed in order to identify the MR findings that predict acute cholangitis using multivariate logistic regression analysis. For each MR finding, the interobserver agreement was evaluated using the kappa statistic. A kappa value less than 0.20 was considered poor; 0.21–0.4, fair; 0.41–0.60, moderate; 0.61–0.80, good; and 0.81–1.00 excellent. Statistical analysis was conducted using SPSS version 14.0 software (SPSS, Chicago, IL, USA).

3. Results

MRI correctly assessed the cause of the biliary abnormalities in 163 patients (94%). Table 2 summarizes the MR imaging findings of both the acute cholangitis group and the non-acute