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Detection and characterization of focal hepatic lesions by T_2-weighted imaging: comparison of navigator-triggered turbo spin-echo, breath-hold turbo spin-echo, and HASTE sequences

Ho Yun Lee[a], Jeong Min Lee[a,*], Se Hyung Kim[a], Kyung Sook Shin[b], Jae Young Lee[a], Joon Koo Han[a], Byung Ihn Choi[a]

[a]*Department of Radiology and Institute of Radiation Medicine, Seoul National University College of Medicine, Clinical Research Institute, Seoul National University Hospital, 28, Yongon-dong, Chongno-gu, Seoul 110-744, Korea*
[b]*Department of Radiology, Chungnam National University Hospital, Daejeon, Korea*

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Abstract

The aim of this study is to evaluate the diagnostic performance of T_2-weighted (T_2-w) images obtained using navigator-triggered turbo spin-echo (TSE), breath-hold TSE (BH-TSE), and BH haft-Fourier single-shot TSE sequences for the detection and characterization of focal hepatic lesions. Two blinded reviewers independently analyzed three types of T_2-w image sets totaling 86 solid and 75 nonsolid lesions in 59 patients. Receiver operating characteristic curves were established to analyze reviewer and sequence results.

Keywords: Liver; Neoplasms; Magnetic resonance (MR); Comparative studies; Pulse sequences

1. Introduction

Cross-sectional imaging modalities such as ultrasound (US), computed tomography (CT), and magnetic resonance imaging (MRI) are usually used to evaluate focal liver lesions [1,2]. Gadolinium-enhanced multiphasic dynamic imaging plays a major role in the detection and characterization of focal liver lesions. Moreover, although a few studies have described the role of T_2-weighted (T_2-w) imaging for the detection of focal liver lesions, this type of imaging provides important information for the detection of small lesions with high fluid content and also for lesion characterization [3,4]. Obtaining high-quality MRI liver images in the shortest possible time remains a major challenge, especially for T_2-w imaging [5,6]. Indeed, many researchers favor breath-hold sequences because they enable rapid data acquisition and effectively reduce motion artifacts [4,7–9]. However, image artifacts, which are related to their long echo trains with apparent blurring due to off-resonances during the readout of echo trains, decrease soft-tissue resolution and signal-to-noise ratio (SNR) [5,10].

In addition to the breath-hold strategy, respiratory monitoring with the aim of avoiding motion artifacts prospectively by using respiratory signals to control image acquisition has been the focus of several studies [6,11–13]. Respiratory triggering provides better T_2 contrast with improved SNR from liver tissue and better liver-to-lesion contrast than breath-hold T_2-w FSE or single-shot sequences (Fig. 1). Recently, free-breathing two-dimensional prospective acquisition correction (PACE), which is a two-dimensional navigator-based technique that measures the position of the diaphragm and prospectively corrects the positions of the following measurements, was introduced [5,10].

The purpose of this study was to determine the diagnostic performance of navigator-triggered fat-suppressed turbo

* Corresponding author. Department of Radiology, Seoul National University College of Medicine, 28 Yongon-dong, Chongno-gu, Seoul 110-744, Korea. Tel.: +82 2 2072 3154; fax: +82 2 743 6385.
E-mail address: chacha96@snu.ac.kr (J.M. Lee).

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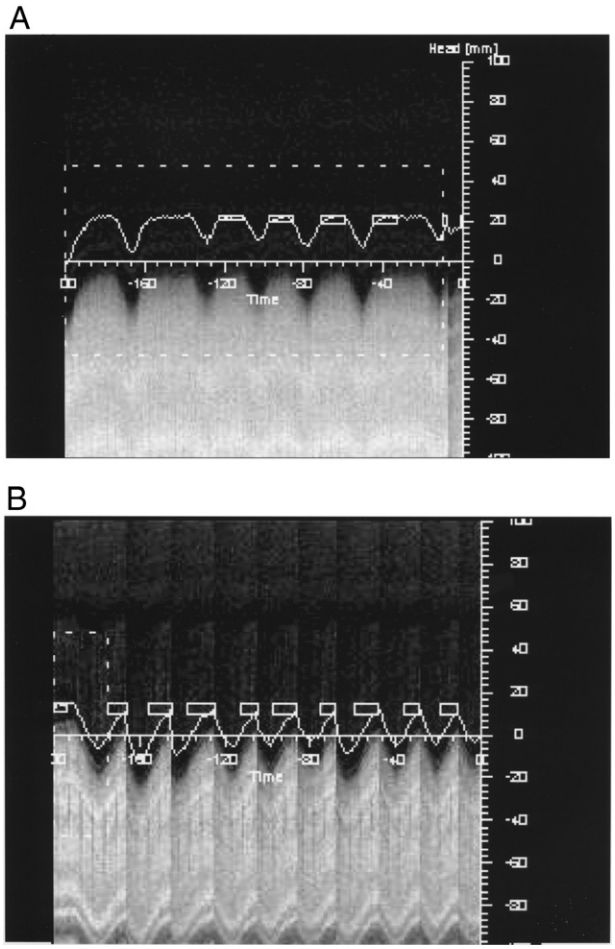

Fig. 1. Respiratory triggering curve. (A) The turquoise dotted window (showing the navigator position) marks the learning phase of the trigger algorithm. During the learning phase, white boxes indicate the proposed anatomical data acquisition periods. The locations of these boxes are based on parameter settings and an evaluation of previous respiratory cycles. Parameter settings are relatively easy for certain respiratory cycles, if data are acquired in a relaxed position near the end of expiration. If the horizontal width of the boxes is comparable to or greater than one respiratory period, the measurement must be stopped and the acquisition duration must be reduced. (B) This figure shows a respiratory trace during the imaging phase. When the system detects a rising signal (onset of expiration), the acceptance window is shown as a white box. If the detected diaphragm displacement window (white curve) falls into the acceptance window, the basic anatomical imaging bloc is executed.

spin-echo (TSE) (T_2-w PACE) for the detection and characterization of focal hepatic lesions and to compare this with other breath-hold T_2-w sequences, namely, BH haft-Fourier single-shot TSE (HASTE) and breath-hold TSE (BH-TSE) sequences.

2. Materials and methods

2.1. Patient selection

This retrospective study involved MRI examinations performed between January 2004 and October 2005. Seventy-three MR studies, each involving three types of T_2-w images (i.e., navigator-triggered TSE, HASTE, and BH-TSE images), were examined. Each patient had confidential proof of the diagnosis of focal hepatic lesions through one's past liver imaging history. Of these 73 patients, 14 were excluded from the analysis for the following reasons: (a) a huge lesion extending beyond one segment (n=6); (b) MRI based on a nonidentical T_2 sequence (i.e., a fat-suppressed study) (n=5); and (c) presence of more than 10 lesions (n=3).

The remaining 44 men and 15 women comprised the study population. The mean patient age was 55±12 years (range, 17–76 years). Patients had focal abnormalities that corresponded to a total of 161 hepatic lesions (number of focal abnormalities per patient: one, n=20; two to five, n=34; six to eight, n=5). In 33 (56%) of the 59 patients, liver cirrhosis was diagnosed histopathologically or by clinical and laboratory examinations (Child–Pugh classification: A, n=5; B, n=11; C, n=17). Among these, 29 patients had chronic hepatitis B, two patients had chronic hepatitis C, and the remaining two patients had alcoholic liver disease. Institutional review board approval was granted, and requirement for consent was waived because of the retrospective nature of the study.

2.2. Lesion confirmation and determination of lesion numbers

Of the 161 lesions, there were 86 solid lesions (diameter, 7–60 mm; mean, 15.4 mm) and 75 nonsolid lesions 75 (diameter, 4–35 mm; mean, 12.3 mm). The solid lesions included the following: 31 hepatocellular carcinomas (HCCs), 30 metastases, 11 dysplastic nodules, 8 inflammatory lesions, 3 intracytoplasmic cholestasis, 2 adenomas, and 1 congenital hepatic fibrosis. Twenty-two metastases arose from colorectal carcinoma, four metastases arose from stomach cancer, and the remaining four metastases arose from breast cancer. Solid lesions subsequently underwent definitive surgery with intraoperative US within 3 weeks of MRI. Three patients with metastases and nine patients with benign solid lesions, such as an inflammatory lesion or intracytoplasmic cholestasis, underwent US-guided needle-core aspiration biopsy of at least one liver tumor for histologic confirmation within 2 weeks of MRI; in these patients, other tumors with imaging findings similar to those of the histologically evaluated lesions were considered to be due to the same disease. Twelve patients underwent transarterial chemoembolization (TACE) and had no histologic confirmation. Diagnoses of HCC in these patients depended on a combination of clinical and characteristic angiographic findings and compact iodized oil (Lipiodol; Guerbet) uptake on follow-up CT performed 2 weeks after TACE. Nonsolid benign lesions such as hemangiomas (n=26) or hepatic cysts (n=49) were verified pathognomonically or ultrasonographically, by contrast-enhanced US, and based on the absence of growth over a follow-up period of at least 6 months.