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Original Article

Assessment of hepatic focal lesions on top of cirrhotic liver using dynamic and diffusion weighted magnetic resonance imaging

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ABSTRACT

Aim: This work aims to assess the role of dynamic and diffusion weighted magnetic resonance imaging in diagnosis of hepatic focal lesions in cirrhotic patients.
Methods: A prospective study included 30 patients (42 focal lesions) who were evaluated by dynamic contrast enhanced MRI and diffusion weighted imaging.
Results: Statistically significant difference was found between ADC values of malignant and benign hepatic focal lesions. Statistically significant difference is noticed between different types of benign hepatic focal lesions. No statistically significant difference could be detected between different types of malignant hepatic focal lesions. Dynamic MRI yields sensitivity 85%, specificity 80% and 83.3% accuracy. DW and ADC mapping revealed sensitivity 90%, specificity 90% and accuracy of 90%.
Conclusion: The combination of Dynamic MRI and DW is sensitive for early detection of malignant neoplastic hepatic lesions, and for differentiation between the benign and malignant lesions.

1. Introduction

Liver cirrhosis is a major public health problem worldwide. Common causes of cirrhosis include hepatitis C virus, hepatitis B virus, alcohol consumption and non-alcoholic steatohepatitis [1].

Imaging characterization of focal lesions in cirrhosis is of the utmost importance for appropriate patient management. The radiologist's primary task is to maximize tumor detection, because missing the diagnosis of HCC may preclude potentially curative therapies [2,3].

Magnetic resonance imaging (MRI) plays an increasingly important role in the evaluation of patients with liver disease because of its high contrast resolution, lack of ionizing radiation, and the possibility of performing functional imaging sequences. DW MR imaging enables qualitative and quantitative assessment of tissue diffusivity (apparent diffusion coefficient) without the use of gadolinium chelates, particularly in patients with severe renal dysfunction at risk for nephrogenic systemic fibrosis [4,5].

Diffusion of water molecules is the target of diffusion-weighted imaging (DW-MRI), although water mobility in biological systems is a complex process. Diffusion-weighted measurement in the body is frequently performed using Stejskal—Tanner echo-planar imaging experiment. However, in living tissues there are

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physiologic motions unrelated to diffusion that can mimic diffusion processes and confound in vivo measurements. In particular, the use of low *b*-values is sensitive to the microcapillary perfusion effects within the image voxel. Hence, accurate estimation of the apparent diffusion coefficient (ADC) of tissues in the body is dependent on the proper choice of *b*-values, which, in turn, is influenced by the baseline signal-to-noise and to the target tissue diffusion properties. Body tissues also exhibit true multi-exponential diffusion decay with increasing *b*-value that is unrelated to false multi-exponential appearance due to perfusion and/or noise. However, very high *b*-values (e.g. >3000 s/mm^2) are usually required to appreciate this behavior [6].

Focal lesions in liver cirrhosis include hemangiomas, focal nodular hyperplasia, adenomas, peribiliary cyst, cholangiocarcinoma, metastasis, arterio-venous shunt, focal confluent fibrosis and dysplastic nodules. Cirrhotic patients are at higher risk of end stage liver disease, portal hypertension, and hepatocellular carcinoma (HCC) [7,8].

1.1. Aim of the work

The purpose of this study was to assess the role of dynamic and diffusion weighted magnetic resonance imaging in diagnosis of hepatic focal lesions in liver cirrhosis.

2. Patients and methods

2.1. Population

Between Jan 2015 and Jan 2016, 30 consecutive patients referred for hepatic MRI because of hepatic focal lesions in liver cirrhosis proved by ultrasonic examination. They were prospectively enrolled. These 30 patients include 17 males and 13 females with age range between 30 and 70 year (mean age, 50 year). Inclusion criteria were patients who presented with ultrasonic examination revealing hepatic focal lesions in liver cirrhosis. Exclusion criteria were the common contraindications to MRI (pacemaker, metallic foreign bodies, and impaired renal function). This study was approved by the ethics committee of our institution; an informed consent was obtained from all patients after full explanation of the benefits and risks of the procedure.

3. Methods

Conventional MRI, post Gd-DTPA dynamic and diffusion MR imaging studies were performed for all patients for detection and characterization of hepatic focal lesions were performed followed by diffusion weighted images and ADC values. MR imaging was performed on high field system (1.5 Tesla) magnet units (Toshiba Vintage) using a phased array coil to cover the whole liver. Patients did not undergo bowel preparation, but were instructed to fast for at least 4 h before the examination. Intravenous injection of 20 mg of hyoscine-N butyl bromide (Buscopan) was injected 30 min before examination to reduce intestinal peristalsis.

Pulse sequences and scanning planes are as follows:

A. Pre-contrast imaging included the following:
   - T1 weighted image (T1WI) (TR/TE = 10 msec/4.58 msec).
   - T2 weighted images (T2WI) single shot free breathing: (TR/TE 445 msec/26–28 msec).
   - T2 SPAIR (Spectral Attenuated Inversion Recovery) fat suppression sequence: (TR/TE = $\geqslant$ 400 msec/80 msec).
   - In phase and out phase gradient echo sequence (Dual/FFE): TR/TE = 75–100 msec/4.6 msec for in phase and TR/TE = 75–100 msec/2.3 msec for out phase.

B. Dynamic study: During dynamic MRI study, bolus intravenous injection of 0.1 mmol/kg body weight of Gd-DTPA at a rate of 2 ml/s flushed with 20 ml of sterile 0.9% saline solution through the antecubital vein was done. The injection of contrast media and saline solution was performed automatically using automatic injector. Dynamic imaging using T1 THRIVE (High Resolution Isotropic Volume Examination) technique was performed in triphasic way using dynamic study with continuous imaging to obtain multiple arterial and portal phases after administration of the contrast medium.

C. Diffusion study: Respiratory triggered fat suppressed single-shot echoplanar DW imaging was performed in the transverse plane with tri-directional diffusion gradients by using *b* values (500, 1000) sec/mm^2. Parallel imaging with generalized auto-calibrating partially parallel acquisition (GRAPPA) with an acceleration factor of two was applied to improve image quality. The other parameters were as follows: repetition time (TR) $\geqslant$1880 ms, echo time (TE) = 70 ms, scan time 3–4 min with a field of view as small as possible with 52% rectangular field of view.

3.1. Image analysis

The morphological features of each lesion were recorded including size, shape, margin and signal characteristics, pattern of enhancement in the dynamic imaging as well as number and site of the detected focal lesions. Then, provisional diagnosis was reported. Second, we reviewed the diffusion images with ADC (range between 1.0–2.3 $\times$ 10^{-3} mm^2/sec for benign lesions and 0.9–1.5 $\times$ 10^{-3} mm^2/sec for malignant lesions) values for final radiological detection and characterization of focal lesions.

The mean ADC of each detected focal lesion is measured by drawing a region of interest (ROI) over the lesion. The ADC was measured twice and the two measurements were averaged. To ensure that the same areas were measured, regions of interest were copied and pasted from DW images to ADC maps. The results were compared to laboratory and histopathology results in all patients.

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