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The use of DWI to assess spleen and liver quantitative ADC changes in the detection of liver fibrosis stages in chronic viral hepatitis

Hasan Cece[a], Abdulbasit Ercan[a], Sema Yıldız[a], Ekrem Karakas[a,*], Omer Karakas[a], Fatıma Nurefsan Boyacı[a], Timucin Aydogan[b], Emel Yigit Karakas[c], Nesat Cullu[d], Turgay Ulas[e]

[a] Harran University, Faculty of Medicine, Department of Radiology, Sanliurfa, Turkey
[b] Harran University, Faculty of Medicine, Department of Gastroenterology, Sanliurfa, Turkey
[c] Sanliurfa Training and Research Hospital, Department of İnternal Medicine, Sanliurfa, Turkey
[d] Muğla Sıtkı Koçman University, Faculty of Medicine, Department of Radiology, Mugla, Turkey
[e] Harran University, Faculty of Medicine, Department of İnternal Medicine, Sanliurfa, Turkey

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ABSTRACT

This study aimed to evaluate the changes in spleen and liver diffusion-weighted magnetic resonance imaging (DWI) in chronic viral hepatitis patients.

The study comprised 47 patients and 30 healthy volunteers. DWIs were obtained. Apparent Diffusion Coefficient (ADC) measurements were made by transferring the images to the workstation. The measurements of value *b* 1000 were made from a total of five points of the liver and three points of the spleen. Liver biopsy was performed on the 47 patients. The fibrosis stages of the patients were defined according to the METAVIR scoring system. Student's *t*-test was used in the comparison of mean ages, liver and spleen ADC values between the patient and the control group. Kruskal–Wallis followed by Mann–Whitney U Test with Bonferroni adjustment was performed in the comparison of mean ADC values of the patients at different stages and the control group.

A statistically significant difference was determined between the patient and control group in respect of liver and spleen mean ADC values ($P < 0.05$). F3 group showed a significant difference compared to control and F1 and F4 group showed a significant difference compared to control, F1, F2 and F3 group in terms of the mean liver ADC value ($P < 0.01$). F3 and F4 group showed a significant difference compared to control and F1 group in terms of the mean spleen ADC value ($P < 0.01$).

As a result we believe that the measurement of liver and spleen ADC values may be an indicator in the determination of the level of fibrosis.

1. Introduction

The most significant complications associated with chronic hepatitis B virus (HBV) and hepatitis C virus (HCV) infections are cirrhosis of the liver, hepatic decompensation and hepatocellular cancer. It is important to determine the presence and extent of fibrosis to direct the treatment, prognosis and estimation of possible complications in chronic liver diseases [1]. The gold standard for the determination of the stage and extent of chronic liver diseases is the amount of fibrosis that can be defined histopathologically by liver biopsy [2]. However, as histopathological methods are invasive, there are risks for both patient and physician [3]. Therefore, there has been felt to be a need for a more reliable, simple non-invasive method in the determination, measurement and monitoring of hepatic fibrosis. It has been proposed that routine contrast-enhanced magnetic resonance imaging (MRI), perfusion MRI, MR Elastography and MR Spectroscopy can be used in the evaluation of hepatic fibrosis [4]. Unenhanced inversion recovery, magnetisation transfer MRI have been shown to be inadequate in the determination of minimal hepatic fibrosis [5,6]. As the loss of elasticity and increased stiffness supported by FibroScan examinations are associated with fibrosis and cirrhosis, some researchers have reported that it can be used as an indicator of fibrosis [7].

* Corresponding author at: Harran University School of Medicine, Department of Radiology, Yenisehir Campus, 63000, Sanliurfa, Turkey. Tel.: +90 0414 3183027; fax: +90 0414 3183192.
E-mail addresses: hasan_cece@yahoo.com (H. Cece), abdulbasitercan@hotmail.com (A. Ercan), drsemayildiz@yahoo.com (S. Yıldız), karakasekrem@yahoo.com (E. Karakas), dromerkarakas@hotmail.com (O. Karakas), drnurefsan@yahoo.com (F.N. Boyacı), drtaydogan@yahoo.com.tr (T. Aydogan), e.ygtkarakas@yahoo.com.tr (E.Y. Karakas), nesatcullu77@gmail.com (N. Cullu), turgayulas@yahoo.com (T. Ulas).

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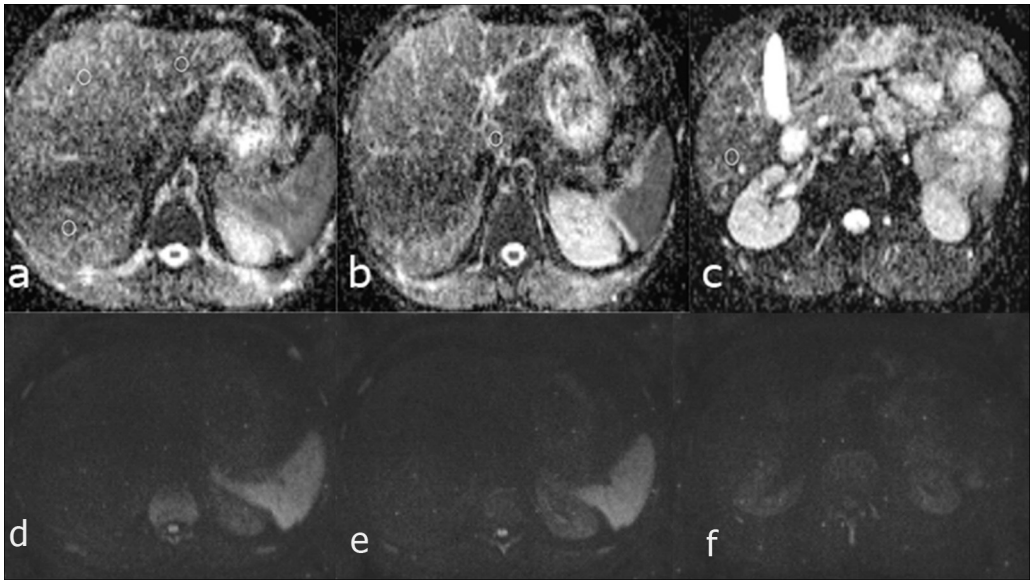

Fig. 1. (1a–c) Upper abdominal ADC images of 40-year-old patient with stage F3 fibrosis. Measurements of value *b* 1000 were made from a total of five points of the liver. (1d–f) DWI images at same sections.

Diffusion-weighted imaging (DWI) is a fast, non-invasive imaging technique which does not require contrast agent [8]. Recent studies have shown promising results of the use of DWI in the diagnosis of fibrosis of the liver [8–11]. To the best of our knowledge there has been no study as yet examining the role of spleen DWI in the evaluation of chronic liver disease. This study aimed to evaluate the changes in spleen and liver DWI in chronic viral hepatitis patients.

2. Materials and methods

2.1. Patients

The study comprised 47 patients who presented at our hospital between October 2009 and September 2010 and were diagnosed with chronic viral hepatitis from the clinical and laboratory findings, and a control group of 30 healthy volunteers. The patients included in the study were determined as 33 with chronic hepatitis B, 13 with chronic hepatitis C and 1 with chronic hepatitis B + C. Portal veins were open in all patients and none of the patients had a history of transjugular intrahepatic portosystemic shunt. None of the patients had the signs of decompasated liver cirrhosis such as ascites or hepatic encephalopathy or a history of varices bleeding.

The exclusion criteria were as follows; those with a poor-quality DWI resulting from an inability to breath-hold, those who had undergone splenectomy, and those who had a low signal-to-noise ratio (SNR) on DWI.

2.2. MRI Examination

A 1.5 Tesla Magnetom Symphony A Tim System (Siemens, Erlagen, Germany) was used for the imaging, which was performed without any need for sedation, in a supine position with a 16-channel body coil over the liver. DWI images directed at the upper abdomen were taken in all patients and control group subjects. By selecting TR 6000 ms, TE 88 ms, FOV 380 mm, matrix 512 × 512, NEX 4 in the single shot, spin echo, echo planar (SS-SE-EP) DWI, images with *b* 0, 500, 1000 s/mm^2 values were obtained. Choice of *b* values may be affected by perfusion contamination, which is known to affect ADCs in patients with liver cirrhosis [12], therefore high *b* values (1000 s/mm^2) were preferred due to the effects perfusion of low *b* values.

Circular Region of Interest (ROI) was used for the quantitative analysis of the ADC value of the hepatic parenchyma. To avoid artefacts, images were taken away from the vascular and biliary structures and from areas of the parenchyma at least 1 cm far from the capsule. The measured area of ROI was set at approximately 1 cm^2.

According to these criteria, measurements of value *b* 1000 were made from a total of five points comprising one from the left lobe of the liver, one from the caudate lobe and 3 from separate points in the right lobe. The right lobe measurements were taken as one from the right lobe anterior section and to reduce the perfusion effect, one each from segment 6 and segment 7 of the posterior section (Fig. 1). The mean hepatic ADC value was calculated by taking the mean of the total five ADC measurements obtained.

For the spleen ADC measurements, a circular ROI of approximately 1 cm^2 was used. The measurements were taken from parenchyma areas at least 1 cm away from the capsule and not crossing major vascular structures as far as possible. According to these criteria, measurements of *b* 1000 value were made from a total of three points as one each from the inferior pole, the interpolar section and the superior pole (Fig. 2). The mean spleen ADC value was calculated from the mean of the three measurements. All of the measurements were obtained by two experienced radiologists and intra/inter observer variability were less than 5%.

2.3. Histopathology

Biopsy was performed on the 47 patients with chronic viral hepatitis using an automatic tru-cut biopsy needle with 16–18 gauge × 16 cm trigger, under ultrasonography by a radiology specialist experienced in this area. No biopsy was performed on the control group. After staining with hematoxylin and eosin (H&E) and Masson's Trichrome (TRI), the results of the DWI and biochemical indicators of the pathology specimens were evaluated by pathologists blinded to the research. The fibrosis stages of the patients were defined according to the METAVIR scoring system. Liver fibrosis was staged on an F0–F4 scale: F0, no fibrosis; F1, portal fibrosis without septa; F2, portal fibrosis with few septa; F3, numerous septa without cirrhosis; and F4, cirrhosis [13]. Those in the patient group