Physiological Changes of Liver ADC values during Cardiac Cycle using DW-EPI

M. Umeda[1], C. Tanaka[2], T. Higuchi[2], Y. Watanabe[3], M. Kitamura[4], I. Aoki[1], S. Naruse[5]

[1]Medical Informatics, Meiji University of Oriental Medicine, Nantan-shi, Kyoto, Japan, [2]Neurosurgery, Meiji University of Oriental Medicine, Nantan-shi, Kyoto, Japan, [3]Meiji shool of Oriental Medicine, Suita-shi, Osaka, Japan, [4]Radiology, Meiji University of Oriental Medicine, Nantan-shi, Kyoto, Japan, [5]Radilogy, Kyoto Prefectural University of Medicine, Kyoto-shi, Kyoto, Japan

Introduction

We have reported that the signal intensity in echo planar diffusion weighted magnetic resonance imaging (DWI) imaging is decreased in skeletal muscular contraction [1] as well as in heart muscle contraction [2] and muscle deformation [3]. Recently, DWI has been reported as useful for the detection of tumor tissues in the body. In these studies, it is well known that the left lobe of the liver is not clearly visible in DWI. And now, the heart is located above the left lobe of the liver. In this study we demonstrate that cardiac motion increases the liver ADC, which is equivalent to signal decrease in DWI.

Material & Methods

Five healthy volunteers were asked to lie in supine position and underwent MRI of the liver with single shot diffusion EPIs and gradient echo, respectively. A Signa LX 1.5 T (CN/I, GEMS) scanner and a standard body coil were used. The scanning parameters of the coronal DWIs were chosen as follows: 96x96 matrix, 50 ms TE, 10 mm slice thickness, 36 mm FOV, 4 averages and 200 KHz receiver band width. The repetition time was two cardiac cycles (about two seconds). DWIs were performed using different motion probing gradients (MPG) of 6 ms duration and 0-4 gauss/cm strength, b-factors were 0,13,23,33,43 s/mm^2, with peripheral gating and breath holding. Three sensitizing gradients in x (R-L), y (S-I) and z (A-P) direction were used. Scanning parameters of the coronal and oblique sliced, cine mode gradient echo images were 256x256 matrix, TR/TE= 4.9/1.3 ms, FA=20 degree. DWIs were obtained during this process. The ADC and diffusion tensor images were calculated using MRVision software (MRVision co., USA).

Results

The cine mode MRIs was evaluated to find the systolic and diastolic periods. Diastole started around 100 ms after peripheral gating. At diastole the cardiac muscle exerts pressure on the left liver lobe and deforms it. The signal of the liver in the DWIs(x) was decreased at the beginning of diastole (Fig. 1, 2). The signal reduction in DWI(x) was larger than that in DWI(y) and DWI(z).

Discussion

The signal reduction of the liver in DWI could be observed starting at the diastolic phase. At this period the left liver lobe is pushed and deforms it by diastole cardiac muscle. Accordingly, this signal decrease might be driven from that tissue water, which was moved incoherently during the application of the MPG. This may be result from the same mechanism, which induces the signal decrease during muscle deformation [3]. The ADCs of the liver were reported in several papers as having a wider range compared with the ADCs of the brain [4]. This variety of the liver ADC can be explained by the deformation of the liver by cardiac motion and respiratory motion. Thus, cardiac gating for stable periods and breath holding techniques are important to measure the ADC of the liver. Observation of increase and decrease of the ADC in the liver may provide valuable information about its elastic properties.

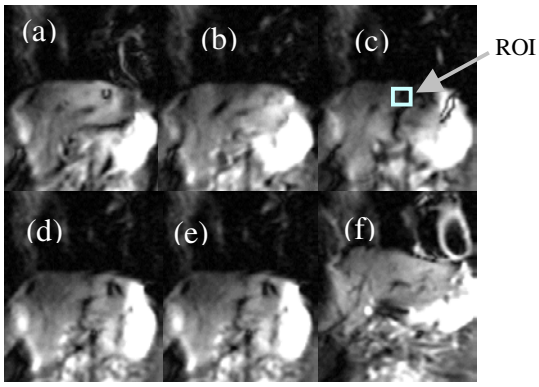

Fig. 1 The signal of the liver in DWIs obtained with b=33 s/mm^2 in x direction changed according to the cardiac cycle. Delay time after peripheral gating was (a) 20 ms, (b) 120 ms, (c) 220 ms, (d) 320 ms, (e) 420 ms, and (f) 520ms.

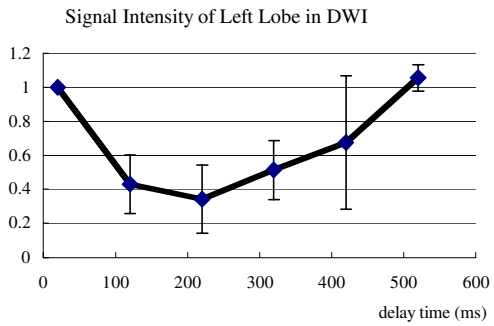

Fig.2 Relative signal changes of left lobe in DWI (x;RL directin , b=33).

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