Assessment of Diffuse Liver Disease by MR Diffusion Measurement: Influence of Perfusion

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Introduction

Recent human studies have indicated that diffusion-weighted imaging using high b values may negatively correlate with the stage of hepatic fibrosis [1] and be a promising method for non-invasive assessment of fibrosis. Work with a rat model of fibrosis has also shown that the apparent hepatic diffusion coefficient (ADC) *in vivo* is negatively correlated with the length of exposure to carbon tetrachloride [2]. However, in the same rat livers *ex vivo*, the negative correlation of the ADC with fibrosis is lost. The authors concluded that perfusion effects therefore explain the correlation differences. MR diffusion measurements can be influenced by many different factors, including perfusion, cellular architecture and permeability [3]. This study aims to determine whether *in vivo* perfusion changes influence hepatic ADC measurements in healthy volunteers. Prandial state is known to strongly influence portal vein bulk flow and hepatic sinusoidal perfusion [4,5].

Methods

10 healthy volunteers with no history of liver or gastrointestinal disease were recruited (3 Male:7 Female Age 23-56 yrs). Subjects fasted for 8 hours before the examinations, all performed at 1.5T (EX, Excite GEHT Milwaukee) with an 8-channel body array and a restraining band to minimise liver motion. A cine phase-contrast velocity study (venc 40cm/sec, matrix 256x256) was performed through the main portal vein and bulk flow (ml/min) calculated. A diffusion weighted-EPI examination was performed through the liver during quiet respiration as follows: matrix: 128 x 128, NEX = 8, b = 0 and 750 s/mm^2, 7 axial slices, 10 mm sections, gap 1.5 mm, TR/TE = 2000/81ms, Acquisition time 2 minutes. It has been shown in the same volunteers that the ADCs measured with this protocol at low b value are equivalent to those acquired with a single breath-hold: this protocol has the advantage of providing higher signal to noise ratio, particularly useful when using high b-values. The volunteers were then given a standard meal (3260 kJ/777 kcal, 77g carbohydrate, 41g fat, 25g protein, 8g fibre) and the above protocol repeated at one hour. Internal landmarks (portal vein) were used to match the locations of both sets of images. Two circular regions of interest were defined in the right lobe (anterior and posterior segments) on the best 5 image sections of each set of images (figure 2). Insufficient measurements were available in the left lateral segment due to the effects of cardiac motion and difficulties in location matching post-feeding (figure 3). A non-parametric Friedman test was performed on the paired data (pre and post meal) to determine whether changes in the estimated ADCs were significant.

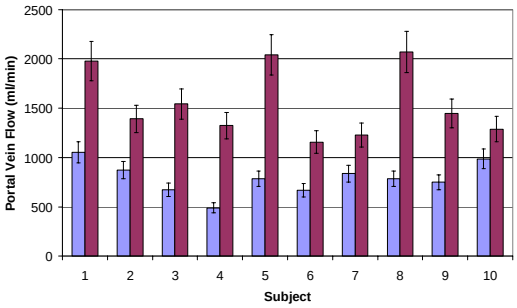

Figure 1: Portal vein flow (ml/min) pre- and post-feeding

Results

Bulk flow in the portal vein increased significantly ($p < 0.001$ in all cases: mean flowrate pre-prandial 789 ml/min, post-prandial 1546 ml/min, range 490-2040 ml/min) in all subjects. The ADCs in the posterior right lobe (figure 4) were found not to change significantly across all subjects ($p = 0.06$), but the ADCs in the anterior right lobe (figure 5) were found to be significantly higher ($p = 0.02$).

Conclusions

This study suggests that in the posterior right lobe the diffusion measurements shows the least variation between individuals and are unaffected by the change in portal vein flow and related hepatic perfusion. This is likely to be the optimum location for diffusion-weighted measurements and any anticipated ADC changes in fibrosis. The results for the anterior right lobe are more complex; the observed changes in ADC may be related to perfusion, however there is greater inter-subject variability and the observed changes may be influenced by motion artefacts or large vessel flow. A correlation between fibrosis grade and ADC would be harder to establish in the anterior right lobe and further repeatability studies are required. Further work will examine the sensitivity and specificity of these techniques in a patient population with known cirrhosis.

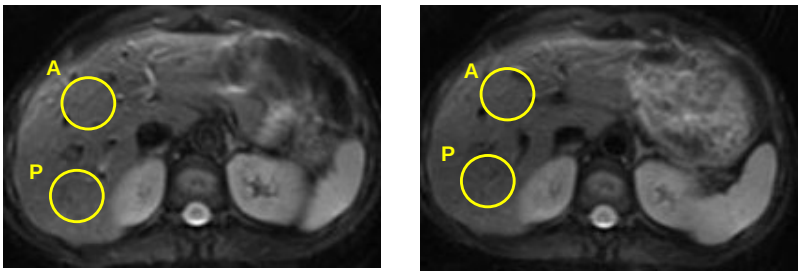

Figure 2 : Axial DW-EPI images (b=0 s/mm^2), (a) fasted and (b) fed, showing the placement of the ROIs in the posterior (P) and anterior (A) right lobe.

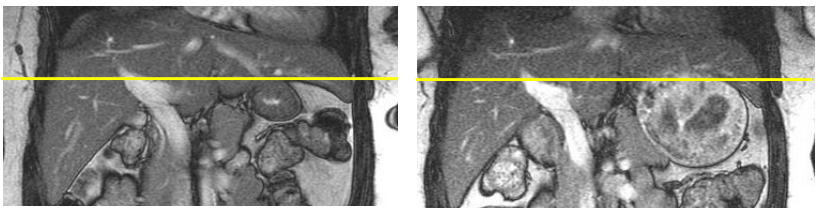

Figure 3 : Coronal images showing the difficulty in location matching the left lobe due to gastric enlargement between the (a) fasted and (b) fed state.

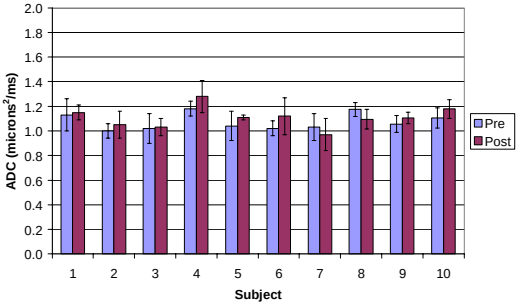

Figure 4 : Average ADC measured in the posterior right lobe

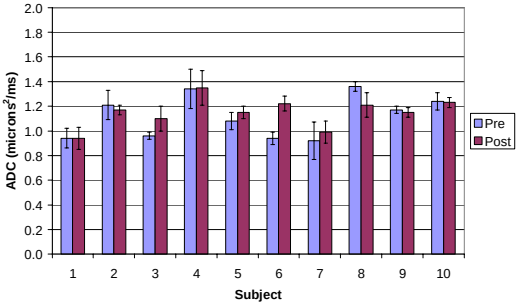

Figure 5 : Average ADC measured in the anterior right lobe

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