

Effect of region of interest position on liver apparent diffusion coefficient.

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Introduction

Diffusion MRI has been used to diagnose liver fibrosis by calculating the apparent diffusion coefficient (ADC) in liver tissue (1,2). The ADC is calculated from diffusion weighted images with different b-values. In order to be useful as a whole liver test, the calculated ADC should be independent of position in the liver. However, it is recognised that in certain areas of the liver such as the left lobe it is difficult to obtain diffusion weighted images. Other areas of the liver may have poorer SNR (e.g. centrally in the liver in the anterior-posterior direction) and this can be especially noticeable with the use of parallel imaging. The aim of this study was to establish if there was a significant difference in ADC between different regions of the liver.

Methods

33 patients who were referred to the MRI unit for an assessment of their liver for assessment of suitability for surgical resection of colorectal liver metastases were included in this study. Diffusion weighted trace images were acquired through the liver using a navigator triggered technique with the following parameters; TR / TE = 1900 / 69 ms, EPI factor = 116, parallel imaging factor = 2, bandwidth = 1628 Hz/pixel, matrix = 116 x 192, number of averages = 2, slice thickness = 7 mm, b = 0, 150, 300, 450 and 600 s/mm². 24 slices, FOV=320 – 400 mm, phase FOV = 72%.

The trace images were transferred to an in-house image processing system (Matlab, Mathworks, Ca) and three regions of interest (ROIs) were drawn in the following locations; ROI 1 was positioned superiorly in segment 2 of the left lobe, ROI 2 was positioned centrally in the antero-posterior direction in the right lobe and ROI 3 was located posteriorly in the right lobe. No attempt was made to exclude ROI 1 from positions which showed artefactually large signal drop out at high b-values. ADC values were calculated for each region by fitting the signal intensities to $S = S_0 \exp(-b \cdot \text{ADC})$ using (a) all b values and (b) using b = 150, 300 and 450 s/mm². The average ADC value for each position and each b value set was calculated. The statistical significance of any difference in ADC between each position was calculated using the paired t-test. The average intra-patient coefficient of variation (COV) for each patient was calculated for both b-value sets. The inter-patient coefficient of variation was calculated for each ROI and each b-value set.

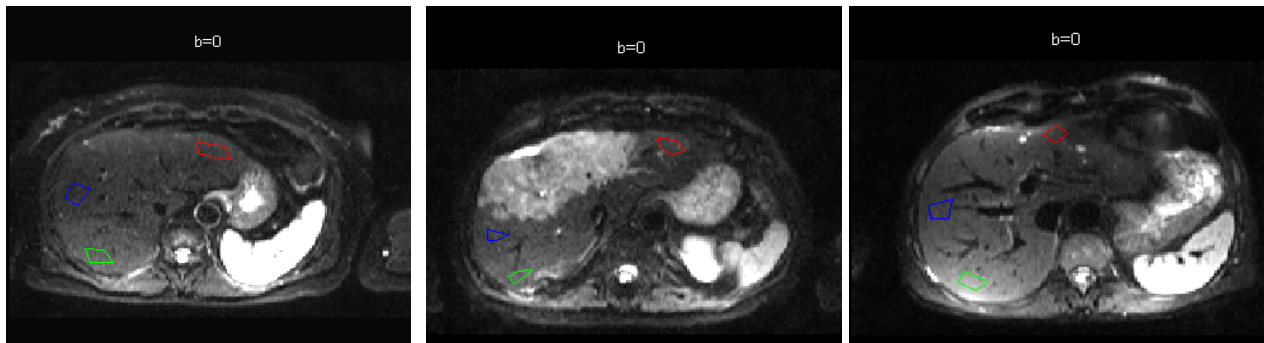


Figure 1. Liver images ($b=0 \text{ s/mm}^2$) showing ROI 1 (red), ROI 2 (blue) and ROI 3 (green) for 3 different patients.

Results

The average ADC value and inter-patient COV for each ROI position are given in table 1. There was a significant difference at the 0.05 level between the ADCs calculated in each position of the liver for both b-value combination sets except for between ROI 2 and ROI 3 for b-values of 150, 300 and 450 s/mm². The average intra-patient ADC coefficient of variation for all b-values and for b-values of 150, 300 and 450 s/mm² was 32% and 36% respectively. The inter-patient coefficient of variation was highest for the b-value set 150, 300 and 450 s/mm² and was higher for the left lobe for both b-value sets.

	All b values	b=150, 300, 450 s/mm ²
ROI 1 (L lobe)	1764 (24%)	1880 (39%)
ROI 2 (R lobe central)	978 (14%)	1064 (24%)
ROI 3 (R lobe posterior)	1134 (17%)	1188 (28%)

Table 1: Average ADC values ($\times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$) with the inter-patient coefficient of variations for each ROI in parentheses.

Discussion and Conclusion

The results show that great care must be taken in positioning regions of interest to calculate ADC values in the liver. This is particularly true for the left lobe of the liver which can be affected by its proximity to the heart. This leads to very rapid signal loss at higher b-values and can often be identified by examination of the corresponding trace images. Noise effects in the middle of the liver may also have a systematic effect on the calculated ADC as demonstrated by the decrease in ADC for this region compared to the more posteriorly positioned ROI 3. Further work is needed to develop methods to eliminate this effect.

References: (1) Taouli B, Tolia AJ, Losada M et al. Diffusion-weighted MRI for quantification of liver fibrosis: preliminary experience. AJR 189:799-806, 2007. (2) Koinuma M, Ohashi I, Hanafusa K, Shibuya H. Apparent diffusion coefficient measurements with diffusion-weighted magnetic resonance imaging for evaluation of hepatic fibrosis. J Magn Reson Imaging. 22:80-85, 2005.