

Comparison of liver ADC measurements using breath-hold, free breath-hold and respiratory gating echoplanar diffusion-weighted imaging sequences using parallel imaging technique with different acceleration factors

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Introduction:

Echoplanar diffusion-weighted images (EP-DWI) with breath holding (BH) have been widely applied to evaluate the apparent diffusion coefficient (ADC) of liver. Clinically, the spatial coverage of DWI is usually limited by the duration (around 20 seconds) of breath hold. Free breathing (FB) and respiratory gating (RG) methods allow larger spatial coverage of liver in one scan. Comparison of liver ADC measurements in BH, FB, and RG EP-DWI at two folds of acceleration has been rarely investigated recently [1-3]. The aim of this preliminary study was to verify the measurement differences of liver ADC among clinically available BH, FB and RG methods with different acceleration factors.

Materials and Methods:

Seventeen volunteers without any hepatic lesion (11 men and 6 women; 43.12 ± 16.44 years) were enrolled. All liver scans were performed on a 1.5T MR scanner (GE Healthcare, Signa HDx, US) using a 12-channel phase-array body coil. Scanning parameters including resolution (128x128), slice number (8), slice thickness (8 mm), gap (1 mm), b values (0 sec/mm² and 600 sec/mm²) and NEX (3) were consistent in all diffusion protocols. Four methods including BH (TR/TE/scan time = 1650/60.1/20), FB 1650 (1650/60.1/20), FB 4000 (4000/60.1/48) and RG (4000-7000/60.1/50-110) with acceleration factors of 1 and 2 were applied. In each volunteer, five circular regions-of-interest (ROIs) were manually placed in the peripheral liver parenchyma to avoid partial volume effect of blood vessels and bile ducts (Fig. 1).

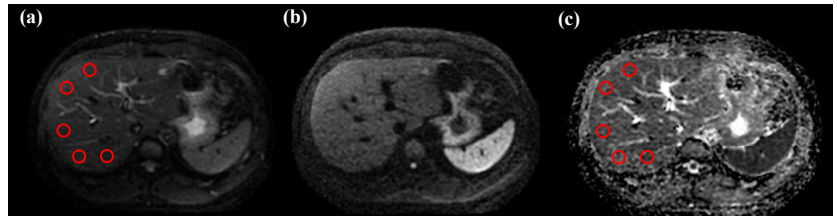


Fig. 1. EP-DWI (a) $b = 0 \text{ sec/mm}^2$, (b) $b = 600 \text{ sec/mm}^2$ and ADC map (c) using breath hold method were demonstrated. Circular ROIs were manually placed on DWI ($b = 0 \text{ sec/mm}^2$).

A total of 375 pixels, 75 pixels in each ROI, were used for analysis of ADC value. Statistical analyses were performed by using SPSS 13.0 (SPSS, Chicago, Ill). Normality of the perfusion parameters was examined using Q-Q plots and Kolmogorov-Smirnov tests. Student t test was used for group comparisons of ADC. A *P* value of less than 0.05 was considered as statistically significant.

Results:

All EP-DWI sequences showed satisfactory imaging quality on both DWI and ADC maps without perceptible distortion. Ts parenchymal ADC values, however, showed significant differences among different pulse sequences with details as summarized in Fig. 2.

Discussion & Conclusion:

The liver ADC values acquired by RG method are significantly higher than that acquired by BH method no matter with acceleration or not. Our results are in consistent with Kwee's and Taouli's studies [1, 2]. Kandpal's study, however, shows no difference of liver ADC values acquired by RG and BH methods [3]. Such discrepancy might be attributed to the different repetition times. While choosing the same repetition time, we find that the ADC values acquired by FB 1650 method do not differ from that acquired by BH method no matter with acceleration or not. The ADC values of liver parenchyma measured by accelerated EP-DWI are significantly higher than that measured by non-accelerated EP-DWI in BH, FB 4000 and RG methods. Our findings are in consistent with a recent research in parotid glands [4]. In conclusion, our study demonstrates significant quantification differences of liver ADC values among three different clinically available pulse sequences. Unlike FB 4000 and RG, FB 1650 method allows ADC measurement similar to BH method and therefore might serve as a substitute for BH method for those who have difficulty in breathing hold.

Reference: [1] Kwee TC, et al. JMRI 2008, 28: 1141-1148. [2] Taouli B, et al. JMRI 2009, 30: 561- 568. [3] Kandpal H, et al. AJR 2009, 192: 915-922. [4] Juan CJ, et al. Radiology 2009, 253: 144-152.

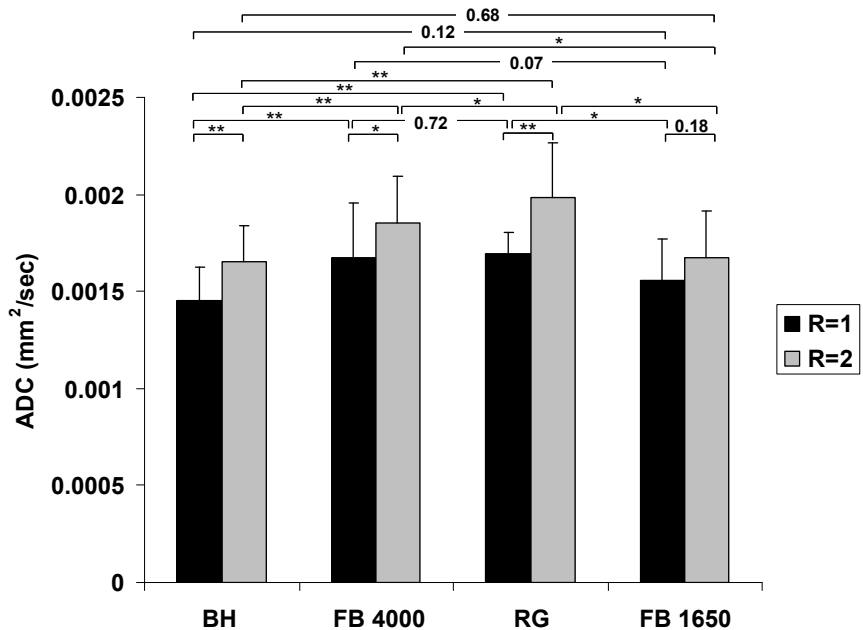


Fig. 2. ADC values of liver parenchyma acquired by BH, FB 4000, RG and FB 1650 with acceleration factors (R) of 1 and 2. Numbers at top are *P* values for comparisons between different DWI sequences, with significant differences ($P < 0.005$ [**], $P < 0.05$ [*]) noted.