Comparing the results of intravoxel incoherent motion diffusion-weighted imaging calculated by different estimation methods

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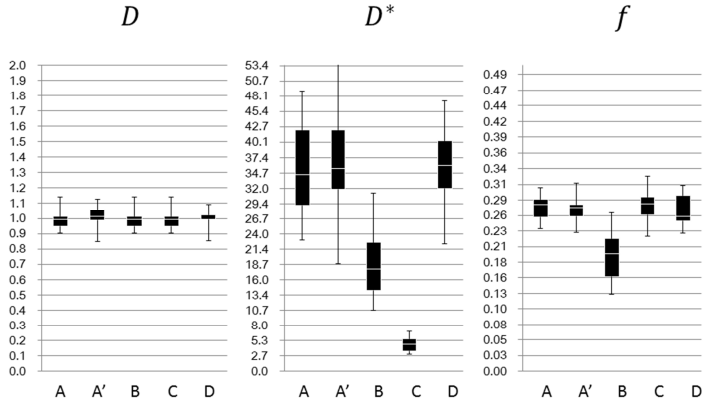
Purpose: To compare the results of intravoxel incoherent motion (IVIM) diffusion-weighted (DW) imaging model calculated by 5 different estimation methods.

Methods: The liver of a healthy volunteer was scanned to obtain DW images with multiple b values of 0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 175, 200, 400, 600, and 800 s/mm^2. The scan was repeated 10 times with a few minutes interval. The signal intensities (SI) of each DW image in the right lobe of the liver was used to calculate the IVIM-DWI results using the following equation: $S_b = S_0 \cdot \{(1-f) \cdot exp(-bD) + f \cdot exp(-bD^*)\}$. Where, S_b = SI on DW image of certain b value; D = true or slow diffusion coefficient ($\times 10^{-3}$ mm^2/s); D^* = pseudo- or fast-diffusion coefficient ($\times 10^{-3}$ mm^2/s); and f = pseudo-diffusion fraction. During the calculation, 5 different estimation methods were used: **(A)** obtaining the D value first using DWI of b ≥ 200 s/mm^2, followed by obtaining $D^*$and f simultaneously using non-linear fitting; **(A')** obtaining all 3 values simultaneously using non-linear fitting; **(B)** obtaining the D value first as described in method A; (Since the linear regression line suggests the SI contributed by only true diffusion (SI_{true}), pseudo-diffusion only linear regression line can be drawn using SI_{pseudo}, which were obtained by subtracting SI_{true} from S_b, and the f value can be obtained by third linear regression); **(C)** After obtaining the D value as described in method A, the f value was obtained using the intersection of the regression line and SI of b = 0 (the third linear regression can provide the D^* value); and **(D)** Bayesian estimation for D, D^*, and f, which was proposed by Neil JJ and Bretthorst L. Mean values of D, D^*, and f estimated by the aforementioned methods were compared with each other using the Wilcoxon test with Bonferroni correction. A p value less than 0.005 was considered statistically significant. We also calculated the coefficient of variations (CVs) of each value for the 5 estimation methods.



Results: The results were shown in Box-Whisker plots. The D values seem to be consistent with no large variability. The CVs of D values were <10% for all estimation methods. However, the D^* value by estimation methods B and C, and the f value by method B had significantly lower results than that obtained by the A, A', and D methods ($p < 0.005$). The CVs of D^* and f values ranged from 22 to 35% and 8 to 24%, respectively.

Conclusion: IVIM DWI results significantly vary by estimation methods using non-linear and linear regression. Bayesian estimation provides equivalent results of non-linear estimation.