Reproducibility of Intravoxel Incoherent Motion Diffusion-Weighted Imaging in Small Bowel Crohn¡¯s Disease

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PURPOSE: Parameters obtained from intravoxel incoherent motion (IVIM)-diffusionweighted imaging (DWI) has been employed to quantitatively characterize the diffusion and perfusion of small bowel of Crohn's disease (CD) [1]. However, the reliability of the IVIM model parameters, which include pure diffusion coefficient (D), pseudodiffusion coefficient (D*) and perfusion fraction (f), may be affected by the intestinal peristalsis and the difficulty in delineating the bowel loops. The purpose of this study was to test the reproducibility of the IVIM model parameters in assessing small bowel disease.

MATERIALS AND METHODS: Eleven patients with clinically or pathologically confirmed CD underwent DW-MRI using a 3.0T clinical scanner (Achieva 3.0T TX, Philips Healthcare, Best, Netherlands). The DW-MRI sequence were performed twice on each patient with following parameters: (free-breathing single-shot echo-planar imaging, TR/TE = 3050ms/54ms, SPAIR fat suppression, 13 b-values with the distribution of 0, 20, 40, 60, 80, 100, 120, 160, 200, 400, 600, 800, 1000 s/mm^2, FOV 300×260mm, matrix 100×83, NSA=2,slice thickness 5mm, 36-48 axial slices, acquisition time 10 min). For the analysis of IVIM, the region growing method based on signal intensity thresholding was used to determine a 3D region of interest (ROI) of the disease segment. Parameters D, f, and D* of the pixels within the ROI were obtained according to the bi-exponential model published previously[2]. Then the coefficient of determination reflecting fitting error were calculated to correct the mean D, f and D* of the 3D ROI. Parameters derived by IVIM-DWI were compared between the first and the second acquisitions by using the paired *t*-test. Reproducibility was evaluated by the Bland-Altman plot and intraclass correlation coefficients (ICC).

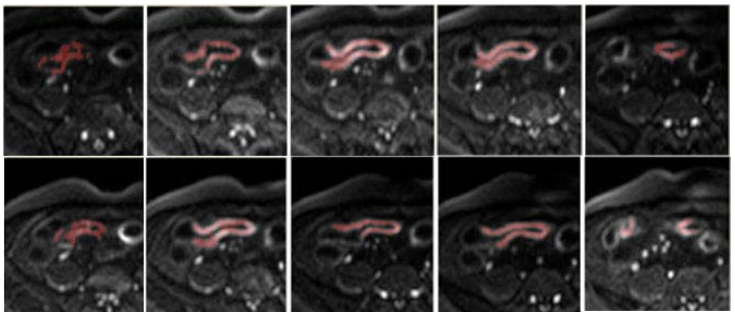

Figure 1. Region growing 3D ROIs of the same bowel loop lesion from two different acquisions, shown in different rows.

Parameter	1st acquisition	2nd acquisition	Mean difference	p-value
D*(10^{-3}mm^2/s)	29.110 ± 9.060	29.419 ± 7.887	-0.309 ± 7.383	0.801
D(10^{-3}mm^2/s)	1.385 ± 0.382	1.380 ± 0.318	0.004 ± 0.211	0.904
f	0.250 ± 0.089	0.253 ± 0.080	-0.003 ± 0.055	0.751

Table 1: IVIM parameters of 2 different acquisitions.

Parameter	Bland-Altman 95% LoA	ICC(95%CI)
D*(10^{-3}mm^2/s)	-14.780–14.162	0.773(0.562–0.883)
D (10^{-3}mm^2/s)	-0.410–0.418	0.904(0.814–0.950)
f	-0.110–0.104	0.885(0.778–0.941)

Table 2: Summary statistics of the reproducibility of parameters measurement on repeated acquisitions

RESULTS and DISCUSSION: 37 ROIs of 11 patients were drawn on each of 2 acquisitions. Fig.1 illustrates the case of one ROI. IVIM parameters of the first and the second acquisitions were shown in Tab.1. There were no significant differences in these parameters between the 2 acquisitions (P>0.05). For D measurement, 95%LoA was 0.410 10^{-3}mm^2/s to 0.418 10^{-3}mm^2/s , and the ICC was 0.904 (95%CI:0.814–0.950). For *f* measurement, 95%LoA was -0.110 10^{-3}mm^2/s to 0.10410^{-3}mm^2/s, and the ICC was 0.885 (95%CI: 0.778–0.941). And for D* measurement, 95%LoA was -14.780 10^{-3}mm^2/s to 14.16210^{-3}mm^2/s, and the ICC was 0.773 (95%CI: 0.562–0.883). The Bland-Altman plot analysis (Fig. 2) showed small differences. D and *f* measurement had higher ICC, they demonstrated better reproducibility on the 2 acquisitions, while D* measurement had lower ICC, which showed moderate reproducibility.

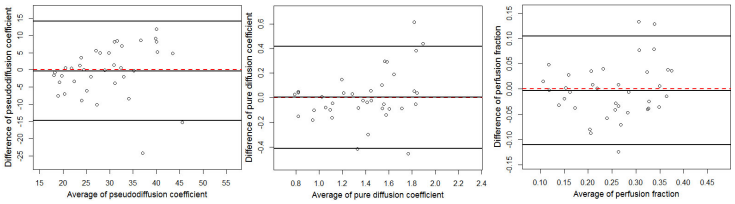

Fig2. Bland-Altman plot of D*, D and f measurement.

CONCLUSION: The IVIM DWI can provide quantitative parameters that may prove to be useful in assessing disease activity and in monitoring the response to the treatment of CD. For this study population, there was good to moderate measurement reproducibility of D, *f* and D* of small bowel CD.

REFERENCE: 1. Freiman, M., et al J Magn Reson Imaging, 2013. 2. Le Bihan, D., et al., Radiology, 1988.