Diffusion weighted Imaging using Intravoxel incoherent motion model with T2 relaxivity correction for therapeutic efficacy in VX2 liver tumor in Rabbits

Jeong Hee Yoon[1], Jeong Min Lee[1], Mun Young Paek[2], Sangwoo Lee[3], and Joon Koo Han[1]
[1]Radiology, Seoul National University Hospital, Seoul, Seoul, Korea, [2]Siemens Healthcare Korea, Seoul, Korea, [3]Samsung electronics, Seoul, Seoul, Korea

[Target audience] audience who are interested in liver diffusion weighted imaging (DWI)

[Purpose] DWI using intravoxel incoherent motion model (IVIM-DWI) has been widely used for liver parenchymal or tumor evaluation in body imaging. Among the parameters, perfusion fraction (f) is known to be affected by tissue T2 relaxation time and MR TE parameter. Thus, alteration of T2 relaxation time of tumors may hamper accurate quantification of IVIM-DWI parameters. Therefore, the purpose of this study is to determine whether T2 correction on diffusion weighted imaging (DWI) using intravoxel incoherent motion (IVIM) model can provide different perfusion fraction (*f*) on DWI without T2 correction in Sorafenib treated VX2 liver tumors in rabbits.

[Methods] The institutional animal care and use committee approved this study. In New Zealand White male rabbits (control [n=15], treated [n=16]) on days 0 and 7 after Sorafenib administration (20mg/kg, p.o.). DWI using nine b values (b=0, 10, 20, 30, 40, 50, 100, 150, 400, 800 s/mm^2; TR/TE=3000/63; NEX=8) followed by T2 mapping obtained byT2WI spin echo EPI with eight TEs (12 to 96ms in every 12ms)were performed a 3T MR scanner (Trio, Siemens Healthcare, Erlangen, Germany). IVIM parameters (D, D* and *f* were estimated pixel by pixel using the nonlinear least squared fitting algorithm[1]. The perfusion fraction with relaxivity correction (*f'*) was calculated based on the *f*, measured T2 and blood T2 from T2 map according to prior studies[2].

[Results] Tumor size of treated group was significantly smaller than control group on day 7 (10.1±2.3mm vs. 15.4±3.2mm, *P*=0.004) whereas baseline size was not different between two groups (8.8±3.5mm vs. 9.5±1.7mm, *P*=0.47).T2 relaxation time of VX2 tumors tended to increase on day 7 in control group (115.5±81.3ms vs. 158.2±61.7ms, P=0.2) and tended to decrease in treated group (103.7±34.8ms vs. 90.1±19.6ms, *P*=0.26). On day 0, perfusion fraction (*f*) and T2 corrected perfusion fraction (*f'*) were not significantly different between control and treated groups (*f*, 20.0±19.8% vs. 20.2±24.2%, P=0.98; *f'*, 11.5±0.60 vs. 11.4±0.5%, *P*=0.41), but values were decreased after T2 correction (*P*=0.046). On day0 IVIM-DWI, tumors with T2 relaxation time (≤90ms, twice of rabbit blood T2 relaxation time on T2 map) showed marginally different f and f' values (f=27.6±28.7%, f'=11.6±0.7%, *P*=0.05) whereas tumors with T2 relaxation time (>90ms) did not show significantly different f and f' values (12.0±4.1% vs. 11.3±0.3%, *P*=0.52). On day 7, perfusion fraction (*f*) was significantly higher in treated group compared to control group (5.5±1.1% vs. 24.3±28.6%, *P*=0.002). However, corrected perfusion fraction (*f'*) was significantly lower in treated group compared to control group (10.5±0.09% vs. 10.3±0.1%, *P*=0.0074). Compared to baseline value (day 0), corrected perfusion fraction (*f'*) was significantly reduced on day 7 in treated group (*P*=0.0002), whereas perfusion fraction (*f*) was not significantly different (*P*=0.43).

[Discussion] T2 relaxation time seemed to affect perfusion fraction (*f*) of IVIM-DWI. The relaxivity correction for the *f* will also help to predict perfusion-related information more accurately without T2 relaxivity contamination.

[Conclusion] T2 relaxation in a tissue may affect perfusion fraction of IVIM-DWI and T2 correction using T2 mapping can be used to reduce influence of tissue T2 relaxation time on perfusion fraction value.

[References] 1. Yoon et al, JCAT 2014;38(1): 110-116. 2. Lemke et al, Magn. Res. Med. 2010; 64:1580-1585

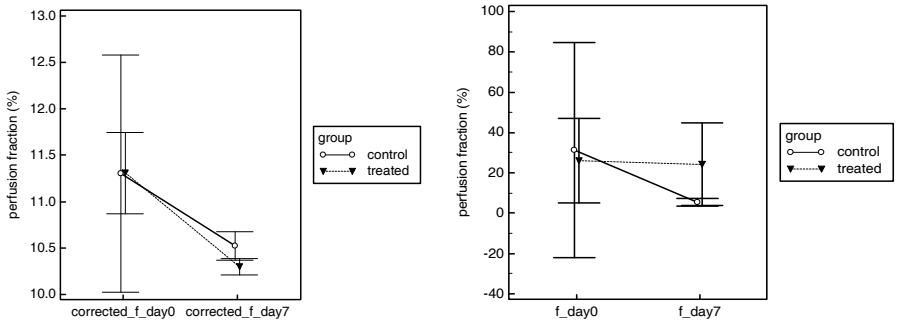

Figure 1. corrected perfusion value (left) showed decreased perfusion fraction in treated group and overall values decreased after T2 relaxivity correction. Perfusion fraction without T2 relaxivity correction (right) showed reversed results that perfusion fraction (f) was higher in treated group.