Synthesized Diffusion Weighted Imaging in Liver: Comparison between conventional ADC and IVIM fitting models

Tetsuya Wakayama[1], Utaroh Motosugi[2], Shintaro Ichikawa[2], Hiroyuki Morisaka[2], and Hiroyuki Kabasawa[1]
[1]*Global Applied Science Laboratory, GE Healthcare, Hino, Tokyo, Japan,* [2]*Radiology, University of Yamanashi, Chuo, Yamanashi, Japan*

[Target audience] This presentation will be targeted to audience interested in post-processing, diffusion and/or liver.

[Purpose] Adjustability of b-value in synthesized diffusion-weighted image (DWI) can provide the optimal diffusion weighting and be useful for clinical diagnosis in many regions including liver. The usefulness of synthesizing high b-value DWI from low b-value DWIs has been reported,[1] however, to our knowledge, there's no publication regarding synthesis of low or intermediate b-value DWI and also regarding comparison between fitting models in synthesis of DWI. In this study, in order to synthesize virtual DWI in low b-value range, two fitting models, conventional ADC model and IVIM model, were applied and compared with DWI actually acquired.

[Methods] Liver DWI was acquired from two subjects using a 1.5T clinical scanner (Signa HDxt, GE Healthcare, WI, USA). DW-EPI sequence was used with respiratory gating and ASSET parallel imaging. The acquisition parameters were TR=1RR (over 3000 ms), effective TE=70.8 ms, THK=7 mm with 2.5 mm spacing, FOV=40x40 cm^2 with matrix=128x128, NEX=4, b-values were=0, 10, 20, 30, 40, 50, 80, 100, 200, 500, 1000 s/mm^2, respectively. The acquired data were analyzed by using two fitting algorithms. One algorithm was linear regression based on the conventional ADC model where the signal decay is mono-exponential along b-values. In the ADC model, one unknown parameter, ADC, was calculated, and then virtual DWI was synthesized by using the T2 (b=0 s/mm^2) image and the calculated ADC with a given b-value. Another algorithm was non-linear fitting based on IVIM model where the signal decay can be expressed as the sum of two mono-exponential terms.[2] In the IVIM model, three unknown parameters, true diffusion coefficient, pseudo-diffusion coefficient and perfusion fraction, were calculated by Levenberg-Marquardt method.[3] The virtual DWI was synthesized by using the T2 image and the IVIM parameters with a given b-value. These virtual DWIs by the conventional ADC and IVIM models were compared with the DWI actually acquired.

[Results] The virtual DWI could be successfully synthesized by using both IVIM and ADC models. Figure 1 shows the actual DWI (a,e), synthesized DWIs by IVIM model (b,f) and ADC model (c,g) with b-values of 50 (a,b,c) and 1000 s/mm^2 (e,f,g), respectively, in addition to T2 image (d). When compared between DWIs with b-value of 50 mm/s^2, the synthesized DWI by ADC model showed the signal overestimation in the intrahepatic vessels (red arrow in c), whereas the synthesized DWI by IVIM model could show very similar contrast with the actual DWI. On the other hand, when compared between DWIs with b-value of 1000 mm/s^2, unstable fitting results was seen in few pixels of the synthesized DWI by IVIM model.

[Discussion] The synthesized DWI by IVIM model could provide more accurate contrast than that by ADC model, in low b-values less than 200 mm/s^2. This is because the IVIM model could reflect rapid signal decay in extremely low b-value due to perfusion-based pseudo-diffusion effect. The conventional ADC model couldn't reflect the rapid signal drop in b-value of 50mm/s^2, therefore the contrast of the synthesized DWI was slightly closer to T2W image than in IVIM model. Whereas in high b-values, e.g. 1000 mm/s^2, both the synthesized DWIs by ADC and IVIM models were similar to the actual DWI. In such ranges, the use of ADC model would be enough to generate the original diffusion contrast.

[Conclusion] IVIM model can provide more accurate contrast than ADC model, when synthesizing DWI with low b-value.

[References]

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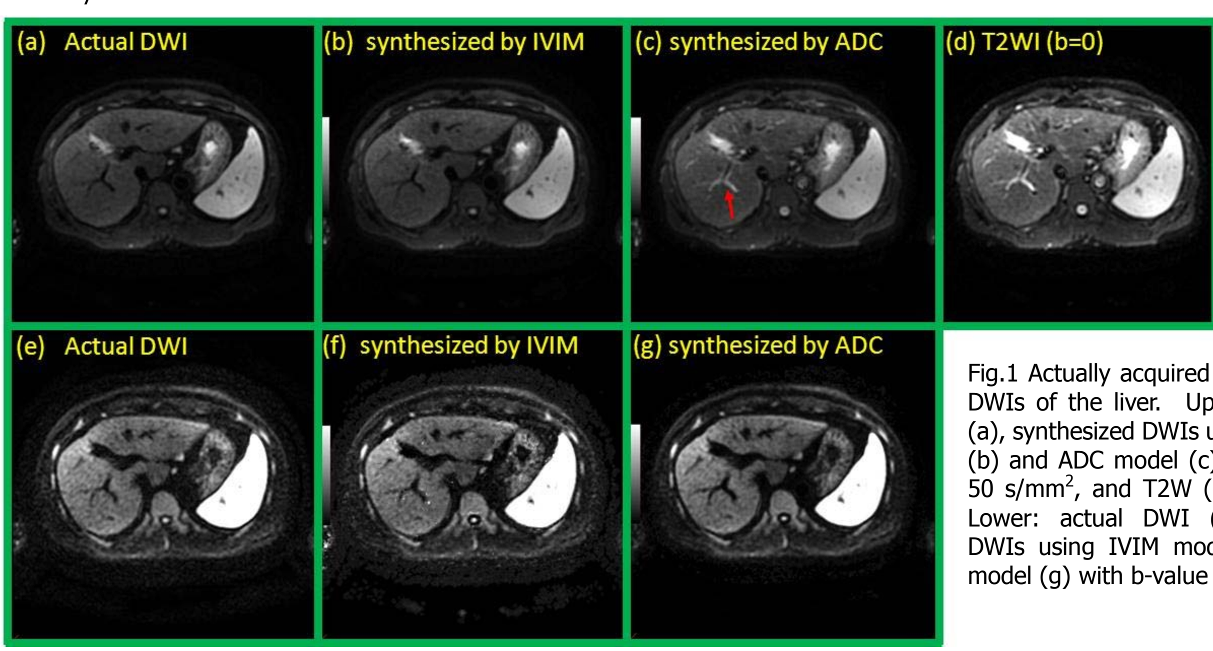

Fig.1 Actually acquired and synthesized DWIs of the liver. Upper: actual DWI (a), synthesized DWIs using IVIM model (b) and ADC model (c) with b-value of 50 s/mm^2, and T2W (b=0) image (d). Lower: actual DWI (e), synthesized DWIs using IVIM model (f) and ADC model (g) with b-value of 1000 s/mm^2.