3T PROPELLER DiffusionTensor Imaging and Tractography : A method for SAR reduction.

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[Introduction]

3Tesla MRI has high signal to noise ratio (SNR) comparing to lower field (1.5T) MRI, so it is expected that diffusion tensor imaging could be applied to small neuro anatomy such as cranial nerves. That is often difficult with single shot Echo Planar Imaging (ssEPI) due to its sensitive to magnetic susceptibility. 3T PROPELLER-Diffusion tensor tractography could be an available acquisition strategy for such challenging area [1]. Despite its usefulness, this acquisition method suffers from SAR limitation at high field, and that results in long scan time or limited slice coverage. EPI or GRASE based solutions have been proposed to reduce PROPELLER SAR issue at high field, but those methods introduced acquisition instability caused by eddy current difference in various blade orientation [2][3]. In this study, we propose another strategy to reduce SAR of PROPELLER-DTI acquisition using VERSE excitation [4].

[Materials and Methods]

VESER RF pulse with minimum SAR design was implemented to PROPELLER-DTI pulse sequence. Diffusion Tensor Images were acquired on 3T MRI scanner (SIGNA HDx ver.14, GE Healthcare, Waukesha, WI) with Transmit/Receive QD head coil. Two healthy male (29yr. and 39yr.) were scanned by VERSE PROPELLER based DTI (V-PROP-DTI) and PROPELLER-DTI pulse sequence. The following scan parameters were used for V-PROP-DTI acquisition (TR/TE, 8000ms/83ms; thickness, 3 mm with no gap; b-value, 800 s/mm2; echo train length, 16; FOV 24 cm; NEX 2; the number of blade, 24; Matrix 128×128, rbw=62.5kHz, MPG encoding gradient 6). PROPELLER-DTI was also acquired with the same scan protocol with 12sec of TR. SAR was estimated using SAR meter equipped with the MRI system. All fiber tracking was performed with “volume-one” and “dTV-II” software [5]. Seed and Target ROIs were placed on isotropic diffusion image based on anatomical knowledge.

[Results]

No significant distortion was observed in the vicinity of the pons or midbrain in PROPELLER-DTI comparing to high spatial resolution anatomical T1 weighted image (Figure.1 (A)). It also provided sufficient SNR and spatial resolution to track cranial nerves (Figure.1 (B)). Slice coverage was limited to 10-12 slices with 12sec of Repetition Time due to SAR safety limit (2.0W/kg) in PROPELLER-DTI. The Slice coverage was increased to 28 slices with 8sec of Repetition Time. The relationship between the estimated V-PROP-DTI SAR value and VERSE RF power reduction ratio was shown in Figure.1 (C). The estimated average SAR value was reduced to 1.2 W/kg with 16% amplitude of the nominal peak value of refocus RF pulses, while the echo space was increased to 7ms.

[Discussions and Conclusion]

In this study we have shown that PROPELLER-DTI and DTT was feasible at 3T. The VERSE implementation to PROPELLER reduced SAR and that helped to increase volume coverage and reduce scan time to clinically acceptable range. We conclude that 3T V-PROP-DTT has potential for acquiring diffusion tensor images without compromising both image geometry accuracy and slice coverage.

[Reference]

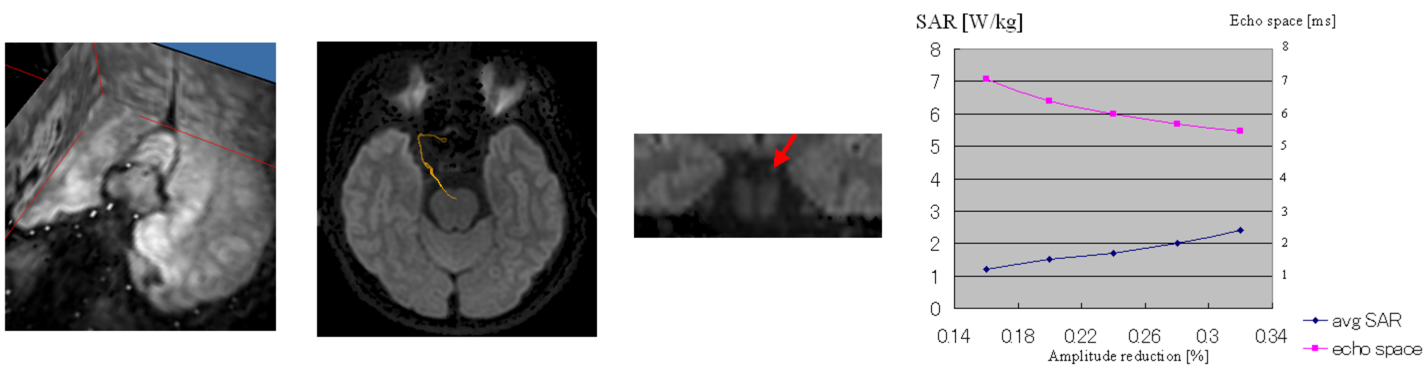
[1] Proc of ISMRM 2007; 1563.

[2] Magn Reson Med. 2006;55(2):380-5.

[3] Magn Reson Med. 2005;54(5):1232-40.

[4] Magn Reson Med. 1991;18(1):28-38.

[5] The software can be downloaded from the following URL (http://www.ut-radiology.umin.jp/people/masutani/dTV.htm)



(A) (B) (C)

Figure 1. (A) Diffusion tensor image with V-PROP-DTI method. (B) 3T-PROPELLER-DTT result shows oculomotor nerve. Seed ROI was placed on the arrowed area. (C) The relationship between the estimated V-PROP-DTI SAR value and VERSE RF power reduction ratio.