REAL-FLAIR: REAL-PART IMAGING FOR FLUID ATTENUATED INVERSION RECOVERY SEQUENCE

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Introduction

In magnitude-based inversion recovery (IR) imaging, it is sometimes difficult to set optimum inversion time (TI) for nulling target tissue signals. When TI is shorter than the optimum, contrast reductions or dark line artifacts due to wraparound of negative signals are introduced. A real-part imaging for IR (real-IR) [1-5], providing both positive and negative signals, is a solution for those problems and is clinically useful to provide higher contrasts especially for T1W, for brain [3] or myocardium infarction [4-5] than those magnitude-based IR images. Fluid attenuated inversion recovery (FLAIR) imaging is also IR sequence and widely used for brain study. However, real-IR applied to FLAIR sequence has not been reported on. In this study, we applied real-IR technique to Fast-Spin echo (FSE) based interleaved FLAIR sequence [6] and assessed by volunteer brain study.

Methods

Imaging was performed on Toshiba Excelart Vantage Titan™ 1.5T and Vantage Titan™ 3T MRI. Healthy volunteer brain study was performed after obtaining written informed consent. The following parameters were used; 1.5T T2W-FLAIR (T2FLAIR): TR/TE=8000/105 ms, 23 slices, acquisition time=2 min; 1.5T T1W-FLAIR (T1FLAIR): TR/TE=2600/10ms, 17 slices, acquisition time=1 min 43 s. Other common parameters for 1.5T were: 2DFSE, FOV=24 cm, acquisition matrix=192x320 (0.9x0.9x5 mm^3), slice-thickness=5 mm. Multiple TIs including nulling CSF signals were compared. For spatial phase correction to eliminate background phase, a homodyne-filtering technique [7], subtracting low-frequency phase from the original phase, was employed; the low-pass filter used here was 2D Gaussian linear in k-space, and the FWHM was 5% of the maximum sampling frequency. For evaluations, several tissue contrasts for multiple TI between real and the magnitude, each for T2W- and T1W-FLAIR were compared mainly on 1.5T, and in addition, the possibility of reducing CSF inflow artifacts by real-FLAIR were also assessed.

Results and Discussion

In comparison between real and magnitude images for T2FLAIR and T1FLAIR (**Fig. 1**), CSF-soft tissues (GM, WM) contrasts were enhanced on the both real-FLAIR images compared to those corresponding magnitude images; In contrast, GM-WM contrasts at shorter TI from the optimum (nulling CSF signals) were slightly decreased on the T2FLAIR but enhanced on the T1FLAIR in this TI range. In real-FLAIR imaging, recommended TI is set to be shorter than the optimum so as to make the CSF signals negative while keeping contrasts between soft-tissues. It was suitable TI of ~500 ms shorter from the optimum for T1FLAIR as shown by Hou [3], and relatively shorter TI (~300 ms) from the optimum for T2FLAIR. Real-FLAIR is also useful for discriminating low signals region from CSF (**Fig. 2**) – it is especially likely to be useful for subdural pathology. In addition, CSF inflow effects were reduced by real-FLAIR at shorter TI than the optimum (**Fig. 3**). This effect was likely due to cancelling CSF signals between negative and positive, respectively from inside and outside of inversion slab. In conclusion, real-FLAIR imaging has more advantageous than the magnitude-base FLAIR imaging from the points of tissue contrast enhancement, robust against TI setting, and reducing CSF inflow artifacts.

References:

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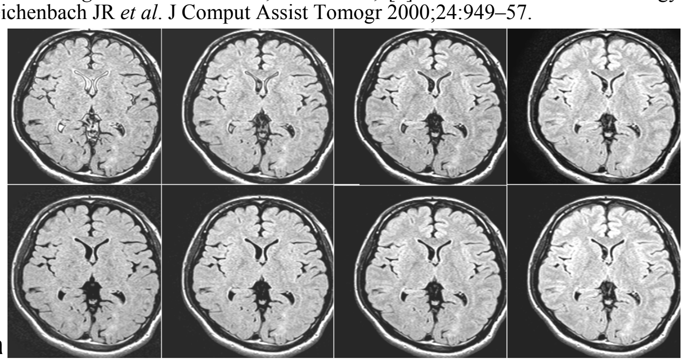

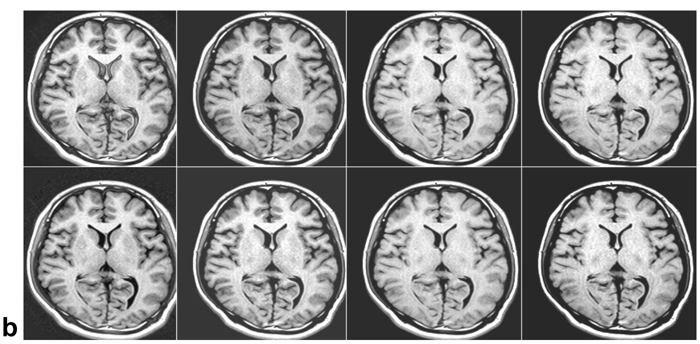

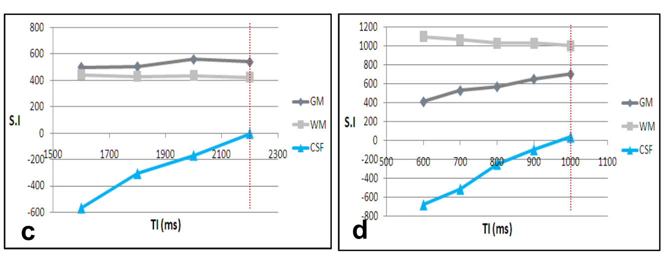

Fig. 1 1.5T brain results for multiple TIs. **a**: 1.5T T2FLAIR images of TI[ms]=1600, 1800, 2000, 2200 (left to right); **b**: T1FLAIR images of TI[ms]= 700, 800, 900, 1000 (left to right), each top is magnitude-IR and bottom is real-IR; real-IR signal intensities vs. TI of GM,WM and CSF for T2FLAIR (**c**) and T1FLAIR(**d**). CSF signals were negative before optimum TI of 2200ms on T2FLAIR and 1000 ms for T1FLAIR, each shown by red-vertical line.

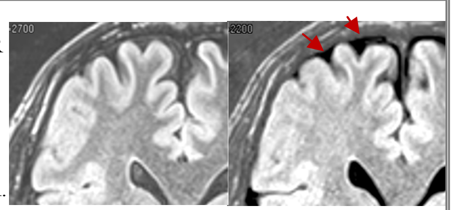

Fig. 2 3T T2FLAIR images for magnitude-IR of TI=2700(optimum) (left) and real-IR of TI=2200ms (right). Subdural boundary (arrows) was better enhanced by real-FLAIR.

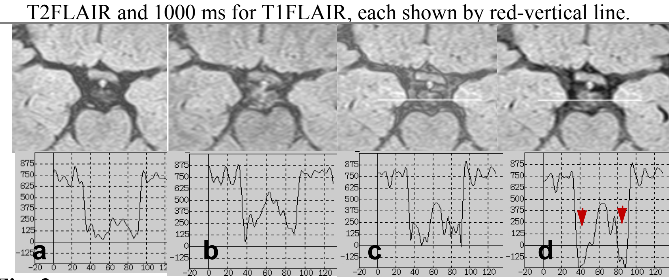

Fig. 3 1.5T T2FLAIR images and profiles of: magnitude of TI=2200 ms with twice of imaging slice (**a**), magnitude of TI=2200ms (**b**), TI=1800 ms with magnitude (**c**), and real (**d**). IR slab thickness for **b**, **c** and **d** was same as the imaging slice. The difference between **a** and **b** was regarded as CSF inflow from the outside of the IR slab. Those artifacts were partly (red arrows) reduced by real-FLAIR of shorter TI.