Utilizing Supplementary Flow Information in Dual Contrast SIMVA for Black-Blood MRA
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Introduction
One of the conventional acquisition for black-blood MR angiogram (BB-MRA) is proton-density weighted (PDW) fast spin echo (FSE) sequence (1). A dual contrast FSE (DFSE) sequence can provide both PDW and T2-weighted (T2W) images simultaneously. Distinct advantages of this method are supplementary or complementary flow-related information on both images, and the absence of mis-registration error.

This work mainly discusses possibilities of how to utilize supplementary information from T2W images acquired with a DFSE sequence, in order to optimally combine two kinds of images together, more accurately rendering vessel definitions.

Methods and Materials
In conventional PDW FSE sequence, the first echo is usually put into the center of k-space, resulting in better SNR as well as brighter background for intracranial morphology. However, the first echo only experiences one 90° excitation and one 180° refocusing RF pulse. Thus for very slowly flowing spins, it would be still possible that they could be refocused, contributing signal instead of signal voids (Fig.1A). Pre-saturation RF pulses or even cardiac gating could be used but at a cost of decreased efficiency and increased SAR. Particularly, SAR issue becomes critical at high field. With dual contrast 3D FSE acquisition, even without using any pre-saturation RF pulses, the slowly flowing spins can hardly be refocused in T2W images because they can not "see" many 180° refocusing RF pulses, usually eight. In such case, vessels are well defined (Fig.2B).

Dual contrast SIMVA (2,3) was installed on 1.5T Eclipse, 1.0T Polaris, 0.5T Apollo system (Picker International Inc. Highland Heights) with SW version of VIA2.0. A 16-echo train was used, of which the first eight echoes form the PDW images while the latter eight echoes form the T2W images. View sharing in k-space was not used in the acquisition. All images were reconstructed off-line with a zero padding factor of 2 in all directions. PDW and T2W image combination were performed by using a non-linear processing, which inherits the advantages of brighter background from PDW images and better vessel definitions from the T2W images. A simple minimum intensity projection algorithm was then used within a carefully cropped volume.

Results and Discussion
Figure 1 shows a pair of source PDW and T2W axial intracranial images respectively. Due to slow flow, a vessel (middle cerebral artery) definition in PDW is rather equivocal but is unequivocal in T2W image. Using a proper image combination, these supplementary information are used to render vessel definitions and form a new image (Fig. 1C) which inherits advantages from both images.

Conclusions
Dual contrast SIMVA (3D FSE) sequence can simultaneously provides PDW and T2W images. The flow related information in these images is supplementary and complementary. Therefore, it is possible to combine these two kinds of images together, to form more accurate black-blood MRA. Since there is no mis-registration error, the image combination can be simplified and performed either in image domain or in k-space.

References

Figure 1: Axial intracranial images of a healthy volunteer acquired with a dual contrast SIMVA sequence: A) PD-weighted; and B) T2-weighted, and C) combined image. Imaging parameters were TR = 2400 ms, TE = 12/96 ms, BW = ±20.8 kHz, FA= 90/110, FOV/THK = 220 / 1.2mm, 248 x 256, 8 (10) slices/slabs, 11 slabs, axial imaging plane, 12 min. 48 sec of imaging time, 1.5T scanner (Eclipse®).