Hybrid HYPR MRA

Y. Wu[1], S. R. Kecskemeti[1], P. Turski[2], and C. A. Mistretta[3]

[1]Medical Physics, University of Wisconsin, Madison, MADISON, WI, United States, [2]Radiology, University of Wisconsin, Madison, MADISON, WI, United States, [3]Medical Physics and Radiology, University of Wisconsin, Madison, MADISON, WI, United States

INTRODUCTION

We have previously reported on a hybrid HYPR MRA technique called HYPR FLOW in which a separately acquired phase contrast image is used as a composite image for HYPR processing of undersampled time frames acquired during the first pass of injected contrast [1,2]. With VIPR acquisition, this technique was able to provide 0.69 mm isotropic (.33mm^3) spatial resolution with 0.5s frame rate and a 0.75s temporal window for contrast-enhanced information. Although this approach has good resolution and provides flow information and flow derived quantities, it is difficult to reduce voxel volume below about 0.3 mm^3 due to the need to acquire four excitations per projection. We present here early results using an alternate hybrid HYPR MRA technique called HYPR TOF in which a separately acquired TOF examination is used to provide a composite image for processing time resolved CE MRA data. Although initially implemented in a stack of stars geometry, this approach when combined with VIPR acquisition will permit greater spatial resolution than HYPR FLOW at the expense of physiological information. This will be important for some aneurysm cases where higher spatial resolution is desirable.

METHODS

A set of thin slab 3D TOF images are acquired before contrast injection. Following contrast injection, a CE-MRA examination is performed using the time resolved stack of star (SOS) acquisition, where radial projections in k_x-k_y plane are interleaved during the time series with Cartesian encoding along k_z direction. The imaging parameters for TOF were: FOV = 22x22x22cm^3, TR/TE = 24/2.7 ms, BW = 41.67 kHz, flip angle was 20 degree, slice thickness was 1 mm, acquisition matrix was 512x512x48, A magnetization transfer pulse was applied to suppress the tissue background. Factor of two parallel imaging was adopted to reduce the scan time within 5 mins. The scan parameters for the time resolved SOS sequence were: FOV = 22x22x22cm^3, TR/TE = 4.7/1.7 ms, BW = 115 kHz, 16 slices were acquired with 3 mm slice thickness, acquisition matrix was 256, 13 projections were acquired for each time frame resulting in 1 s frame update time. The contrast material was injected at a rate of 2mL/s. The contrast dose was 0.1 mm/kg.

RESULTS AND DISCUSSION

Figure 1 shows a time series of HYPR TOF images. The kernel used for HYPR LR reconstruction was 8x8x4. The frame update time was 1 second and the spatial resolution was 0.42x0.42x1=0.18 mm^3. Figure 2 compares one of the time frames (corresponding to the 5th image in Fig.1) with HYPR TOF (b) and without HYPR processing (the original image) (a) in the sagittal view. The spatial resolution and SNR was enhanced with preserved temporal behavior.

Compared to HYPR FLOW, where phase contrast images are used to provide vascular structure and potential physiological information, HYPR TOF gains more spatial resolution from the TOF technique which is of benefit for some cases where both high temporal resolution and half millimeter spatial resolution is desirable. TOF before contrast injection helps suppression of vein and tissue enhancement of the dynamic contrast enhanced images. This may help detection of aneurysms. Another potential benefit of using TOF as composite is the shorter echo time and smaller voxel size in the TOF will reduce intravoxel dephasing. Implementation of HYPR TOF with VIPR acquisition will further improve the frame update time and imaging coverage.

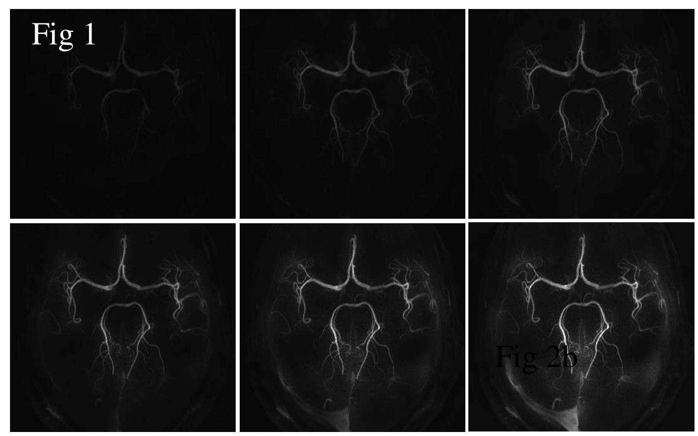

Figure 1. A time series of HYPR TOF images

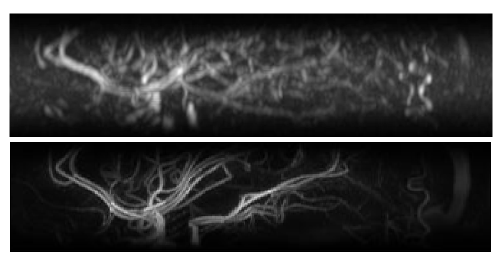

Fig. 2a Original SOS image

Fig. 2b HYPR TOF

Figure 2 Comparison of a single time frame SOS image (a) with HYPR TOF image (b) in sagital view.

CONCLUSIONS

HYPR TOF is able to provide time resolved contrast enhanced MRA with exceptional high spatial resolution (0.18 mm^3) by using TOF as the composite image. Implementation with VIPR will produce further reductions in voxel size.

REFERENCES

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