Evaluation of HYPR PR-TRICKS for contrast enhanced cerebrovascular MRA

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INTRODUCTION

Combination of HYPR (1) with PR-TRICKS (2) achieves a significant Nyquist undersampling with reduced streak artifacts and preserved signal to noise ratio (SNR). HYPR PR-TRICKS has been applied to time resolved contrast enhanced cerebrovascular MRA with sub-second frame time and sub-millimeter[3] voxel size. The purpose of this study is to characterize the achievements of such application, including the temporal behavior, spatial resolution and SNR by comparing to the commercial Cartesian TRICKS and multi-phase 2D SPGR sequence. Time resolved contrast enhanced curves from both large and small vessels were compared. Spatial resolution, SNR and A/V ratio were compared between HYPR PR-TRICKS and the Cartesian TRICKS. HYPR PR-TRICKS and Cartesian TRICKS matched well for the large vessels. HYPR PR-TRICKS captured more dynamic information than the Cartesian TRICKS for the small vessels. HYPR PR-TRICKS has ten times frame rate and four times spatial resolution with about 50% SNR compared to the Cartesian TRICKS.

METHODS

A time series of interleaved undersampled radial acquisitions are obtained during the passage of contrast material. For each radial acquisition in the kx,ky plane, a series of TRICKS encoded kz acquisitions are acquired. A series of sliding window composite images are obtained by combining projections from neighboring frames. These composite images are relatively free of streak artifacts and have good SNR. Individual time frame projection information is backprojected using the constraint that information is non-iteratively deposited in the vessel locations defined by the composite images and with weighting provided by the composite images. Four subjects underwent three contrast enhanced imaging exams at the same scan session to compare HYPR PR TRICKS and Cartesian TRICKS to a 2D SPGR reference scan. Imaging parameters are summarized in Table 1. The sequencing of the scans was varied such that in two subjects the 3D TRICKS exam was performed first and in two subjects the HYPR PR TRICKS exam was performed first. The contrast material was injected at a rate of 2-3mL/sec, the contrast dose was 0.1 mm/kg for each scan. Regions of interest (ROI) were drawn on the carotid artery, sinus vein and small vessels. ROIs of the background were drawn close to the carotid arterial ROIs for SNR calculation. In order to assess arterial and venous separation the A/V ratio was calculated and plotted for each scan using signal intensity measurements from the internal carotid artery and the sagittal sinus.

RESULTS AND DISCUSSION

Figure 1 compares the image series obtained using HYPR PR-TRICKS (2-11) and Cartesian TRICKS (1 and 12). Within the same time period, HYPR PR-TRICKS has nine more images to characterizing the dynamic contrast passing through. The spatial resolution comparison was show in Fig 1a and b. Vessels in the HYPR PR-TRICKS image are sharper than those from the Cartesian TRICKS. Ghosting artifacts appears in the Cartesian TRICKS due to the fast contrast uptake. SNR loss of HYPR PR-TRICKS due to the smaller voxel size and shorter acquisition time was about 50% of the Cartesian TRICKS. The contrast kinetics of the internal carotid artery using three acquisitions was compared in Fig 2a. HYPR PR-TRICKS matched the 2D SPGR very well with similar frame time. Cartesian TRICKS cannot trace the contrast uptake and loses the temporal resolution due to the long frame time and reconstruction footprints. A/V ratio comparison of HYPR PR-TRICKS, composite images used for HYPR reconstruction and Cartesian TRICKS is shown in Fig. 2b. HYPR PR-TRICKS has much higher A/V ratio than the composite images and Cartesian TRICKS, which demonstrates that HYPR PR-TRICKS can separate arterial-venous phase better than the others.

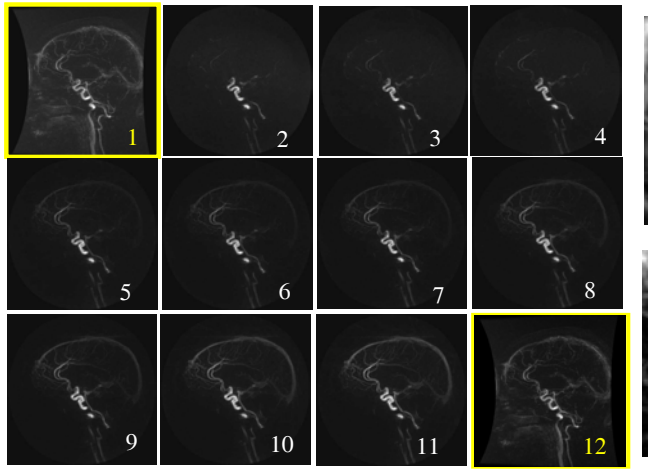

Figure1 Image series obtained using Cartesian TRICKS (1 and 12) and HYPR PR-TRICKS (images 2~11) within same time period. Zoom in images on the right shows that HYPR PR-TRICKS (b) has better spatial resolution than the Cartesian TRICKS (a). Ghosting artifacts appeared in the Cartesian TRICKS (a) due to the fast contrast uptake and low temporal resolution.

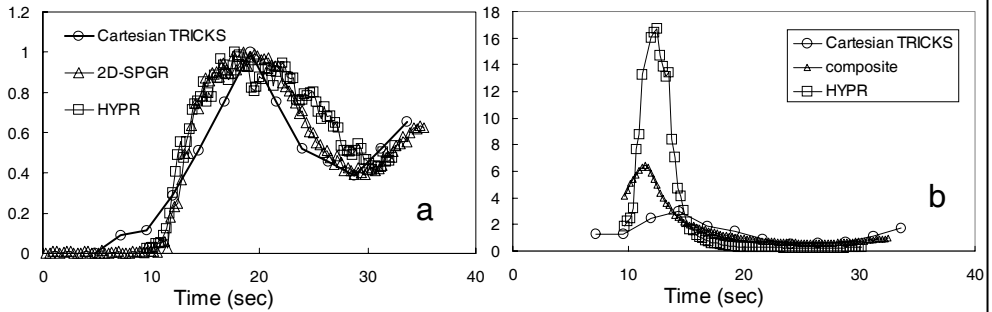

Figure 2. Contrast kinetics comparison (a) shows that HYPR PR-TRICKS matches the 2D SPGR better than the Cartesian TRICKS. A/V ratio comparison (b) shows that HYPR PR-TRICKS has better A/V separation than the Cartesian TRICKS and the composite images.

CONCLUSIONS

HYPR PR-TRICKS provides both high spatial and temporal resolution using a large undersampling factor of more than 200. The temporal behavior is preserved by the weighting images and the SNR is maintained by the composite images. Such large undersampling factor can be used to improve temporal resolution, spatial resolution, SNR, and volume coverage and will be beneficial for the contrast enhanced cerebrovascular MRA.

Table 1. Acquisition parameters of 3 sequences

2D SPGR	Cartesian TRICKS	HYPR PR-TRICKS
128x128x1, 0.8 phaseFOV, 0.3 s/frame	256x160x20, 0.8 phaseFOV, 0.75 NEX, 2.4s/frame,	512x512x20, 10 projections/frame, 0.26s/frame

REFERENCES

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