Time-Resolved Contrast-Enhanced Carotid Imaging Using Undersampled Projection Reconstruction Acquisition

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INTRODUCTION

The short arterial-venous transit time and complex contrast dynamics prove to be challenging for single volume imaging of the carotid arteries (1-3). Time-resolved acquisition provides many advantages for carotid imaging. But the spatial resolution is traded for temporal resolution. The hybrid 3D projection reconstruction sequence combines undersampled projection reconstruction (PR) in-plane and Cartesian slice encoding through-plane in a TRICKS fashion (4), therefore providing both high temporal and spatial resolution with some undersampling streak artifact. It is highly desirable to suppress the streak artifact and apply this sequence for carotid imaging.

MATERIALS AND METHODS

A hybrid undersampled PR sequence was revised for carotid imaging, where the excited spins are mainly distributed along the superior/inferior (S/I) direction, rather than the right/left (R/L) direction. As a result, the undersampling streak artifact is mainly from the S/I excited spins, especially from the heart. To reduce the streak artifact emanating from the heart, projections were aligned elliptically so that more projections were aligned along the S/I direction, while fewer projections along the R/L direction, providing an elliptical-supported FOV (Figure 1). Volunteer studies were carried out on a 1.5 T scanner using a head/neck/vascular array coil. The total acquisition time was 96 seconds (including mask). The acquisition parameters were: FOV = 26 cm, TR/TE = 6.0/2.1 ms, flip angle = 30°, BW = 62.5 KHz, readout = 256, projections = 96, slices = 36, slice thickness = 1.5 mm. A total of 35 ml of gadolinium contrast material was injected.

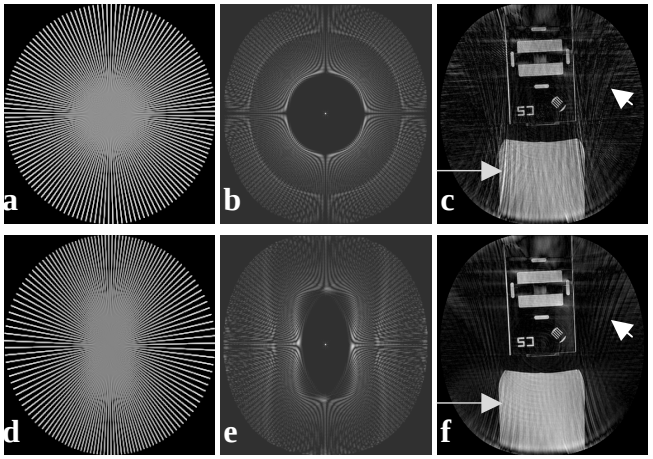

Figure 1. Two alignments of the projections: uniform distribution (a), elliptical distribution (d), as well as their point spread functions (b, e), and phantom images (c, f). The streak artifact is significantly reduced along S/I direction (long arrow), but enhanced a little bit along R/L direction (short arrow) due to the elliptical alignment of the projections.

RESULTS AND DISCUSSION

Figure 1 shows the phantom study to demonstrate the efficacy of elliptical alignment of the projections in suppressing streak artifact. Figure 2 shows the carotid artery study from a healthy volunteer. In total 21 time frames were reconstructed with a frame update rate of 2 seconds. The jugular vein started to enhance very quickly after the peak arterial frame. This revised time-resolved sequence greatly facilitates the depiction of the arterial and venous phase with negligible undersampling streak artifact.

CONCLUSIONS

The revised hybrid undersampled PR acquisition provides high spatial resolution time-resolved carotid images with a temporal resolution up to 0.5 frame-per-second to depict the contrast dynamics without any compromise due to improper triggering or venous enhancement. Streak artifact is well suppressed by aligning the projections in an elliptical fashion.

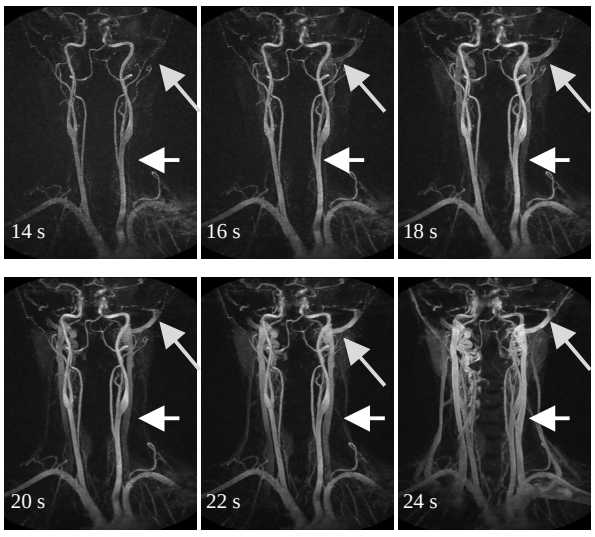

Figure 2. Time-resolved images of the carotid arteries with acquired voxel size of $1 \times 1 \times 1.5$ mm^3 (zero padded to 0.5 $\times$ 0.5 $\times$ 0.5 mm^3) and a frame update rate of 2 second-per-frame, which nicely depicted the rapid venous enhancement (pointed by the arrows).

REFERENCES

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