An Image-Based Navigation Method for Carotid Vessel Wall Imaging

Ioannis Koktzoglou[1,2], and Robert R Edelman[1]
[1]Radiology, NorthShore University HealthSystem, Evanston, IL, United States, [2]The University of Chicago Pritzker School of Medicine, Chicago, IL, United States

INTRODUCTION

Swallowing is reported to be greatest physiologic source of motion within the carotid arteries (1). To detect swallowing and improve image quality during carotid artery wall MRI, 1D pencil-beam navigators positioned through the epiglottis (2,3) and additional motion-sensing coils (4) have been investigated. Although useful and amenable to prospective gating, these methods make assumptions about the motion that will be encountered and may provide a limited ability to characterize complex (e.g., rotational, translational, non-rigid) motion occurring throughout the acquisition. The aim of this work was to investigate whether image-based (i.e., 2D) navigators depicting the carotid arteries and adjacent tissue could be used to identify motion and ameliorate image artifacts during carotid vessel wall imaging.

METHODS

This study was approved by our institutional review board. Eight volunteers were imaged on a 3T MRI system (Verio, Siemens) using a modified variable flip angle fast-spin echo (FSE) sequence (0.9 mm isotropic resolution) incorporating a low resolution echo planar-based navigation image (4 shots; spatial resolution 4.7x4.7x5 mm) prior to FSE readout. Three signal averages were acquired with the FSE sequence (5 min 12 sec) and the navigation images were acquired axially at the level of the carotid bifurcation.

Navigator images were analyzed and used to retrospectively select data for reconstruction. Four reconstruction options were tested: blind signal averaging of all acquired data, and unsupervised selective reconstructions guided by root mean square (RMS), cross-correlation (CC), or center of mass (CoM) analyses. A total of 30 data sets were collected. For each reconstruction, image quality was scored by 2 reviewers (Likert scale with range 1-4; 4: most preferred) and measurements of wall thickness were made. Motion was considered to be present in a data set if a CoM displacement exceeded 4.7 mm, the spatial resolution of the navigation image.

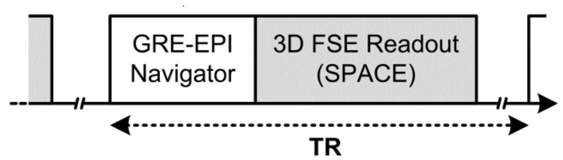

Figure 1. Timing diagram of the imaging sequence. The navigation image was acquired axially through the carotid bifurcation. A coronal FSE based readout was used. GRE-EPI: gradient-echo echo planar imaging.

RESULTS

Motion was detected in 22 of 30 (73%) scans. Across all 30 scans and in scans in which motion was detected, selective reconstruction guided by cross correlation of the navigation images provided the best image quality scores (3.34 and 3.42, respectively; $P < 0.01$ for both). Blind signal averaging provided the largest mean image quality scores (3.7) in the 8 scans where no motion was detected. Arterial wall thickness (assessed via full width at half maximum) was improved (decreased) between 3-5% depending on the reconstruction methodology used ($P < 0.01$ for all).

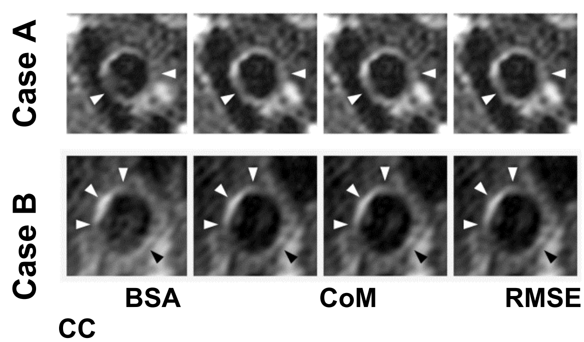

Figure 2. Cross sectional images of the carotid vessel wall in two scans where motion was encountered. Improved delineation of the arterial wall (arrowheads) was observed with selective reconstruction (rightmost 3 columns) compared with blind signal averaging (BSA) of all acquired data.

CONCLUSION

A retrospective image-based navigation and reconstruction method was found to detect motion and improve image quality during 3D carotid arterial wall MRI.

REFERENCES

[1] Boussel et al. JMRI 2006; 23:413-5. **[2]** Crowe et al. JMRI 2005; 22:583-8. **[3]** Koktzoglou et al. JMRI 2007; 25: 815-23. **[4]** Chan et al. JMRI 2009; 29:211-216.

ACKNOWLEDGEMENTS: This work was supported in part by a grant from the American Heart Association, SDG0835367N.