Fast Spin-Labeled Projectional Carotid MR Angiography

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Introduction: Non-contrast MR methods for imaging the extracranial carotid arteries have the potential to reduce costs, eliminate risk of nephrogenic systemic fibrosis, and avoid any overlap of arterial and venous structures. Here we present a contrast-free arterial spin-labeling method for generating two-dimensional MR angiograms of the extracranial carotid arteries in only 20 seconds.

Methods: This study was approved by our institutional review board. The imaging method is similar to that described in the literature [1,2] and consists of acquiring two image sets that, upon conclusion of the scan, are subtracted. The first image set is acquired after blood upstream of the imaging volume is tagged by a radiofrequency (RF) pulse, while the second image set is acquired without application of a tagging RF pulse. Subtraction of image sets in the complex domain eliminates background signal and generates an angiogram.

Imaging of 10 volunteers was performed on a 32-channel Siemens Avanto 1.5 T scanner with a standard 6-channel head and neck coil. Imaging parameters were: sagittal-oblique slice orientation with the slice positioned parallel to the axis of the carotid bifurcation, single-shot balanced SSFP acquisition with TR/TE = 3.6/1.8 ms, 90 degree flip angle, GRAPPA acceleration factor of 2, 24 x 24 cm field-of-view, 256 x 256 matrix, 35 mm slice thickness, 2.5 sec between acquisition of image sets, 0.9 sec between RF tag and image acquisition, RF tag flip angle = 180 degrees, 4 averages, 20 sec scan time. No cardiac gating was used. Contrast between the arterial and background signal, defined by the relation (A-B)/B where A and B denote arterial and background signal, was computed. Projected vessel lengths were measured.

Results: Figure 1 shows carotid angiograms generated by the proposed projection technique at five different delay times after application of the tagging radiofrequency pulse. With a tag delay time of 900 ms, mean contrast produced by the technique for depicting the common, internal, and external carotid arteries was 17.1 +/- 5.4, 13.5 +/- 3.4, and 13.4 +/- 2.8 respectively. Mean projected vessel lengths at this delay time for the common, internal, and external carotid arteries were 69.0 +/- 9.8 mm, 116.9 +/- 17.8 mm, and 70.5 +/- 22.8 mm.

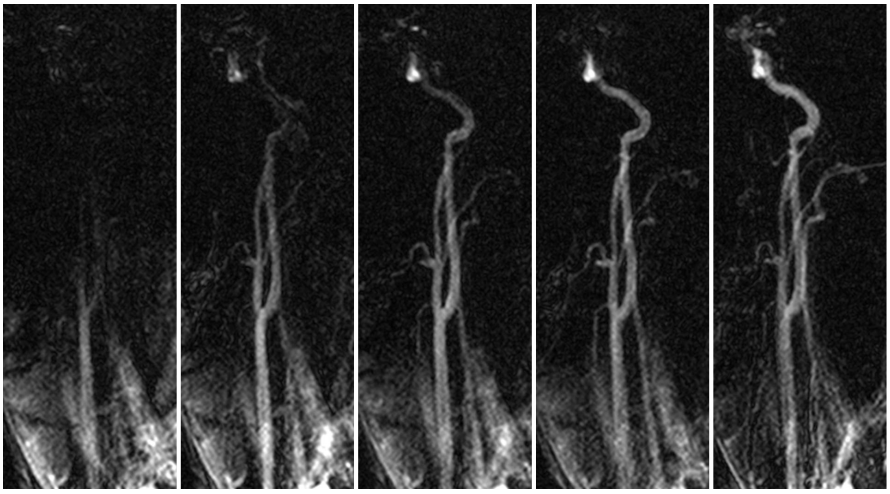

Figure 1. Left to right, Tag delay times of 500 ms, 650 ms, 800 ms, 950 ms, and 1400 ms. Note the progressive delination of distal portions of the carotid arteries and branching vessels with longer tagging delay times.

Discussion and Conclusion: The proposed projection-based arterial spin-labeled angiographic technique depicts extensive lengths of the extracranial carotid arteries in 20 seconds. Unlike previously described approaches for arterial spin-labeled MRA, our technique does not require the use of cardiac gating. Future studies will investigate applications of the method for fast screening of extracranial carotid disease and as a means for determining optimal tag delay times for subsequent high spatial resolution 3D imaging.

References:

[1] Sardashti et al. Magn Reson Med. 15:192-200 (1990)
[2] Edelman et al. Magn Reson Med. 31:233-238 (1994)