3D isotropic non-contrast approach for the assessment of carotid arteries stenosis at 3T

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Introduction:
Concerns about NSF are increasingly driving the development of new MRI techniques, including techniques for non-contrast based angiography and vessel patency assessment. Carotid imaging is a challenging application in this area, which in addition to the use of special phased-array coils, has also relied considerably on the use of contrast agents to facilitate an evaluation of carotid plaque and its hemodynamic significance. It has been previously demonstrated [1] that contrast enhanced MRA tends to over estimate carotid stenosis when compared to TOF. With these issues in mind we present here two 3D techniques that could replace existing contrast enhanced techniques for assessment of carotid artery stenosis.

Method:
A cohort of 12 patients with confirmed diagnosis of carotid stenosis by carotid ultrasound examination was included in this study approved by the institutional review board. The study was performed on a 3T clinical scanner with a custom-built 8-channel carotid coil as described in [4]. An MPRAGE protocol and a T2-weighted SPACE (T2w-SPACE, a variant of 3DTSE) [2, 3] protocol with isotropic voxel size of 0.7mm were both assessed as candidates for determination of stenosis severity. Other parameters for the MPRAGE were: TR/TE=8.3ms/3ms; water excitation pulse for fat suppression; FA=12^o; TI=1000ms (> blood null point at 3T); inversion pulse repeated every 1900ms; bandwidth=200Hz/pixel; 144 slices acquired in 6min. For SPACE the parameters were as follows: TR/TE=1700ms/166ms; bandwidth=500Hz/pixel; a factor of 2 parallel imaging was used, 64 slices were acquired in 5.5min. Imaging slabs were positioned coronally for maximum coverage of the two vessels. A stack of 2D TOF images were also acquired for initial identification of the bifurcations. Data from the carotid ultrasound examination included stensosis severity, and Doppler velocity measurements.

Discussion:
The MPRAGE and SPACE images were navigated in 3D to localize to the point of stenosis. Then the unstenosed diameter of the artery and the total artery diameter were measured along two orthogonal directions along the long and short axis in the transverse plane and their average was taken as the diameter. Two independent observers were asked to measure the stenosis on either the MPRAGE or the SPACE images. The measurements thus obtained were then compared with Bland & Altman plots between both these techniques and also with respect to the ultrasound results. Unlike the measurements from MRI, the results from ultrasound were reported as a band of values, so for this study the mid value of the band was used as the measurement.

Results:
As seen from the Bland & Altman plots in Fig 2. there is very close agreement between the measurements made from both the MPRAGE and SPACE images and similar agreement of these methods with respect to the Ultrasound. Also as seen Fig. 1 the quality of the images with reference to the delineation of the vessel wall and the differentiation of the plaque is sufficiently high for precise stenosis measurements. Unlike 2D techniques, the MRPAGE and SPACE techniques provide precise stenosis measurements, while the different contrast characteristics of these two techniques allow for the differentiation of plaque and its components.

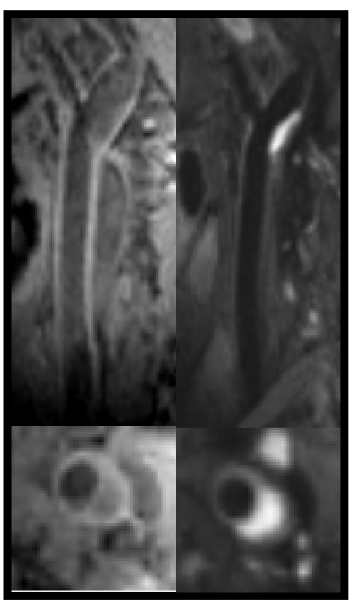

Fig 1. Coronal and transverse images of the stenosed carotid artery in a MPRAGE on the left and SPACE sequence on the right

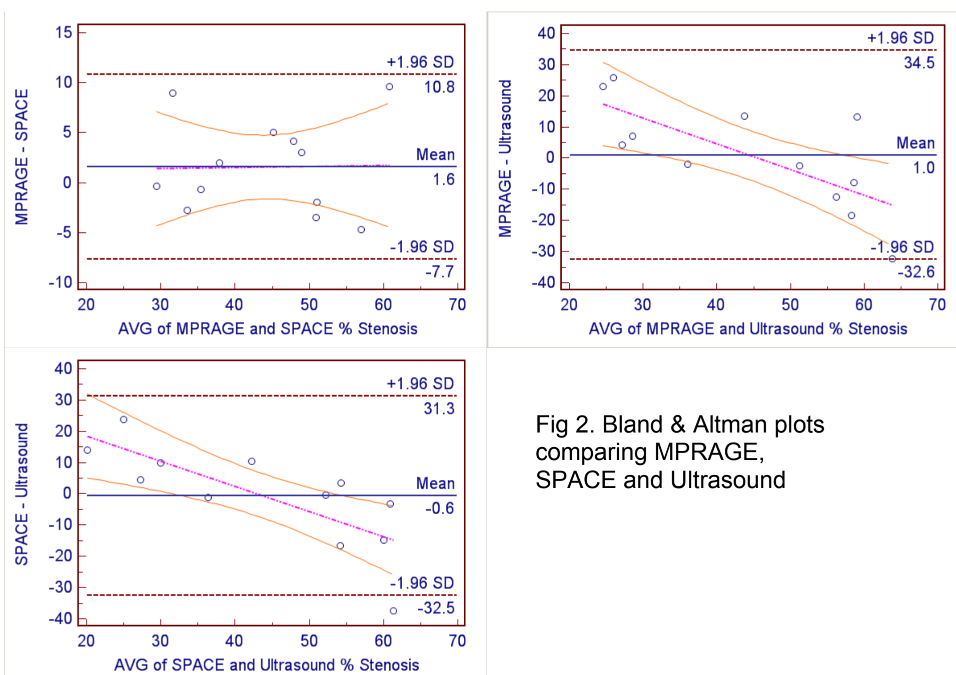

Fig 2. Bland & Altman plots comparing MPRAGE, SPACE and Ultrasound

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This work is supported in part by grants from the Donald W. Reynolds Foundation