A 16 Channel Radio Frequency Anterior Neck Coil for Imaging of the Cervical Carotid Bifurcation

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Introduction Disease of the cervical carotid artery occurs primarily in the region of the cervical carotid bifurcation and is a major source of embolic stroke. Although MRI may be the best method for imaging and characterizing the individual risk of the disease, imaging the disease is hampered by the small size of the plaque morphology, the variable position and depth of the artery in many subjects, variations in external body habitus, and the tendancy for subjects to move or swallow during the course of individual MRI pulse sequences. To foster imaging of the carotid artery with a larger volume of coverage, improved signal to noise ratio (SNR), and improved g-factor for parallel imaging a 16 channel (16ch) phased-array (PA) [1] coil has been constructed for the specific purpose of imaging the carotid bifurcation. This study compares this new 16ch PA RF coil with a standard 4 channel (4ch) PA surface coil consisting of two sets of bilaterally overlapped rectangular loops.

Methods The 4ch coil design used in this coil comparisoin is a sightly modified version of the Hayes carotid coil [2, 3]. The loop dimensions have been lengthened to 4x7cm which extend the superior/inferior (S/I) coverage of the coils over the original design. The 4ch coil has facilitated high quality carotid imaging with the tradeoff of a limited S/I Field of View (FOV) and marginal parallel imaging performance. The 16ch coil was composed of 16 overlapping circular loops arranged on a single semi-rigid fiberglass former which was designed to fit an average sized carotid patient (see Fig 1). Coil elements were 4.5cm wire loops that were positioned and decoupled using standard techniques [1]. The loops were placed on the former to cover the neck from the clavical to the lower ear. The individual loops were attached to the circuit board with 20 cm coaxial cables. Common mode cable traps, phase shifters, and preamps were included as shown in Fig 1. Phantom studies were performed on a home-made phantom filled with a homogeneous CuSo4 solution for the purpose of acquiring rSNR maps. In addition, human volunteer studies were performed to assess carotid vessel rSNR profiles and parallel imaging performance. For these studies, standard 3D-TOF and 2D TSE Black Blood (BB) imaging sequences were used to image 5 volunteers. Using the data acquired from the 3D-TOF studies, an SNR profile plot was created by measureing the average rSNR for each slice of the slab in the carotid vessel from the patient left interior carotid down through the bifurcation and into the common carotid artery. Hand drawn ROI's were used to obtain the pixels within 60% of the peak vessel rSNR which were then used in the measurements. Using R factors of 1, 2, and 3, BB images were used to assess parallel imaging performance of the carotid coils. All images were acquired on a Siemens 3T Trio Scanner (Siemens Health Care AG, Erlangen, Germany)

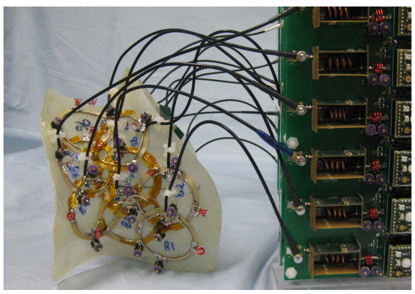

Figure 1: 16 channel PA surface coil designed for imaging the cervical carotid bifurcation.

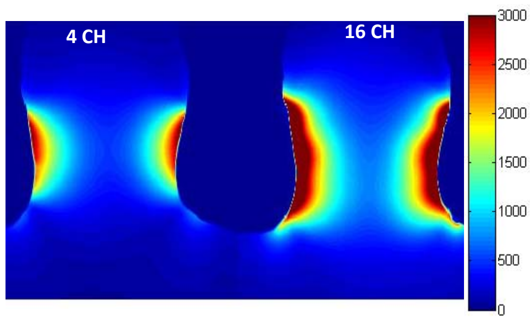

Figure 2: Coronal slices of SNR images of a head phantom using both the 4 (left) and 16 (right) channel coils.

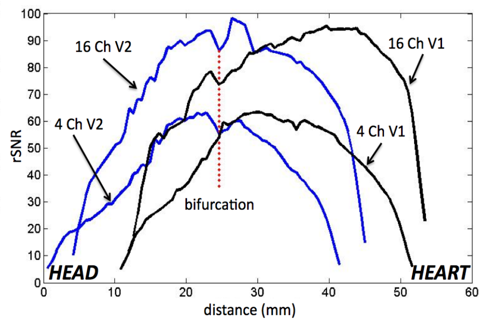

Figure 3: rSNR profile plots through internal carotid for volunteers 1 (V1) and 2 (V2).

Results The phantom imaging results in Fig 2 show the extended S/I FOV of the 16ch PA surface coil compared to the 4ch coil. ROI (circles of 210 pixels) measurements at 3cm depth resulted in a 40% improvement in average rSNR for the 16ch coil over the 4ch coil.

Fig 3 shows typical rSNR vessel profile plots for two volunteers (V1 and V2) aligned at the bifurcation. These results show a significant improvement in vessel rSNR along the length of the vessel. The amount of improvement is dependent on the bifurcation location wrt the 16ch coil and placement of the 4ch coil. These plots also indicate the extended S/I FOV of the 16ch coil

The BB imaging results are shown in Fig 4. These images show that reduction factors of R=2 are acceptable and show great resolution and image detail and that R=3 may still contain usefull information. The same rsults for the 4ch coil show that R=2 has lower image quality than the 16ch images and R=3 g-factors for the 4ch coil were much greater than those for the 16ch coil.

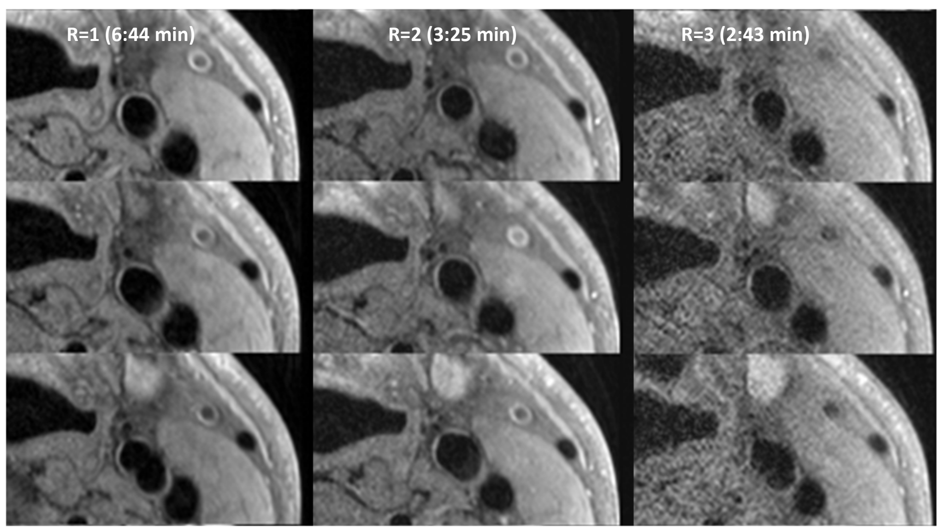

Figure 4: Black blood images showing bifurcation and three successive slices. The Siemens implementation of GRAPPA was used for the R=2 and R=3 imaging.

Conclusions The 16 channel carotid coil has significantly increased rSNR, extended S/I FOV and improved parallel imaigng performance over the 4 channel coil. The improved parallel imaging capabilities could be exploited to reduce scan time, thereby reducing suceceptibility to pulsatile motion and swallowing. This implentation of the 16ch coil could be more patient-friendly, and the single fiberglass former may not fit all patient habitus.

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References [1] Roemer PB et al., *MRM* 1990;16:192-225 [2] Hayes CE et al., *JMRI* 1996;6:109-112 [3] Hadley JR et al., JMRI 2005; 23:629-639