**Transmit-Receive Phased Array for Neurovascular Imaging at 3T**

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**Abstract**

A new transmit-receive phased array coil is presented for neurovascular imaging at 3T. A transmit-receive configuration was chosen in order to minimize the required RF power, reduce the deposited average SAR, and avoid the safety issues that are typically related to the use of whole body coils at high frequency. A power splitter was designed, optimized and implemented to obtain uniform excitation. B1 maps (as flip angle maps) are shown on volunteer images in 3 slice orientations. The high SNR and high-resolution capabilities of the 3T Neurovascular array are demonstrated in a short acquisition time MRA study of the carotids.

**Introduction**

In recent years, the need for higher SNR in magnetic resonance imaging (MRI) has been the driving force for the increased clinical use of high field strength MRI systems. Research systems have been built with magnets as high as 14T and clinical systems are now commercially available at 3T and 4T. The advantages of MRI at 3T compared to the more commonly used systems of 1.5T can provide significant improvement in image quality and resolution. This is evidenced not only in head imaging, but also in other high-resolution applications such as cardiac imaging, spine and vascular studies. Therefore, whole body RF coils at 3T have recently been developed [1,2], in order to be used in conjunction with a variety of receive only coils and phased arrays. However, whole body RF coils at high field (3T and above) are subject to a series of potential obstacles and problems, mainly but not solely related to the required RF power and patient safety. Due to the promising capability of the 3T MRI system in Neurovascular imaging, and the increased use (and performance) of phased arrays, this study pursues the possibilities of transmit-receive Neurovascular phased array at 3T. This will allow high SNR, high resolution and short time neuroimaging, while minimizing the required RF power and reducing average SAR levels.

**Methods**

The configuration of the coil elements in the transmit-receive neurovascular array is shown in Figure 1a. The head quad BC (12 rungs, 28cm ID, 27cm long) and the neck Helmholtz-Pair (HP) are used as a 3-channel phased array transmit-receive elements. The posterior butterfly is a receive only element which enhances SNR in the imaging, but also in other high-resolution applications such as cardiac imaging, spine and vascular studies. Whole body RF coils at 3T have recently been developed [1,2], in order to be used in conjunction with a variety of receive only coils and phased arrays. However, whole body RF coils at high field (3T and above) are subject to a series of potential obstacles and problems, mainly but not solely related to the required RF power and patient safety. Due to the promising capability of the 3T MRI system in Neurovascular imaging, and the increased use (and performance) of phased arrays, this study pursues the possibilities of transmit-receive Neurovascular phased array at 3T. This will allow high SNR, high resolution and short time neuroimaging, while minimizing the required RF power and reducing average SAR levels.

**Results**

The coil was tuned and matched at 127.75MHz, to operate in the GE Signa 3T MR system. The isolation between the coil elements was better than 18dB unloaded, and increased to better than 20dB when loaded. The ratio between the unloaded and loaded Q factors is approximately 8, indicating a load-dominant situation. The loaded SNR at the head region is within 5% of the SNR of the GE standard head coil (16 rungs, 28cm, quad BC). B1 maps were reconstructed by acquiring 2 consecutive SE images with flip angles of 60° and 120° respectively, and by post processing using the algorithm in [4]. Due to the difficulty in obtaining a phantom that correctly represents tissue parameters in all aspects of resistive loading, capacitive loading, dielectric effects and RF eddy currents, volunteer images where used to asses B1 uniformity. Results in all 3 planes are shown in Figure 2a-c. Numbers in the boxes indicate actual flip angle, where nominal 90° is assumed at the center 9-pixels of each image. The drop in flip angle at the superior and inferior ends of the sagittal and coronal slices is mainly due to dielectric effect. This is significantly minimized when a smaller (and more clinically useful) FOV is selected.

**Discussion**

A Neurovascular transmit-receive array was successfully built to operate at 3T. The image quality in the head is not compromised although additional elements are used for the neck region, indicating that no coupling or other losses present. The transmit flip angle maps demonstrate that good uniformity was obtained in all directions and over the entire coil coverage, without any significant voids or hot spots. As expected by the larger coverage of the array, and the linear excitation at the neck, the required RF power is approximately twice that of a typical head coil. Nevertheless, this level is still much lower than the reported power required for a whole body RF coil (up to 25KW [2]), so that the average SAR level for neurovascular application is minimized. In addition, using volume coils as the transmit elements prevents high local SAR that is generally associated with surface transmit coils. The inherent high SNR and high-resolution capability of the 3T Neurovascular array allows short time neurovascular imaging, as demonstrated in Figure 2d (TOF of the carotids, 256x256, 1 NEX, 22sec scan, w/o contrast enhancement).

**References**