Eight-Channel Transmit/Receive Triangle Coil for 3D SENSE

D. Seeber[1], W. Johnson[1], H. Morris[2]

[1]IGC Medical Advances Inc., Milwaukee, WI, United States, [2]NINDS, National Institutes of Health, Bethesda, MD, United States

INTRODUCTION

An MRI coil composed of triangular coil elements(*1,2*) has been demonstrated to permit SENSE(*3,4*) in all three orthogonal directions. Specifically allowing SENSE in the z-direction in contrast to traditionally MRI Head coils consisting of rectangular elements wrapped around a cylindrical form. Eight right triangles, with alternating diagonals, wrapped around a cylinder, have been used in a receive-only configuration. However, for z-directional (superior/inferior) SENSE, the phase encode direction is along the superior/inferior axis, increasing the foldover artifact, wrapping of the chest and neck back into the head. The foldover artifact is caused by the excitation of these spins by the body coil outside the field of view of the image. This foldover artifact can be minimized by configuring the triangular element coil as a transmit/receive coil. Each triangular element was driven with a 45 degree phase shift to it neighbor to produce a uniform circularly polarized magnetic field for transmission. The receive operation of the coil is identical and preserves the SENSE capability of the triangular elements in all three orthogonal directions.

METHODS

Simulations where done in MatLab to determine the homogeneity of the quadrature drive field for the triangular element coil with alternating diagonal elements. Each triangular element was multiplied by a phase shift (0, 45, 90, 135, 180, 225, 270, 315) and added together. The simulated circularly polarized magnetic field in the center axial plane is shown in Figure 1. Each triangular element was capacitively decoupled from every other triangular element, with the coupling coefficient between any pair of coils less than 0.005. The capacitive decoupling network allows the coil to be configured for transmission since preamplifier decouple is incompatible with transmission. A schematic of the transmit/receive electronics chain is demonstrated in Figure 2. The head port power amplifier is split through an eight-way Wilkinson splitter(*5*) and each path is then phase shifted to the appropriate value as shown in the diagram. The Transmit/Receive switch consists of eight parallel combinations of a series PIN diode, connected to the transmitter, and quarter wave transmission line with a shunted PIN diode to ground, connected to the preamplifier. The junction of the two paths in then connected to an element in the MRI coil. As all diodes are on during transmission, the transmitter has low impedance to the coil and high impedance to the preamplifier. During reception the opposite is the case. The low-input impedance preamplifiers, ~2 ohms, decouple the elements further during signal reception.

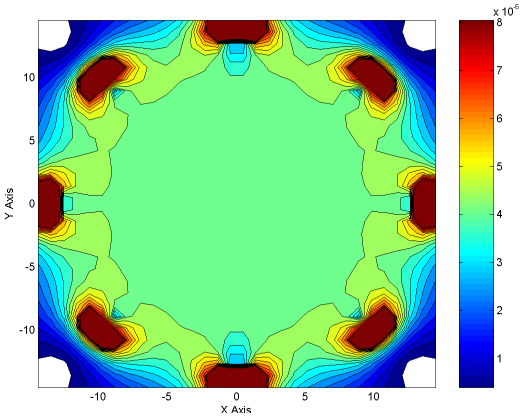

Figure 1. The simulated circularly polarized magnetic field for center axial slice of the triangular coil was simulated using MatLab.

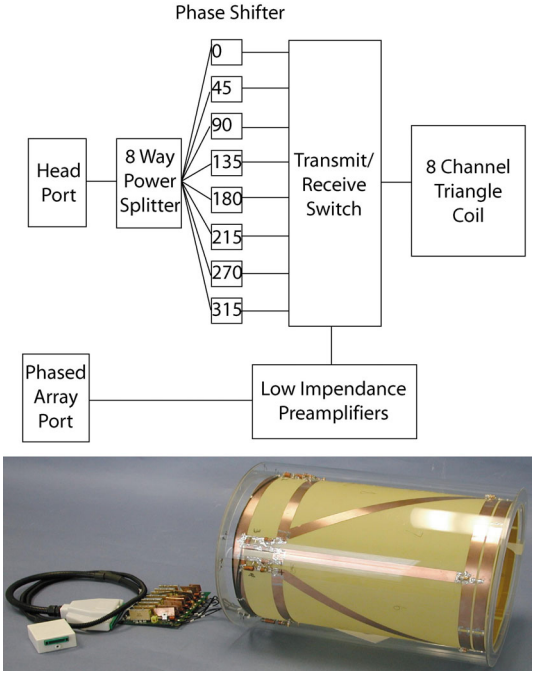

Figure 2. The electrical schematic of the transmit/receive triangular had coil is shown above.

RESULTS

Figure 3 demonstrates the effectiveness of having a transmit/receive head coil in reducing the common foldover artifact. The spin-echo image (TE/TR 14/300, FOV 28x28cm, phase encode S/I) on the left in from the transmit/receive triangular coil demonstrated the ability of the triangular coil to generate a uniform transmission field when driven as a "quadrature" coil. The right image is from a receive-only version of the triangular element coil (same dimensions, number of channels, etc.) showing the foldover artifact. The foldover artifact reduction will make SENSE imaging simpler especially for multi-slice acquisitions and full-three dimensions imaging sequences. Images from the transmit/receive triangular head coil with SENSE acceleration in 2D and multi-slice simultaneous acquisitions using SENSE will be presented as an application of the triangular transmit/receive MRI coil.

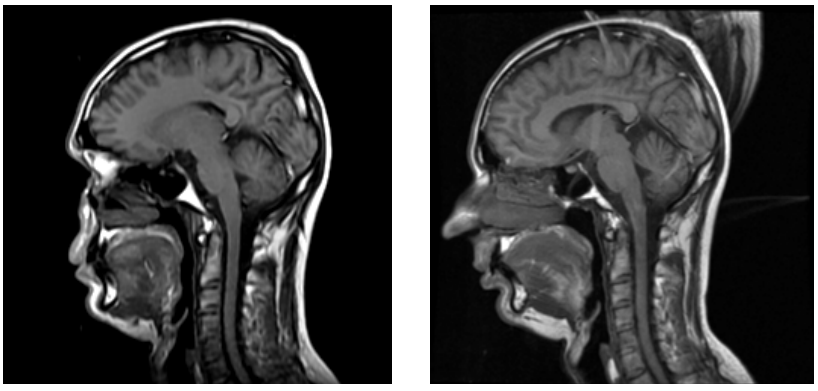

Figure 3. The transmit/receive coil, left, shows a reduction in foldover from the receive-only triangular coil on the right. Both images are spin echo (TE/TR 14/300) with a 28 cm field of view.

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