Triangular Element Vertical Field Torso Coil for 3D SENSE

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INTRODUCTION

Vertical field MRI systems require vastly different coil geometries than horizontal field systems and this difference becomes especially true when designing SENSE(*1,2*) optimized MRI coils for vertical fields. Traditionally, many vertical field coils consist of solenoid elements(*3*), which provide good homogeneity and coverage. However, solenoid coil elements provide limited SENSE accelerations abilities as the sensitivity patterns from individual elements often overlap due to the slow drop-off in sensitivity due to the large diameters of the solenoid elements. A torso coil was developed for vertical field MRI systems consisting of eight triangular elements that where combined in quadrature to be compatible with current four channel systems, and optimized for SENSE capability in all three orthogonal spatial directions.

METHODS

The torso coil consists of eight triangular elements(*4*), with alternating diagonals such that the diagonals all coverage in the center of the coil as shown in Figure 1. Having all the elements converge in the center allows for a capacitive decoupling network(*5*) to be introduced decoupling each triangular element from the remaining seven elements. Experimentally, the coupling coefficient has been reduced to less than 0.02 between any pair of elements, prior to preamplifier decoupling with low-input impedance preamplifiers (less than 3 ohms). These eight elements are than combined in quadrature pairs, each two triangles forming a square are combined as shown in Figure 1. This reduces the eight elements for compatibility with existing four channel vertical field systems. The center converging diagonals represents the top of the torso coil, latching location, and the location of the tuning and match electronics is on the bottom between elements two, three and six and seven. The coil is wrapped around a cylindrical form such that elements two and three are adjacent to elements six and seven as shown in Figure 2. Each element was matched to 50 ohms prior to balancing to reduce losses in the matching network due to the lower loop resistance of the low vertical fields and resonant frequencies (less than one Tesla).

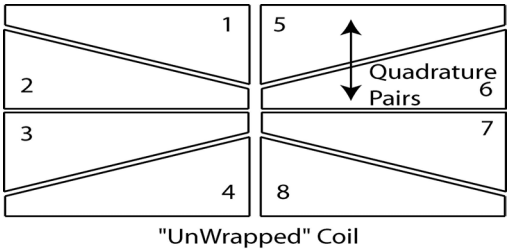

Figure 1. The unwrapped vertical field torso coil demonstrating the coil topology and quadrature pairing is shown above.

Figure 2. A picture showing the torso coil closed on a patient.

RESULTS

Computer simulations using MatLab where done to determine the SENSE capabilities of this coil topology. For superior/inferior acceleration the coil topology permits accelerations factors up to three with the four channel triangular coil. The g-factor map for a field of view of 30x30 cm and a region of interest of 24 cm diameter circle is shown in the upper left of Figure 3. The average g-factor is 2.0 with a maximum value of 4.8. For right/left acceleration three times acceleration is permitted with acceptable g-factors. The average g-factor is 1.8 and the maximum g-factor is approximately 4.0 and is the upper right image in Figure 3. Two times acceleration can be accomplished in the anterior/posterior direction with an average g-factor of 1.4 and a maximum value of 1.9 with the g-factor map the lower left image in Figure 3. The triangular eight element coil allows for SENSE acceleration in all three spatial directions. Two images, one coronal and the other axial were acquired on a 4-channel 0.3 T vertical field MRI system and demonstrate the image quality and homogeneity in Figure 4. The images were acquired with a spin echo sequence with TE equal to 15 ms and a TR of 150 ms.

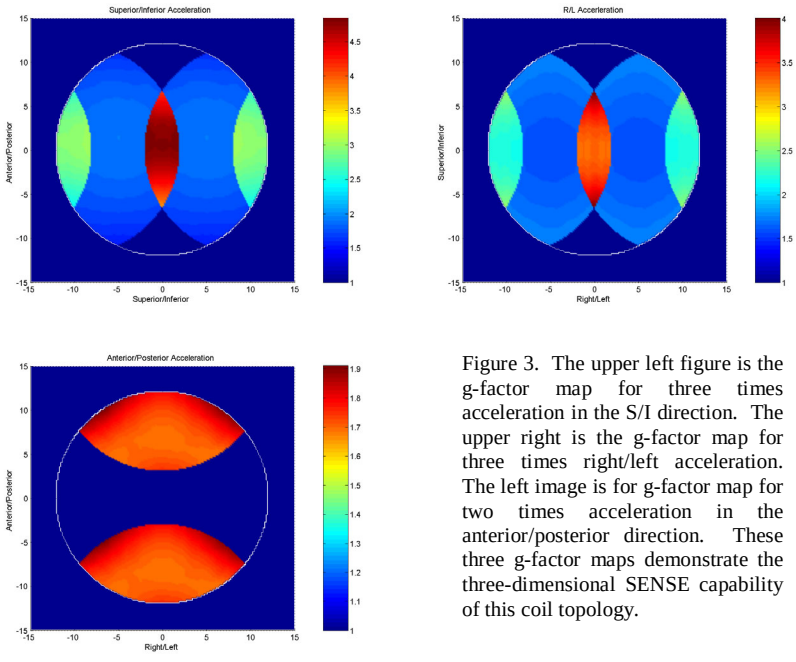

Figure 3. The upper left figure is the g-factor map for three times acceleration in the S/I direction. The upper right is the g-factor map for three times right/left acceleration. The left image is for g-factor map for two times acceleration in the anterior/posterior direction. These three g-factor maps demonstrate the three-dimensional SENSE capability of this coil topology.

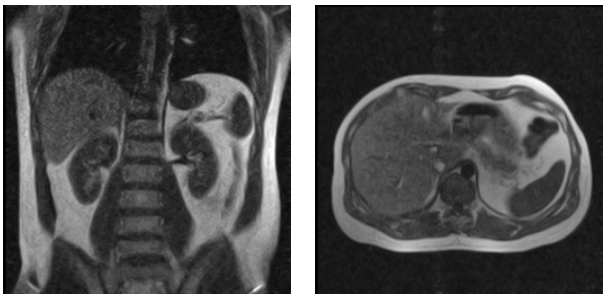

Figure 4. The left image is a coronal spin echoTE/TR of 15/150 and the right image is an axial spin echo of the same parameters on a 4-channel 0.3T vertical field system. The images demonstrate surface coil in vertical field systems to produce homogeneous images and permit SENSE applications without solenoid elements.

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