A Bi-planar Surface Coil For Parietal Lobe Imaging

Daniel Hernandez[1], Marlon Perez[1], and Soo Yeol Lee[1]
[1]*Bio-medical Engineering, Kyung Hee University, Yongin-si, Gyeonggi-do, Korea*

TARGET AUDIENCE: MRI RF engineers working on receive array coil for brain imaging

PURPOSE: Most of head array coils have loop-coil elements on a helmet-style frame to maximize the SNR and parallel imaging performances. However, the loop-coil elements positioned at the vertex of the frame have blind regions around the central axis of the loop-coil element resulting in very poor SNR performance at the parietal lobe of a brain. We propose a surface coil structure that has no blind regions around the coil axis.

METHODS: The surface coil consists of two parallel conductor planes that lie vertically to the z-axis as shown in Fig. 1. The inner plane, under which a human subject lies, splits into multiple line elements to make uniform current distribution at high frequency. The outer plane acts as a current return path. We make a vertical loop by connecting the inner and outer conductor planes with tuning capacitors at both ends of the conductor planes. We can employ the conventional pre-amplifier decoupling circuit to use the vertical coil as a receive coil element in a helmet-style array coil. We computed the B_1 field below the inner plane of the bi-planar coil, the size of 80×80×20mm^3, and we also computed the B_1 field of a square-loop-coil that has the same dimension of 80×80mm^2. We split the inner plane into four line elements with a width of 15mm and a gap of 6mm. The plane of the square-loop coil was vertical to the z-axis. We computed the B_1 field using a commercial FDTD solver [1] inside a cylindrical model that had the electrical conductivity of 0.62S/m and the relative permittivity of 80. Figure 2 shows the iso-contour maps of the B_1 magnitude for the bi-planar coil and the square loop coil. The square loop coil has a blind region as expected, but, the vertical loop coil has no blind regions beneath the inner plane. We made a square-loop coil and a bi-planar coil using 0.6 mm-thick copper plates with the same dimension used at the FDTD computation. We made pre-amplifier decoupling circuits using the same low-input-impedance pre-amplifiers for both coils. We performed imaging studies for a cylindrical phantom, the size of 220mm (diameter)×220mm (height), and a human brain using a 3T MRI system.

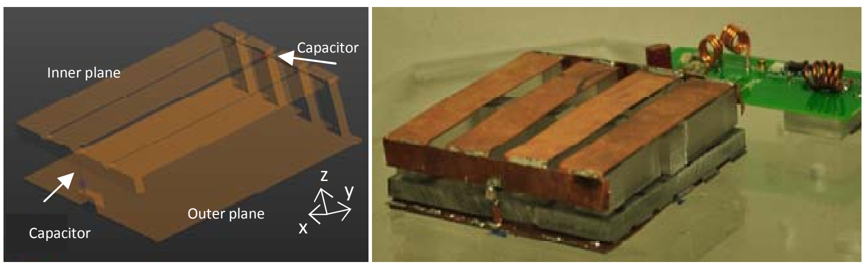

Fig. 1 A schematic of the bi-planar coil and the developed coil with a pre-amp circuit.

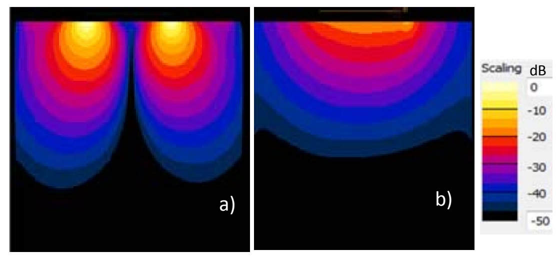

Fig.2 Simulated iso-contour plots of B_1 magnitude for a) the square-loop coil and b) the bi-planar coil.

RESULTS: Figure 3 shows the sagittal-view phantom images acquired with the square loop coil and the bi-planar coil. The phantom has the size of 220mm (diameter)×220mm (height). We used the spin echo sequence with TR/TE of 200/20 ms and slice thickness of 5 mm. From the figure, we can notice the blind region around the central axis of the loop coil. On the other hand, the bi-planar coil shows no blind regions.

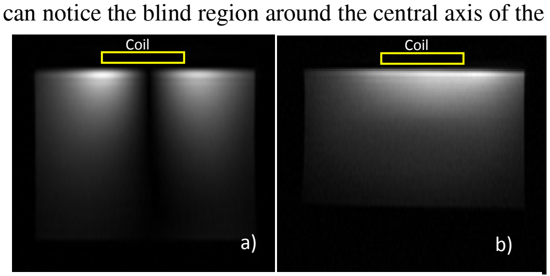

Fig. 3 Sagittal-view phantom images obtained with a) the square-loop coil and b) the bi-planar coil.

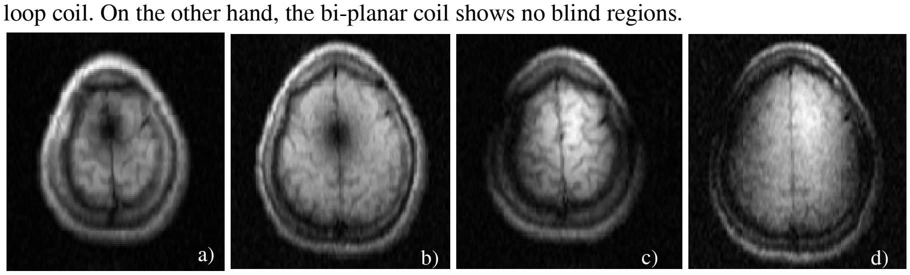

Fig. 4 Axial-view human head images obtained with a), b) the square-loop coil, and c) ,d) with the bi-planar coil

Figure 4a and 4b show the human brain images obtained with the square loop coil, and Fig. 4c and 4d show the ones obtained with the bi-planar coil. At the experiments, we placed the coils at the vertex of the human subject. Here again, we see the blind region in the images obtained with the square loop coil. The bi-planar coil shows higher SNR than the square loop coil at the slices shown in Fig. 4c, but the SNR of the bi-planar coil degrades faster than the square loop coil along the z-axis due to the return current on the outer plane.

DISCUSSION: The bi-planar coil has higher on-axis sensitivity than a same-sized loop coil that has a blind region around the coil axis. We expect it may help improve the SNR performance at the parietal lobe if adopted in a helmet-style head array coil. But, we need further verification studies using an array coil adopting the bi-planar coils since the bi-planar coil has lower off-axis sensitivity than a loop coil due to the return current on the outer plane.

CONCLUSION: We expect we can use the proposed coil to improve the sensitivity of a helmet-style head array coil at the parietal lobe of a human brain.

REFERENCES: [1] SEMCAD X by SPEAG, www.speag.com