EVALUATION OF MICROSTRIPS AND SURFACE COILS FOR USE IN PHASED ARRAY SURFACE COILS AT 11.1 T

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Introduction

Although phased array coils are now standard in clinical MRI, they are not available at very high fields, where there is a greater complexity, coupling, and general lack of excitation coils. Microstrip construction techniques have been offered as a way to reduce coupling between coil elements in arrays. We have been comparing a shunt terminated loop microstrip, a tunable loop microstrip, and an unshielded surface coil, as well as, microstrips on different circuit board substrates. The implementations were compared as single elements and arrays.

Methods

We built a Rogers microstrip loop, a shielded loop, and an unshielded loop (Fig 1). In addition, we duplicated the Rogers microstrip loop on FR4, a common epoxy laminate and modified it by trimming back the substrate on the edge of the loop that was placed adjacent to the other loop, and adding a vertical shield to reduce coupling. All loops measured 1.2” (3cm) on each side and were tuned and matched to 50 Ω at 470 MHz. A series of bench measurements with a magnetic field probe were made as well as MR images on our 11.1T (470MHz)/40cm Magnex/Bruker system. Single loops were place on a phantom filled with a tissue equivalent solution (ε = 48.6, σ = 0.6 S/m @470 MHz). A magnetic field probe embedded in the phantom measured the field 2 cm from the coil. Images were acquired (field probe not present), from which depth penetration and SNR were evaluated. We then evaluated each design by placing two loops side-by-side. Isolation between the loops was measured.

Results

Bench and magnet measurements for the single coils show that the FR4 microstrip loop and the unshielded loop have lower Q, SNR, and field measurements that the Rogers microstrip loop and the shielded loop. Field plots indicate that the Rogers microstrip and shielded loop have the highest signal intensity along the entire plot, whereas the FR4 microstrip and the unshielded loop have the lowest signal intensity. Images of the two coil setup for the Rogers microstrip indicated little shared signal between the coils. Images from Rogers microstrips indicate a signal void between the coils caused by the wide width of the shield trace on the bottom of the microstrip. The modified microstrip showed improved signal intensity between the coils because the width of the shield trace on the bottom has been reduced and the coils can be placed closer together.

Conclusion

The Rogers microstrip loop and shielded loop show superior performance to unshielded loop and FR4 microstrip loop at 470 MHz. However, the traditional implementation lends itself to a signal void between the two loops of a small array. This problem can be overcome by a modification of the microstrip that improves the isolation and signal intensity between the coils. These data indicate a great potential for the construction of high frequency phased array coils using microstrip arrays. The work has been submitted to the ISMRM (1).

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References