Design of an 8-channel Head Coil for SENSE Acceleration in 2 Directions

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Introduction

SENSE (1) has become a widely used technique to reduce scan time based on coil geometry. Thus far there have been only a few coils that enable SENSE acceleration in arbitrary directions, which results in restriction of application flexibility, especially to acceleration in 3D images. Seeber *et al* (2) proposed an array design for 2D acceleration adopting a triangular shape. Now we simulated 4 types of 8-channel head arrays, classified by the shape and the coil base: triangle or rectangle for shape, cylinder or dome for coil base (Fig. 1). Each type was further classified into four categories, depending on how one of the coils overlaps with others adjacent to it. The g factor was calculated in a sagittal plane where phase encoding can be done either in the AP direction or in the SI direction. A comparison was carried out among the types both for maximum g values and for mean g values.

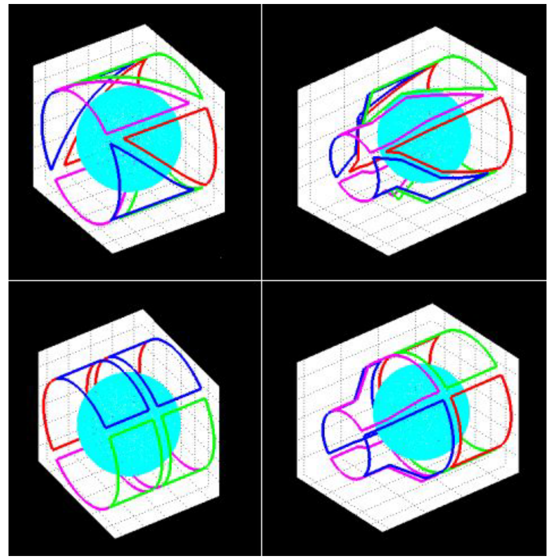

Fig. 1 Four coil types. (Left) Coils on a dome coil base. (Right) On a cylinder base. The spheres indicate phantoms.

Results

In Fig. 2, calculated g values are shown for reduction factor of 2. For AP phase all the arrays have g factors small enough to acquire a good SNR. For SI phase triangular arrays have significantly larger g values than rectangular ones. We compared the sub-types of rectangular arrays. The arrays with elements' overlaps in the SI direction showed better g factors than without overlaps in SI. Fig. 3 shows g maps for the AP phase encode. B1 profiles in the AP direction of these two kinds of coils are also shown in Fig. 4. The overlap between adjacent elements generates sensitivity differences between the pixels to be superimposed in the image of the reduced FOV. On the other hand, the coil without overlap has a sensitivity decay in the area near the elements, resulting in an increase of the g factor. That's because z components of B1 don't contribute to MR signals and this affects the B1 profile shown in Fig. 4 if coils aren't overlapped. In the case of the rectangular type, there were no big differences between g factors of the different coil bases; we chose the dome type, because of its better filling factor. In the case of the dome type, overlap in tangential direction reduces the g factor. All things considered, the rectangular array with overlap in the SI direction is the best candidate for 2D SENSE.

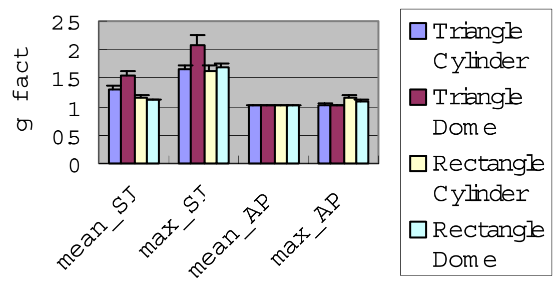

Fig. 2 G factor comparison among the four array types

Discussion

The fact that SI overlap reduces the g factor for AP phase encode seemingly conflicts with the results of a cardiac coil's study in reference (3). But now we focused on the sagittal or coronal plane and each element has only an AP or RL component of B1 on the centerline of the FOV along the AP direction, where g factors tend to increase. This is due to the symmetry of the cylinder, and the zero contribution of the SI component of B1. Also, since the phantom doesn't closely contact the elements, the phase of B1 doesn't change at all along the centerline for each element. The overlap in the SI direction could be applied to many situations of coil design for the SENSE technique in the coronal and sagittal planes and also to SENSE imaging in 3D.

References

1. Pruessmann, K.P. et al., MRM42:952-962 (1999).
2. Seeber, D. et al., Proc. ISMRM11 #0465 (2003)
3. Weiger, S. et al, MRM 45:495-504 (2001)

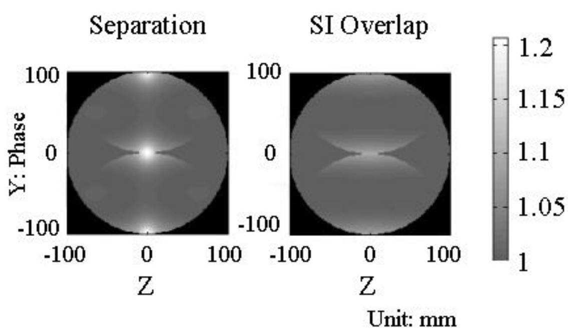

Fig. 3 G factor of rectangular coils on the cylinder

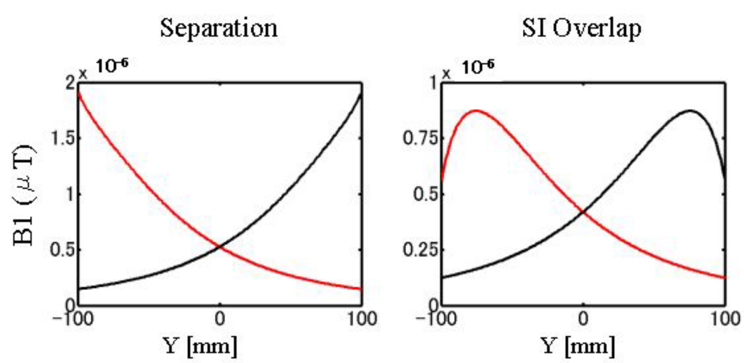

Fig. 4 B1 map profiles in AP direction along the centerline