Multi-direction SENSE imaging using a Head coil based on Trianglular elements with a standard clinical scanner

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Synopsis It is recognized that RF coil geometry plays a crucial role in SENSE performance.. We test a new coil topology using triangular loops, specifically tailored for SENSE acceleration along all three orthogonal axes. the design allows for an additional 2-fold acceleration in the z-direction, without compromising the SENSE performance in the transverse plane, and without increasing the number of channels.

Introduction. Seeber and co-authors described a novel phased array coil geometry to provide phase difference maps in 3 dimensions uniquely. [1] Non-overlapping coils produces better SENSE performance primarily due to the phase difference between the coils. The new coil topology uses triangular loops consisting of right triangles with alternating diagonals. An important aspect of the coil is the capability of z-direction SENSE capability without compromising homogeneity or SENSE performance in the transverse plane when compared to the conventional "head" coil composed of rectangular loops equally spaced around the circumference. The triangular loops provide two different field profiles in the z-direction without doubling the number of loops in the coil. Thus it is possible to perform SENSE axially that is not possible with a rectangular looped coil. This capability is gained without the loss of homogeneity or SENSE performance transversely.

Methods. The coil was tested on a General Electric (Waukasha WI, USA) Excite 1.5 T 8-channel system. Normal volunteers were used in standard gradient echo imaging sequence which has been modified to use the GE ASSET accelerated imaging software. Some care was required to select parameters that would allow a Z-direction SENSE image which is a non-standard ASSET orientation. The prototype coil is receive-only so outer volume suppression pulse was used to eliminate any aliasing artifacts. Figure 1 shows GRE human sagittal images (256 x 96 matrix, 24 x 12 cm FOV, 4 mm slice thickness) obtained on 8-channel coil at 1/2 phase FOV. The corresponding overlap compares to the SENSE rate 2.0 reconstructed image in Figure 2.

Results. We used the triangular coil geometry of right triangles with alternating diagonals which preserves the SENSE g-factors in the axial plane, x or y directional acceleration as compared with an 8-coil rectangular design constructed of non-overlapping coils.. In addition to preserving the axial acceleration g-factors, the triangle coil allows for 2 times acceleration in the coronal or sagittal planes, z-direction SENSE, without increasing the number of coils, remaining at 8 coils. Below, we show slice images from a multi-slice data set with SENSE rate 2 in the direction, z-direction SENSE, for the triangular coil. Calculations show the triangular coil has a maximum g-factor of approximately 1.8 for the same FOV and ROI along the z-direction. In the transverse plane the g-factor remains the approximately the same for 4 times acceleration for both coil topologies.[1]

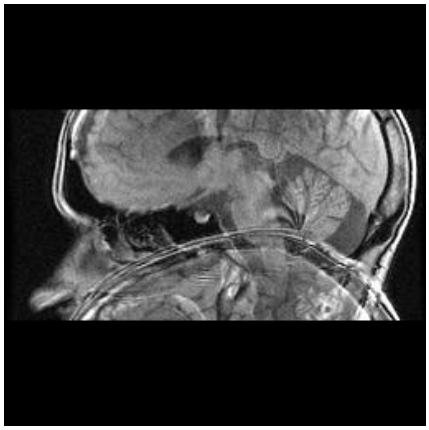

Fig 1: Half-phase FOV image of in Z -

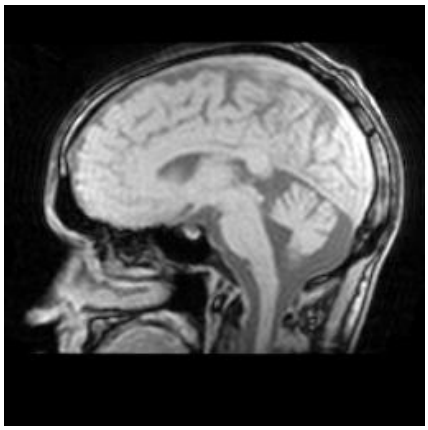

Fig 2. SENSE rate = 2 reconstruction along the Z-direction.

Discussion. The use of the triangle coil topology allows for robust SENSE rate 2 imaging in any direction without severe distortions due to rapid g-factor expansion. Higher acceleration rates are possible as the scan plane approaches the coil transverse plane with high g-factor Expansion. Though the current implementation uses 8-channels it is not limited only to a 8-channel system but is applicable to any number of channels or geometry that can be described by trigonal tiling. All triangular coils have some z-directional SENSE capability, however, the use of right triangles with alternating diagonals does not adversely affect transverse SENSE acceleration and maintains ease of construction.

References . 1) Seeber D et. al. Proc ISMRM 11: (2003).