Parallel imaging using a four coil array at 600 MHz

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INTRODUCTION:

Phased array coils and parallel imaging techniques have become standard on almost all clinical imaging systems. Such techniques also have large potential applications for high field MR microscopy, where measurement times are typically long and susceptibility artifacts can be severe. However, the design of efficient high-frequency phased arrays for small-diameter, vertical-bore magnets is technically very challenging, especially since standard decoupling methods such as impedance mismatched preamplifiers cannot easily be integrated. Here we report a four coil phased array constructed for microimaging at 600 MHz, and show SENSE reconstructions of spin-echo and echo planar images of the mouse brain for reduced imaging time and reduced susceptibility artifacts, respectively.

METHODS:

Four coils were constructed, each covering 120°, with 30° overlap. Each coil was curved to fit on a plastic cylinder (32 mm OD, 25 mm ID) surrounding the sample. Individual coils measured 36 mm x 34 mm, and were made of 20 AWG magnet wire, divided into 4 segments using 3 capacitors to reduce wavelength-effects. Each coil was impedance matched in a balanced configuration. Capacitive decoupling networks were used as described previously (1) to attain isolations greater than 25 dB between all sets of coils. Figure 1 shows a photograph of the coil assembly. A power splitter with cables of appropriate wavelengths was used for transmission. The signals were fed into the four-channel receiver on the Varian Inova 600 MHz system.

Figure 1: Photographs (top and bottom views) of the four coil phased array with impedance matching and decoupling networks.

RESULTS:

Figure 2 shows a demonstration of a SENSE factor of two for images of a mouse tumour model [4]. Since high resolution images need to be acquired very rapidly due to the very limited time of anesthesia which the animals can survive, typically <15 minutes, increases in imaging speed are extremely important in this application.

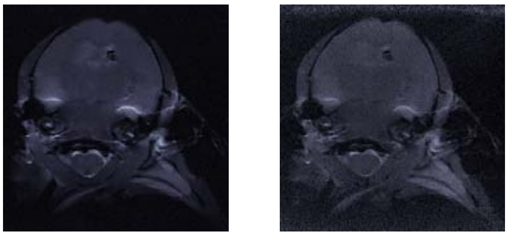

Figure 2. (left) full encoded image and (right) SENSE factor of two reconstruction of a mouse brain containing a small tumour. TR=1s, TE=14 ms, FOV 2.1 x 2 cm, 1024 x 512 complex points, slice thickness 500 μm.

In addition to increasing basic imaging speed parallel imaging techniques can be used for reducing susceptibility artifacts in single-shot methods such as echo planar imaging (5) at high fields. Figure 3 shows EPI images from a mouse brain, and the improvements possible using SENSE reconstruction.

One-shot Two interleaves Four interleaves

Fully encoded

SENSE factor 2

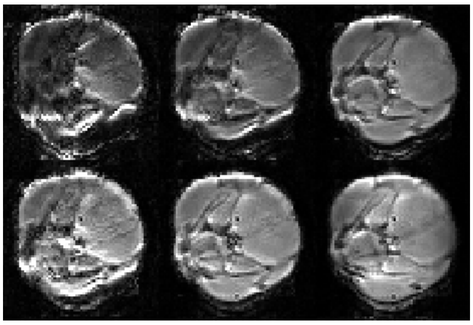

Figure 3. EPI of mouse brain showing the reductions in susceptibility artifact using SENSE. Data matrix 128 x 64, slice thickness 1 mm, FOV 1.7 x 1.7 cm, TE 47 ms.

DISCUSSION:

Initial results using parallel imaging at 600 MHz show promise for increasing imaging speed and reducing susceptibility artifacts for small animal structural and functional imaging.

REFERENCES:

[1] Zhang X, Webb AG. 2004J.Magn.Reson. 170:149-155. [2] Wichmann T, Gareis D, Griswold M, Neuberger T, Wright S, Faber C, Webb A, Jakob P. 2004.Proceedings of the Eleventh ISMRM. Kyoto, Japan. p1578. [3] Pruessman KP, Weiger M, Scheidegger MB, Boesinger P. 1999. Magn Reson Med. 42: 952–962. [4] Roy EJ, Gawlick U, Orr BA, Rund LA, Webb AG, Kranz DM.2000. J.Immun, 165, 7293-7299. [5] Griswold MA, Jakob PM, Chen Q, Goldfarb J, Manning WJ, Edelman RR, Sodickson DK. 1999. Magn Reson Med 41:1236–1245