Focused Parallel Imaging Array for Mouse Brain Imaging at 11.1T

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Introduction

In clinical settings, surface coil arrays offer high sensitivity and extended fields of view for human MRI that are crucial for diagnostic coverage. Coupled with parallel imaging (PI) techniques, these coil arrays dramatically decrease the acquisition times of clinical scans. However, for MR research efforts focused on *in vivo* animal models, the exact point of anatomical interest for imaging is often known *a priori* due to a predetermined disease or injury site. Standard surface arrays, such as a linear layout (1) or a matrix (2), do not offer much advantage to the animal imager when the precise location is known. Alternately, array elements that are focused on a common location can provide the animal image with enhanced signal-to-noise performance, improved B1 field homogeneity at high magnetic fields and accelerated imaging times via PI methods. In this study, we present a receive-only array design for animal MRI at high fields (> 11 T) that focuses each element at a single location. Through geometric and passive techniques, the individual elements of the array are well isolated making it useful for PI applications. Sample images were acquired at 11.1 T on biologically relevant phantoms and *in vivo* mice.

Methods

A 3-element array was built on a curvilinear fiberglass half-shell of diameter 3.8 cm (figure 1). The design consists of two orthogonal butterfly coils centered over a single loop coil (Figure 2). The single loop is 3.2 cm in diameter, built on a Teflon substrate, and has two distributed capacitors. The butterflies, also placed on the Teflon substrate, are 2.8 by 4 cm and have four distributed capacitors. The middle cross-overs are built with Teflon coated wire. Each coil element contains a passive trap (MA45471Schottky diodes) across one of the distributed capacitors. Each coil is driven through ±90 degree circuits (3), and each cable contains a cable trap. Small isolation capacitors are added between elements.

The coil array was placed in a small transmit-only birdcage and parallel imaging was performed on a 11.1-T, 40-cm Magnex/Varian magnet interfaced with a Bruker Biospec imaging/spectroscopy console and PI algorithms based on GRAPPA (4). The coil first was evaluated with a tissue equivalent phantom (5) with characteristics of average brain at 470 MHz (ε =48.6, σ =0.6 S/m). *In vivo* brain imaging of a native C57 mouse followed. Fast Spin Echo (FSE) and Gradient-Recall Echo (GRE) images were acquired with acceleration factors of 2 and 3.

Results

Return loss for all coil elements was ≤ -22 dB, and isolation between all elements was better than 20 dB. Axial profiles of each coil element, all focusing on the same volume, are shown in Figure 2 (bottom). Figure 3 shows GRAPPA acquisitions of the tissue phantom with acceleration factors of 2 and 3. The characteristic aliasing of parallel imaging is seen in the single element reconstructions, but is corrected in the GRAPPA reconstruction. Figure 4 shows GRAPPA acquisitions of the *in vivo* mouse (with focal location in the cortex) with an acceleration factor of 2.

Conclusions

We have built, tested and utilized a 3-element surface coil array for mouse brain parallel imaging. Each element of the array is sensitive to the target region, thus maximizing the signal-to-noise in the volume of interest. GRAPPA images indicate good coverage and signal quality in the target volume of the mouse brain.

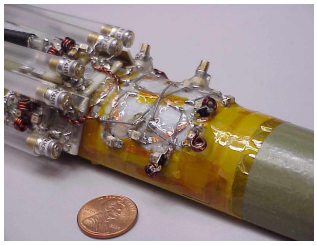

Figure 1 Photo of 3-element PI coil

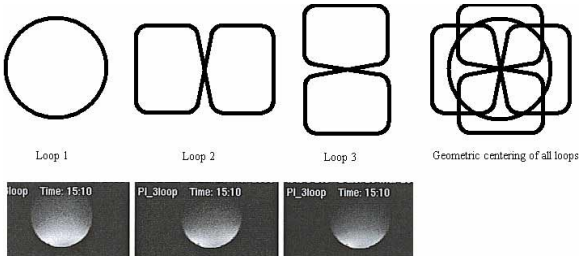

Figure 2 Top: single loop schematics and combinations
Bottom: single loop sensitivities

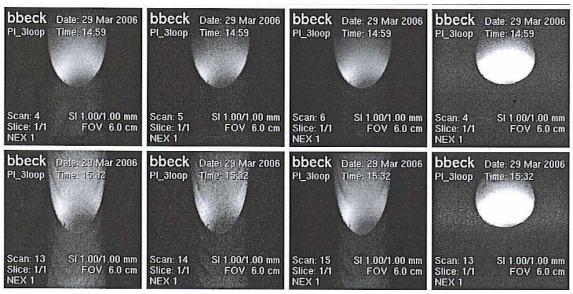

Figure 3 Parallel Imaging of phantom,
Acceleration of 2 (top) & 3 (bottom)

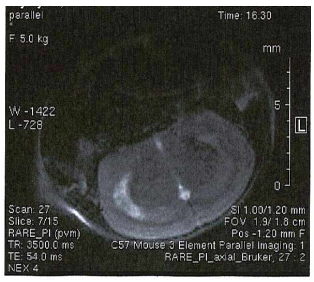

Figure 4 Parallel Imaging of mouse brain
Acceleration factor = 2

References

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