A 16 channel head coil

J. Jevtic[1], V. Pikelja[1], R. Duensing[2]

[1]Advanced Concept Development, Invivo Corporation, Pewaukee, WI, United States, [2]Advanced Concept Development, Invivo Corporation, Gainesville, Florida, United States

Introduction: A new 16 channel, 24 element RF coil array for the human head is introduced. The design goals were to provide partially parallel acquisition speed up factors in all directions while improving the SNR in the center of the head by at least 10%, in comparison to the standard 8 channel head arrays available on many scanners. In order to accomplish this goal, a new approach to coil layout was implemented. Unlike many prototypes previously presented, in which the surface of the formers are simply covered with small loops, this design utilizes the existing standard 8 channel array as a base. It would be expected that SNR would improve everywhere in the imaging region as long as the isolations were controlled.

Methods: Because of the relative strength and ubiquity of the 8 channel head arrays on most current MR systems, this basic design was taken as a base for improvements to the array. The first consideration was to improve the SNR at the center of the array. From our experience with earlier prototypes, it was known that increasing the number of channels around the coil by keeping the length of the elements constant, but reducing their azimuth and increasing the number of channels would not improve SNR at the center of the array. It was hypothesized that adding much shorter loops to the 8 channel array, and inductively isolating them from the elements of the original channels could result in improved SNR at the center. The starting 8 channels are shown schematically in Figure 1. Shared capacitors and a capacitive end-ring decoupling network (1) are used to isolate the 8 channels. To improve the SNR , 4 loops approximately half as long as the 8 original loops were added at the z-direction center of the array. Each loop had more than a 90 degree azimuthal extent. The added 4 elements are shown schematically added in Figure 2. Figure 3 demonstrates the additional inductive isolators employed to provide adequate decoupling between all 12 elements of the array so far. Finally, “butterfly” coils are utilized in an unconventional way to add 8 more elements (4 channels) that are intrinsically isolated from all of the other channels due to symmetry. While these butterfly elements add no signal at the center of the coil, they do add signal at the superior and inferior ends of the coil, and they provide additional speed up capability in the Bo direction. If the superior end of the coil housing is domed, perfect symmetry does not apply so that the butterfly coils need to be adjusted in position to provide the needed isolation.

Results: Isolation of 20 dB or better was obtained between all elements of the array. Figure 4 shows sagittal slices SNR profiles for the 3 different types of elements. Imaging results on patients and phantoms demonstrate a 10% to 20% improvement in SNR at the center of the imaging region, roughly the location of the center of the brain in the axial plane of the orbits. Figure 5 demonstrates the phantom SNR of the 16 channel array in comparison to the SNR of the standard commercial 8 channel array, while Figure 6 shows comparative clinical images. Note that even though the channel count doubled, the uniformity has not been substantially degraded.

Conclusion: The SNR performance of the array is consistent with predictions and the goals of this project, and represent a visible improvement in brain imaging. Parallel imaging capabilities have not yet been rigorously compared, but they must exceed those of the comparative 8 channel array since these elements are a subset of the new design. Reduction factors of at least 2 in the z- direction are expected to be able to be routinely used, thus allowing significant 3D reduction factors.

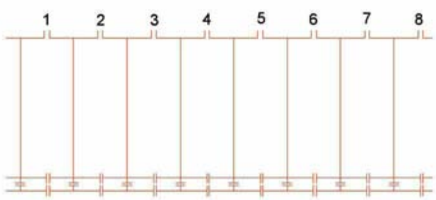

Figure 1. 8 isolated elements

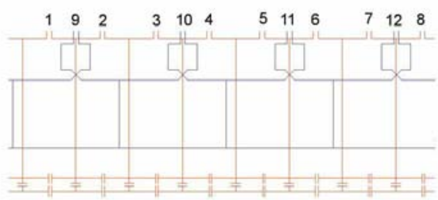

Figure 2. Original 8 elements + 4 shorter elements

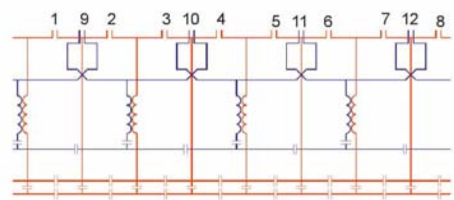

Figure 3. 12 isolated elements

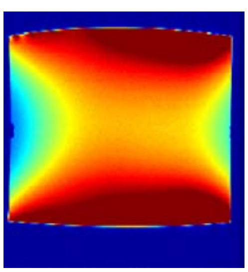
Figure 4a. 8 long elements

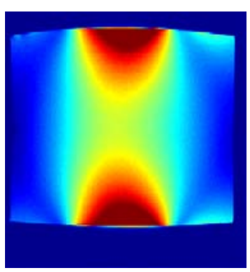
Figure 4b. 4 short elements

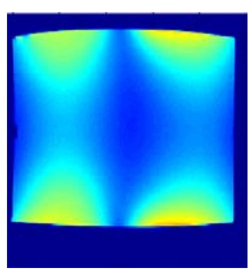
Figure 4c. 4 butterfly coils

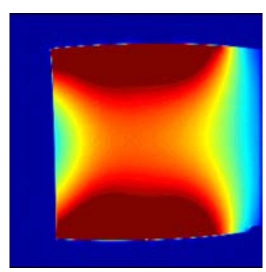
Figure 5a. 16 channel array

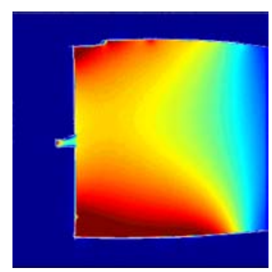
Figure 5b. 8 ch. commercial array

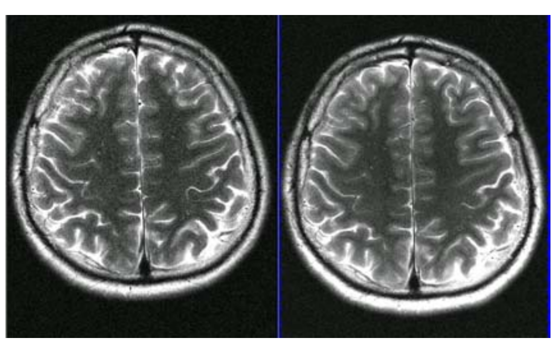
Figure 6. Clinical Image Comparisons: 8 channel commercial array 16 channel prototype array

References: (1) Jevtic, Jovan, Proc. Of the 9th meeting of the ISMRM, 2001, p. 17