A Semi-flexible 32-ch RF Coil Array for Clinical 3T Brain Imaging

Y. Li[1], M. Gyori[1], K. McClellan[1], C. Saylor[1], and A. Reykowski[1]

[1]Advanced Concept Development, Invivo Diagnostic Imaging, Gainesville, Florida, United States

Introduction: Recent developments in research coils have demonstrated that the use of an increasing number of receive coil elements can significantly improve SNR and reduce g-factor in parallel imaging [1-3]. However, clinical applications have not made full use of this gain because the filling factor in clinical coils is limited by the requirements of fitting a large variety of patients and the coil fabrication is limited by the clinical safety and manufacturability. In this study, these issues were addressed and a semi-flexible 32-channel RF coil array was developed for clinical brain imaging. In this coil, a semi-flexible mechanical structure was used to minimize the gap between the head and coil elements for different sized patients. The alignment of 32 coil elements was optimized to minimize the coil loss and overall coupling. It was demonstrated that this coil gives lower SENSE g-factor and higher SNR in depth compared with a standard eight-channel clinical RF coil in clinical brain imaging applications.

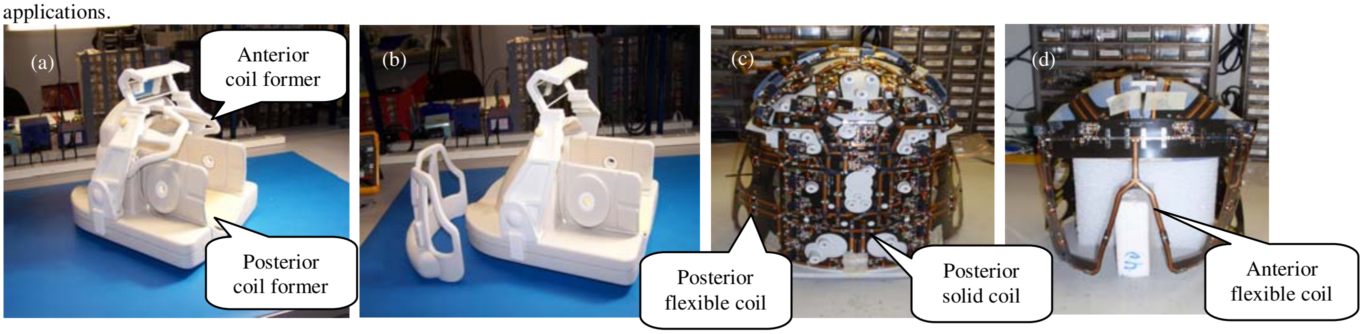

Fig. 1 Mechanic structure and coil configuration of 32ch coil array. (a) Mechanic structure with anterior coil former; (b) Mechanic structure without anterior coil former; (c) Element configuration of posterior coils; (d) Element configuration of anterior coils.

Methods and Materials: As shown in Fig. 1, the 32-channel brain coil array consists of posterior and anterior coils. The posterior coil array has 28 elements, which cover most of the brain region and can be used as a stand-alone coil. The anterior coil array has 4 elements, which cover the optical region and can be used as an add-on coil. The posterior coil elements can be divided into two groups: rigid and flexible elements. The four anterior coil elements are all flexible. All the coil elements are constructed of flexible Kapton PCBs with a thickness of 0.25 mm. In the rigid portion of the posterior coil, the PCBs are placed on a solid former, which includes a posterior cylinder and a top dome surface. In the flexible portion, the PCBs are sealed in flexible foam. This allows it to conform to the head, improving the filling factor of the coil array. The entire coil array has dimensions of about 230 mm in anterior-posterior direction and about 220 mm in left-right direction. From Figs. 1 (c) and (d), it can be seen that the coil elements are designed in different shapes and sizes at different positions. The shape and size of each coil element is optimized based on sample loading, FOV coverage and mechanic structure. It is designed such that the coil elements are uniformly loaded by the sample and the 32 elements cover the entire brain region. In the final design, each coil element has a loaded Q within the range of 60~80 and an unloaded Q within the range of 180~240. Most neighboring coil element pairs are decoupled by optimum overlap and some pairs are decoupled by a shared capacitor. A two-stage preamplifier with an integrated trap is used for signal amplification and common-mode suppression. The coil was tested on a Philips Achieva 3T System and compared with an 8-channel head coil (Invivo, Gainesville, FL 32608). Two sets of brain images were used for comparison. One was a set of transverse images acquired with full Fourier encoding using a spin-echo sequence (matrix 256×256, FOV 230 mm, TR 2000, TE 15 ms, flip angle 90°, slice thickness 4mm, NSA 1, phase encoding direction left-right). The other was a set of T2-weighted high resolution sagittal images acquired with a SENSE reduction factor of 2×3 in AP and LR directions using a 3D spin echo sequence (voxel size 0.68/0.86/0.8 mm, TR 2500 ms, TE 471 ms, TSE factor 147, Flip angle 90°, FOV 250mm, NSA 2).

Results and Discussion: Figs. 2(a) and (b) show the transverse brain images acquired from the 8-channel and the 32-channel coil array respectively. Fig. 2(c) shows the noise correlation of the 32-channel coil. It can be seen that for a few pairs of coil elements, the noise correlation is as high as about 0.6. This can be attributed to the use of flexible coils, which have to rely mainly on the preamplifier decoupling since their positions cannot be mechanically fixed. However, this does not considerably affect the overall coil performance when using optimal reconstruction techniques. From the SNR plots in Figs. 2(d) and (e), it can be seen that the 32-channel coil array gives higher SNR than the 8-channel coil array. This gain in SNR is much greater in the peripheral region of the head and still about 15% at the center of the head. Figs. 2(f) and (g) give the g-factor maps for the two coils using this set of data with a reduction factor of 4. It can be seen that the 32-channel coil array has improved g-factors. Fig. 3 shows a comparison of the sagittal projection of 3D SENSE images taken with the two coil arrays. It is clearly visible that the 32-channel coil array offers much better imaging performance than the 8-channel coil array even at the center of the brain.

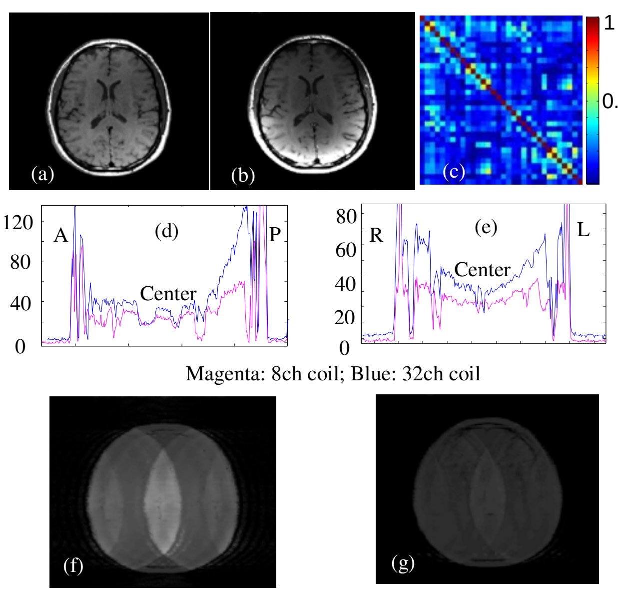

Fig. 2 Transverse brain images. (a) From 8ch coil; (b) From 32ch coil; (c) Noise correlation of 32ch coil; (d) SNR plot in AP direction; (e) SNR plot in LR direction; (f) g-factor map for 8ch coil; (g) g-factor map for 32ch coil.

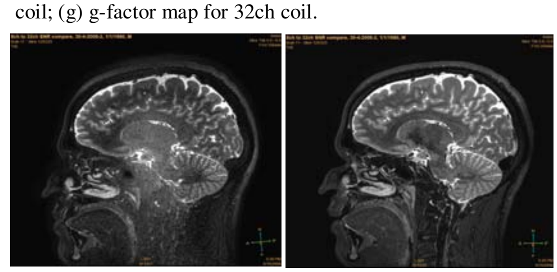

Fig. 3 Sagittal brain images using SENSE. (a) From 8ch coil; (b) From 32ch coil.

Reference: 1). Wiggins G. C. et. al., MRM 56(1): 216-223 (2006). 2). Schimit. M. et. al., ISMRM 2006, p245. 3). Hardy, C. J. et. al., ISMRM 2006, p244. **Acknowledgement:** The authors thank Elizabeth Moore in Philips for her help on data acquisition.