A Novel 10-Element Array Coil for Head Parallel Imaging at 1.5T

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INTRODUCTION Parallel Imaging (PI), SENSE [1] in particular, has become a major technique in head imaging to perform the faster data acquisition. On the other hand, when T_s is reduced by PI techniques, one would face with a fundamental physics problem of inevitable loss of SNR resulting from shortened T_s. To overcome this challenge in PI applications, it is necessary to develop a head coil that provides more SNR with unfolding capability in 3 directions (x, y and z) while maintaining clinically acceptable image quality even when PI technique is applied. This can be achieved by optimizing SNR and phase-encoding capability through coil physical/electrical parameters such as the number of elements, coil-element arrangement/size and electrical dimension (i.e., head coil diameter and length).

METHOD To optimize SNR, the base electrical design was derived from an fMRI coil that consists of 4 QD pairs (Fig. 1), as reported in [2]. However, this coil covers only the areas of brain/head. To extend the design for an entire head coil, two loops have been added in front of a nose/mouth/chin (Fig. 2). The completed coil has individual elements in x, y and z directions, providing the PI phase-encoding capability in the all directions. Furthermore, to provide patient comfort and maximize housing openness, preamps have been positioned in the coil base housing with matching phase-shifter networks with appropriate cable lengths for the preamp decoupling to desensitize each coil element (Fig. 2). As a result, the developed coil offers 50 to 60% more SNR (in-plane average) at an axial slice (coinciding with eyes) than the standard QD head coil used on 1.5T Toshiba EXCELART system. The SNR profile of the 10-element array coil is normalized to that of the QD head coil in Fig. 3. Because of this SNR increase, better image quality can be achieved even when PI technique is applied. It is also noted that the coil can be used with both 4-channel and 8-channel systems, depending upon how the elements are combined.

EXPERIMENTS & RESULTS Presented in Fig. 4 is a comparison for 3D TOF MRA images obtained with the proposed 10-element array coil and the standard QD head coil. In the right image, the acceleration factor of 2 was applied. Although the total scan time is half in the right image, the image quality is still superior to the left one due to the SNR increase achieved by the 10-element array coil. Another example, shown in Fig. 5, is a high-resolution T2W image obtained with the 10-element array coil (slice thickness=3mm).

CONCLUSION We have developed a high performance 10-element array coil for parallel imaging and demonstrated its superior performance in the case studies presented herein.

REFERENCES [1] K. P. Pruessmann, et al., MRM, 42, pp. 952-962, (1999); [2] Y. Hamamura, et al., Proc. ISMRM, p. 738, (1999)

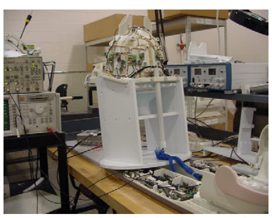

Fig. 1 Head coil elements (also refer to [2] for base information)

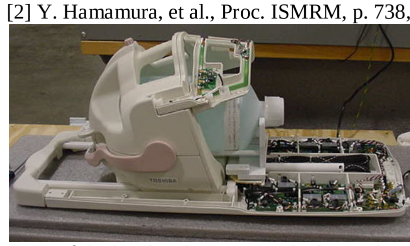

Fig. 2 Side view of the head coil (nose/mouth/chin coil is shown; coil base including preamps and matching networks)

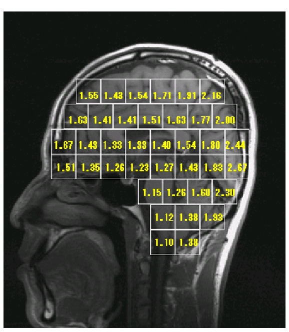

Fig. 3 Normalized SNR profile of the 10-element array coil to the QD head coil

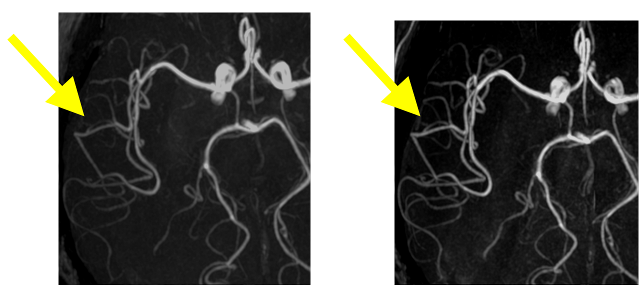

Fig. 4 3D TOF MRA images with Maximum Intensity Projection
(Left: QD Standard Head Coil with T_S=9 min;
Right: 10-element array coil with T_S=4.5 min, i.e., R=2)

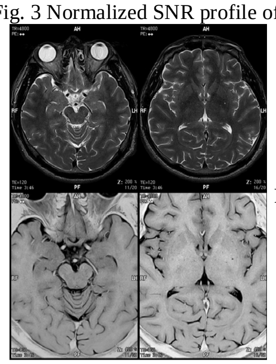

Fig. 5 High-resolution T2W image (R=1.5, T_s=3:46, 384 x 384, T_H=3mm)