20 Channel Coil Array for High Resolution Imaging of the Optic Nerve

J. R. Hadley[1], E. Minalga[1], and D. L. Parker[1]
[1]Radiology, University of Utah, Salt Lake City, Utah, United States

Introduction: The purpose of this work was to design and construct an RF coil that was better optimized for imaging the Optic Nerve (ON) than the clinical 12-channel head coil available on our 3T imaging system. The specific goals were to optimize signal sensitivity from the eyeball to the Optic Chiasm. The constraints were a maximum of 32 available channels.

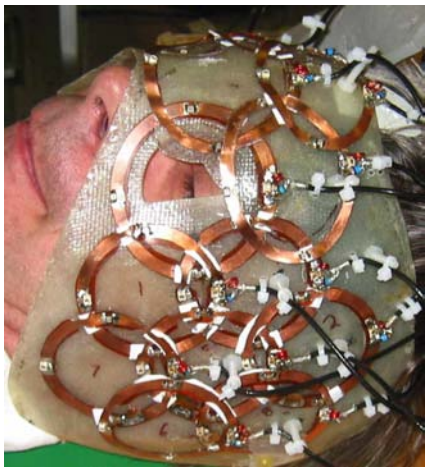

Fig. 1 Optic Nerve coil consisting of 20 overlapped circular coil elements mounted on a fiberglass mask former.

Methods: The Optic Nerve coil was constructed on a fiberglass former that fit over the head as a mask. One coil element was placed over each eye and a cluster of 7 loops were placed over each ear. Four additional elements were placed between the eyes and over the forehead for a total of 20 elements (see Fig 1). Elements were circular in shape and overlapped for optimal decoupling from adjacent elements. Each element was both actively and passively decoupled, and the maximum noise correlation between different elements was 0.45. Imaging experiments were performed on both a homogenous head phantom and human subjects to evaluate and quantify the effectiveness of the ON coil. Experiments were performed on a Siemens 3T TIM Trio scanner (Siemens Medical Solutions). The imaging sequence parameters consisted of a 2D TSE acquisition with a 0.4 x 0.7 x 2.5 mm voxel size (TR/TE = 4.5s / 115 ms). Phantom images were used to assess the relative SNR (rSNR) between the two coil arrays. Relative SNR images were created by computing the square root of the sum-of-squares of the rSNR's from each channel. Three orthogonal SNR profiles through the phantom at the location of the chiasm were determined. Human images were obtained as a visual measure of coil sensitivity and image quality.

Results: Phantom study results showed that the ON coil provided superior rSNR and image quality over the region of the optic nerve. The rSNR profiles showed that the ON coil provided 35% greater rSNR at the region of the optic chiasm and approximately 300% near the region of the eyes. The ON coil also provided 300 to 400 % rSNR improvement near the coil elements when compared to the 12-channel coil. The specific profile plots are not provided, but the rSNR images are shown in Fig 2. Human imaging studies demonstrated the increased image quality that resulted from using the ON coil for imaging the region of the optic nerve between the eye and the chiasm. The images (Fig. 3) show much higher signal in the optic nerve and the images are sharper and more clear than those using the 12-channel coil.

Conclusions: Compared to the Siemens 12-channel coil the ON coil provides between 35 and over 200% rSNR improvement along the length of the optic nerve from the chiasm to the eyeballs.

Acknowledgments: This work was supported by Siemens Medical Solutions, the Cumming Foundation, and Larry Wald at MGH.

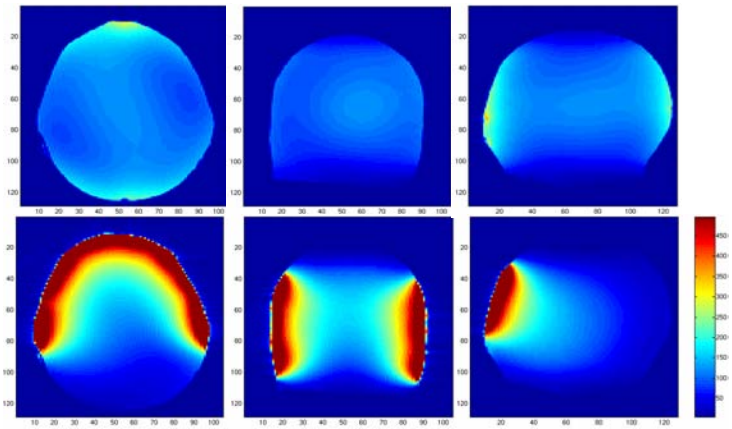

Fig. 2 Relative SNR plots from the 12 channel head coil (top) and ON coil (bottom).

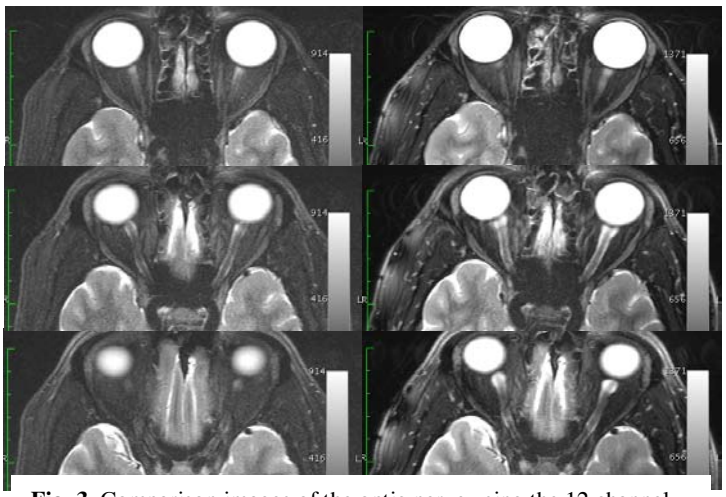

Fig. 3 Comparison images of the optic nerve using the 12 channel head coil (left) and the ON coil (right).