Coil Comparison for In Vivo Eye Imaging at 7T

P. A. Wassenaar[1], K. Richdale[2], P. Schmalbrock[1], and M. V. Knopp[1]
[1]Wright Center of Innovation, Department of Radiology, The Ohio State University, Columbus, OH, United States, [2]College of Optometry, The Ohio State University, Columbus, OH, United States

Introduction

Imaging of the human eye is becoming increasingly important in the assessment of ocular diseases. With the advantage of higher signal and resolution compared to conventional field strengths, ultra high field MRI is rapidly emerging as a promising imaging tool. This study compares coil performance of three different receive coils used for eye imaging at 7 Tesla. Coil diameter and shape are important factors that affect sensitivity in terms of signal strength and profile. Furthermore, shape and size can affect the loading, tuning, and matching, as well as the ease of handling and patient comfort.

Methods

Three subjects with IRB consent were imaged at 7 Tesla (Philips Achieva) using a volume head coil for transmission (Nova Medical) and three different sizes of custom-built single loop eye coils (Figure 2) for reception. Data were acquired using three-dimensional inversion recovery turbo field echo sequences (3D IR-TFE), with the following parameters: TS/TI=1800/900, TR/TE/flip angle=6.8/2.3/8º, 0.25x0.25x1mm^3, scan time 36s per scan. Using identical setups, subjects were positioned as shown in Figure 2. The subjects were instructed to focus on a Maltese cross located at a specific distance from the eye, using a prism inside the transmit coil. A comparison of coil performance was made in terms of handling and placement, patient comfort, coil sensitivity, and artifacts.

Results

Figure 2 shows data from a healthy volunteer, acquired using each of the three different receive coils. It can be seen that with decreasing coil size (5cm, 4cm, and 2/2.3 cm respectively), an increase in the measured lens SNR occurs (Figures 2 and 3). At the same time, the increase in SNR comes at the cost of reduced coil sensitivity in regions farther away from the coil surface. The advantage of the smallest, homebuilt coil for imaging the lens / ciliary body is the result of several factors. First of all, the smaller coil size increases SNR near the coil interface. Secondly, due to its size, the coil is able to fit inside the socket region and cups the eye closer, where the coil sensitivity is highest. The coil couples well with the tissue, as the eye partially protrudes into the coil. Finally, the dimensions increase ease of positioning and patient comfort. Artifacts were not significantly increased compared to the larger diameter coils.

Conclusions

For the study of frontal ocular structures, the small oblong coil has proven to be ideal. Next to increased signal from lens and ciliary body, the reduced signal from regions more distal limit foldover artifacts from e.g. optic nerve and ophthalmic artery. For retinal applications, the larger coils appear to be better suited due to the increased signal depth penetration.

References

[1] Richdale K, et al., JMRI 30:9244-932, 2009
[2] Bert RJ, Patz S, Ossiani M, et al. Acad Radiol 2006;12:368–378

Figure 1, Setup for in vivo eye imaging at 7T. Receive only coils are used in combination with a dedicated head volume coil.

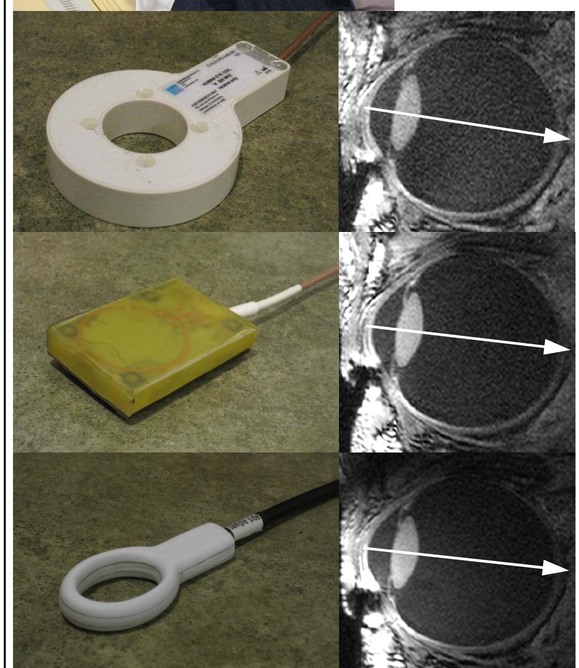

Figure 2, **First column**: the tested coils from top to bottom: Rapid 5cm, Rapid prototype 4cm, 2/2.3cm homebuilt. **Second column**: the corresponding eye images acquired with each coil (3D IR-TFE, 0.25x0.25x1.0mm^3, 9 averages). Lens SNRs: 21, 31, 46.

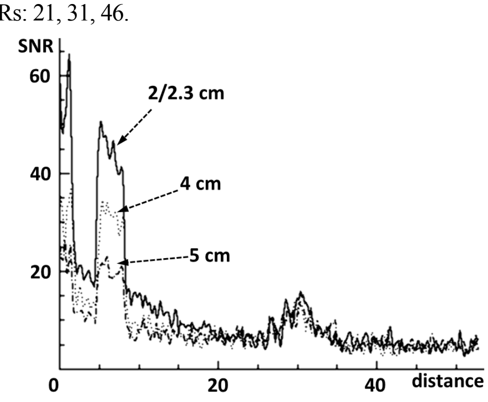

Figure 3, relative signal (SNR) for each of the three coils, measured along the lines indicated in Figure 2.