Hybrid Phased Array Receiver Coil for 3.0T MR Imaging of Internal Auditory Canal

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Introduction
Diagnosis of disease in and around the internal auditory canal (IAC) is particularly demanding, requiring high spatial resolution and high SNR [1,2]. However, limited signal-to-noise ratio (SNR) is a barrier for high spatial resolution MR imaging. One method for improved SNR is application of dedicated surface and phased array receivers. Another method to improve SNR is to image at higher field strength, such as 3.0T. Our 3.0T system currently does not contain a body coil, requiring further development before surface or phased array receivers can be used.

The purpose of this study was to develop a hybrid array combining a birdcage head coil and two surface coil receivers, designed for IAC imaging at 3.0T [3].

Methods
The dedicated hybrid IAC coil was designed and built as two circular surface receive only coils 7.62 cm diameter combined with a standard volume transmit/receive head coil. The coil configuration was modified to allow simultaneous data acquisition from two surface coils as well as from the head coil. All experiments were carried out on a 3.0T VH/i system (GE Signa, Milwaukee, WI). Phantom studies were conducted using 17.8 cm diameter head sphere filled with the solution of CuSO4 and the Milwaukee, WI). Phantom studies were conducted using 17.8 cm diameter head sphere filled with the solution of CuSO4 and the following acquisition parameters: axial plane, TE = 20 ms, TR = 400 ms, 20 cm FOV, 256 x 192 matrix, 1 NEX and 3 mm slice thickness. The SNR measurements were performed on left and right edges as well as in the center of the phantom images. The volunteer studies were performed using T1W spin-echo (SE) and T2W fast spin-echo (FSE) clinical protocols designed for IAC imaging. The clinical protocol included, T1W: 2D, SE, 13/450 TE/TR, 256x256 matrix, 2 NEX, 15.6 kHz bandwidth, 3 mm slice thickness with 0 mm spacing, FOV = 18 cm and T2W: 2D, FSE, 80/4900 TE/TR, 256x256 matrix, 2 NEX, 20.8 kHz bandwidth, 3 mm slice thickness with 1.5 mm spacing, FOV = 18 cm.

Results
Figure 1a demonstrates the SNR profiles of axial phantom images along the X axis using 3.0T hybrid IAC coil and 1.5T TMJ PA (temporomandibular joint phased array) coil. For comparison Figure 1b demonstrates the SNR in axial profiles of phantom images obtained with standard GE volume head coils for 3.0T and 1.5T scanners.

Discussion
Phantom image analysis demonstrates an increase of SNR with increase of magnetic field from 1.5T to 3.0T, by a factor of 3 in the center of the phantom image using standard volume head coils. However for the above mentioned 3.0T coil, decreased SNR was observed at the edges. Phantom image analysis demonstrates an increase of SNR with increase of magnetic field from 1.5T to 3.0T, by a factor of 3 in the center of the phantom image using standard volume head coils. However for the above mentioned 3.0T coil, decreased SNR was observed at the edges. The hybrid IAC coil increased the SNR at the left and right edges of the phantom image, by a factor of 2 compared to the corresponding ROI of the 3.0T standard head coil alone. The 1.5T TMJ PA coil showed high SNR when close within 10 mm to the edge of the phantom. However, in the region corresponding to the inner ear, i.e. 4-5 cm in from the edge, the 3.0T hybrid IAC coil demonstrates 60% to 90% SNR improvement compared to the 1.5T TMJ PA.

The 3.0T hybrid coil demonstrates improved SNR for internal auditory canal imaging without significant susceptibility artifacts and which can be used for higher spatial resolution and faster image acquisitions.

References

Acknowledgements
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Table 1. Signal to noise ratios of phantom images (axial plane)

<table>
<thead>
<tr>
<th></th>
<th>Left edge of phantom image</th>
<th>Center of phantom image</th>
<th>Right edge of phantom image</th>
</tr>
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<tbody>
<tr>
<td>3.0T hybrid IAC coil</td>
<td>540</td>
<td>370</td>
<td>546</td>
</tr>
<tr>
<td>1.5T TMJ PA</td>
<td>395</td>
<td>103</td>
<td>398</td>
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Figure 2. In vivo image of the IAC obtained with 3.0T hybrid coil

Figure 1. The intensity profiles of phantom images normalized to noise: a) 3.0T hybrid IAC coil and 1.5T TMJ PA coil; b) 3.0T and 1.5T GE head coils.

The SNR values presented in Table 1 were obtained in the region of interests (ROI) of 10% of the complete phantom image. Figure 2 demonstrates in vivo T2W FSE image of IAC with arrows identifying the 7th and 8th cranial nerves.