A 3.0-Tesla Transmit and 32-Channel Receive Head Array Coil

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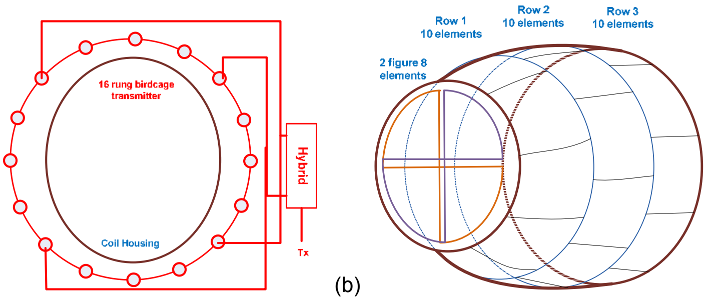
Introduction

With the advantage of signal-to-noise ratio over large volume coils (1) and high acceleration factor parallel imaging capability, high channel count surface array coil has been widely used for imaging of head anatomy (2). Many of the reported high channel count head array coils are receive only coils, which use the whole body coil to transmit RF power for slice excitation and the dedicated receive-only coil to receive the signal from the excited slice for SNR optimization. With this configuration, protocol and slice selections are often restricted due to SAR limitation. To address this issue, a head coil with a local birdcage transmitter and an array of 32 receive surface elements (Tx-and-32Rx head coil) was designed and constructed, with the intention of improving B_1 excitation efficiency and reducing SAR, while providing very high SNR and parallel imaging advantage of high channel count surface array coils.

Method

The schematic representation of the proposed 3.0T Tx-and-32Rx head coil is shown in Figure 1 (a) and (b). The transmit coil is a 16-rung birdcage coil, which has a diameter of 25cm and superior-inferior length of 24 cm. RF signal is injected at four locations on the birdcage ring to ensure its uniform B_1 excitation. The receive coil consists of three rows of coil elements along superior-inferior direction, each of which has 10 receive elements evenly distributed along coil circumference. Two additional figure 8 coils are implemented at the "dome" area to enhance the signal for the top of the head. The inductive coupling between the adjacent loop and figure 8 coil elements are minimized by adjusting the overlap area, and the coil elements are further electromagnetically isolated with each other using a micro-size low input-impedance preamplifiers as shown in previous work (3). The inner surface of the coil enclosure is designed to closely fit the curvature of the human head in order to optimize the performance of the receive array coils. A photo of the completed 32 channel head coil is shown in Fig. 2.



(a) (b)

Fig.1 Layout of (a) transmit coil and (b) receive coil elements of the 3.0T Tx-and-32Rxhead array coil.

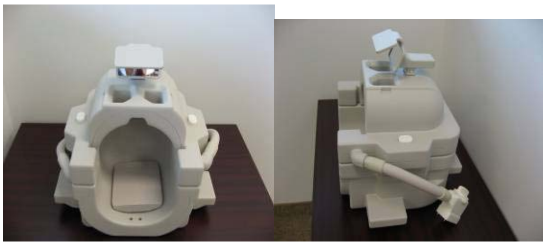
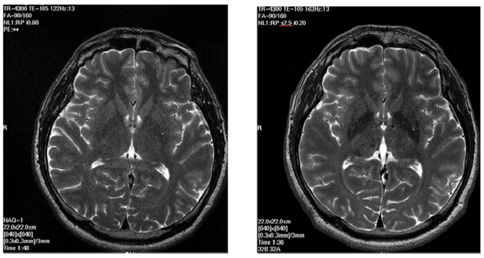


Fig.2 Pictures of the 3.0T Tx-and-32Rx head array coil.

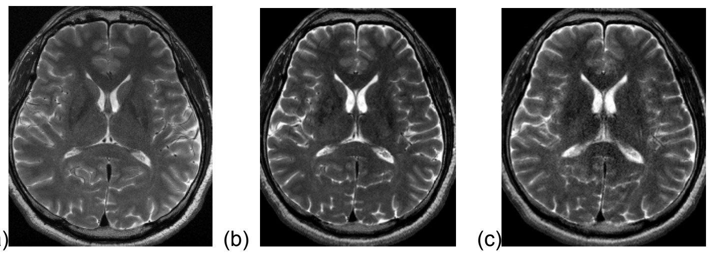
Results

The transmit-and-32-channel-receive head array coil was evaluated on a Toshiba Atlas 3.0 Tesla MRI scanner with 32 receivers. Compared with a commercially available 1.5T 14-channel receive-only head array coil using the same volunteer, the 3.0T Tx-and-32Rx head coil detected much more anatomical details as shown in Fig. 3. Parallel imaging capability of the Tx-and-32Rx head array coil was also evaluated. Figure 4 shows images using the same protocol with (a) no acceleration, (b) acceleration factor of 2.5 and (c) acceleration factor of 5. Imaging results indicate that even with the acceleration factor of 5, the coil can still provide clinically usable images for diagnosis.



(a) (b)

Fig.3 Images of the same volunteer with (a) 1.5T 14-channel head array coil and (b) 3.0T Tx-and-32Rx head array coil.



(a) (b) (c)

Fig.4 volunteer images of the 3.0T Tx-and-32Rx head array coil with (a) no acceleration (b) acceleration factor 2.5 and (c) acceleration factor 5.

Conclusions

A 3.0-Tesla transmit and 32-channel receive head array coil was constructed and evaluated. Initial results showed very promising features of excellent image quality and parallel imaging capability. Future work will be exploiting the optimization of B_1 shimming for some particular head imaging applications that require a very high degree of B_1 transmit uniformity, noting that our Tx-and-32Rx head coil has an option to present two orthogonal linear B_1 transmit modes instead of the quadrature excitation mode that was used for this study reported herein.

References

1. P.B. Roemer, W.A. Edelsten, C.E. Hayes, S.P. Souza and O.M. Mueller, "The NMR Array," Magnetic Resonance in Medicine 16, 192-225 (1990).
2. G.C. Wiggins et al., "A 96-channel MRI System with 23- and 90- channel Phased Array Head Coils at 1.5Tesla," Proc. Intl. Soc. Mag. Reson. Med. 13 (2005).
3. H. Fujita, et al., "A 3T Head Transmitter Integrated with 3D Parallel Imaging Capable 16-Channel Receive Array Coil," in Proc. Intl. Soc. Mag. Reson. Med. 15, 3254 (2007).

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