A Novel Highly Homogeneous Wireless Birdcage Resonator Coil

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Introduction: It is widely accepted that phased array coils are the preferred embodiment for imaging application where the major requirements are high local SNR, capability for ultra-fast parallel imaging application and/or high resolution imaging of localized anatomies. It is well known that one disadvantage of a phased array technology is its ability to generate highly uniform images over the entire imaging volume. In such situations volume RF coil designs such a birdcage resonators are the preferred choice. Furthermore for spectroscopic applications it is desirable to have a birdcage structure that is tuned in multiple frequencies for multinuclear spectroscopic applications. Although the birdcage resonator is the preferred geometry for highly homogenous images, the placement of the structure close to the desired anatomy is mostly restricted due to the the size and length of the RF cables. Volumetric coils that are designated for the lower extremities require longer cable lengths. Such designs might be prohibitive due to the number of cable traps and their proximity to the RF body coil that can lead to RF heating hazard.
In this paper, a novel highly homogeneous wireless birdcage resonator that is capable of dual frequencies is presented [1]. The proposed design addresses the need of eliminating bulky cables without penalty on the coils performance in terms of SNR, uniformity and coverage that a traditional birdcage design exhibits. Furthermore, the proposed design can be easily tuned to a high pass, low pass or band pass configuration, as well as dual frequencies. SNR comparison of the High Pass wireless birdcage configuration with the 12 channel Siemens Head coil at 1.5T yields comparable image quality as well as uniformity. The absence of need for a coil ID and a coil configuration file makes the proposed birdcage design easily adaptable to any OEM MR system.

Methods: The picture of the 16-rung dual frequency and 16-rung high pass wireless birdcage resonator are shown in Fig. 1(a) and Fig. 1(b) respectively. The HP wireless b-cage coil was copper taped on a cast Acrylic tube of diameter 270mm with an overall coil length of 270mm. The endrings have a width of 12.7mm with rungs of width 25.4mm. 16 passive decoupling blocks were alternating on the end rings (between each rung). A transmit RF power change test was conducted using 1.5T Siemens Espree magnet which produced a 3.6% change in power verifying the effectiveness of the passive detune circuit.

(a) (b)

Fig.1 (a) Wireless HP dual freq. (b) Wireless HP b-cage

Results and discussion: Bench measurements on the fabricated coil provided an unloaded Q factor of 270 and a loaded Q factor of 35 at 63.65MHz. FDTD analysis [2] (Fig 2a) of the fabricated wireless high pass birdcage coil showed 15dB improvement in B1 sensitivity at the isocenter of the 1.5T body coil compared with the baseline (body coil alone) as depicted in Fig. 2(b). After successfully completing all the MR safety tests, SNR measurements on the Siemens 7300mL phantom and human volunteer imaging was performed using the HP wireless b-cage and the 12-channel OEM coils. Measured SNR numbers were 105 for the wireless coil and 103 for the 12-channel OEM coil. Volunteer imaging was conducted with a T1 weighted sequence (TR/TE = 500/9.5 ms, Slice thickness = 5 mm, FOV = 240 mm) with the results depicted in figure 3(a) and figure 3(b) for the wireless coil and 12-channel OEM coil respectively.

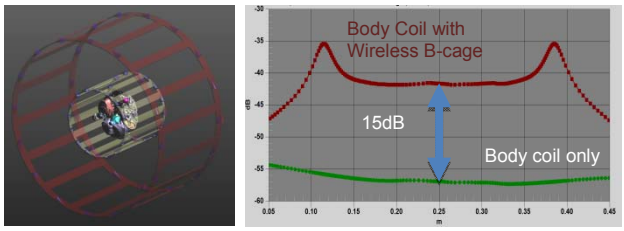
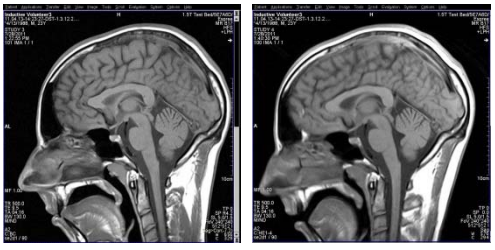


Fig.2 Simulated B1 field of HP b-cage coil with 1.5T body coil

Conclusions and Discussion: In this paper, a wireless HP birdcage coil was presented. The design of this coil can be extended to low pass, bandpass or dual frequency configurations. Simulated B1 field of the HP b-cage within the body coil showed an increase of more than 15dB in magnitude compared to B1 field of body coil only. SNR measurements on phantom showed comparable numbers between the wireless coil and the 12-channel OEM coil. Additionally, volunteer head images were of similar quality and uniformity between the two coils.



(a) (b)

Fig.3 (a) Wireless HP b-cage (b) 12-CH OEM coil

References:

1. US Application Serial Number 13/231004 filed September 13 2011.
2. SEMCAD X Version 14.6.1, Schmid & Partner Engineering AG, Zurich, Switzerland