A whole-body Transmit/Receive RF system for Hyperpolarized ^{129}Xe MRI

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Introduction

Hyperpolarized ^{129}Xenon MRI is a sensitive method for imaging lung disease and there are emergent applications for imaging dissolved phase ^{129}Xe in perfused organs [1]. A high sensitivity whole body RF coil system for ^{129}Xe with volumetric coverage is therefore desirable. An asymmetrical birdcage coil for transmission in combination with an RF coil array for reception [2-3] provides homogeneous RF magnetic field (B_1^+) [4] and high receive sensitivity, with optimal use of space in the bore of the magnet. Here, we describe the development of a 12 leg asymmetrical birdcage coil with an 8 channel receive array, for ^{129}Xe MRI at 1.5T and preliminary MRI results.

Methods

The birdcage is shown in the Figure 1. To tune the coil to ^{129}Xe Larmor frequency at 1.5T (17.66 MHz) the values of tuning capacitances in [5] were used with EM simulations performed with ANSYS HFSS. A ^{1}H cardiac 8-channel array was then retuned for ^{129}Xe to work in conjunction with the birdcage. The coil system was built and tested on a 1.5T GE HDx MRI system. A coronal flip angle map of the ^{129}Xe in the lungs was acquired (Matrix: 32x32, TR/TE 50/4.7ms, BW=±2kHz, FOV=40cm^2) to evaluate the B_1^+ field uniformity. Lung ventilation scanning was performed first with the birdcage as a quadrature transmitter/receiver and then as a Tx coil with the 8-channel Rx array. MRI was performed with bSSFP sequence (Matrix 100x100, TR/TE=6.7/2.2 ms FOV=40cm^2, BW=±8kHz) and a 750ml Hyperpolarized ^{129}Xe dose of polarization 30% was used, and a 25 healthy male volunteer.

Results and Conclusion

Coronal flip angle map in Fig. 2 shows homogeneity of the RF field inside the lungs. In vivo ventilation scanning with the birdcage Tx-Rx configuration (Figure 3) is in agreement with the flip angle map result. Ventilation images with the array (Figure 4) show a SNR of (~40) in the central slices with an enhanced SNR (~60) in the anterior and posterior slices. Further improvements in SNR are expected with the 8ch Rx array with addition of an active decoupling circuit in the transmit birdcage.

References: *[1]* M. R. Rao et al., Radiology 2018 286:2, 659-665 *[2] M.H. Deppe et al., Magn. Reson. Med., vol. 66, no. 6, pp. 1788–1797, 2011. [3] I. Dregely et al., Magn. Reson. Med., vol. 70, no. 2, pp. 576–583, 2013. [4] N. De Zanche, et al., Magn. Reson. Med., vol. 60, no. 2, pp. 431–438, 2008. [5] X. Xu,et al., , Proc. Intl. Soc. Mag. Reson. Med. 20 (2012), pp. 2625*

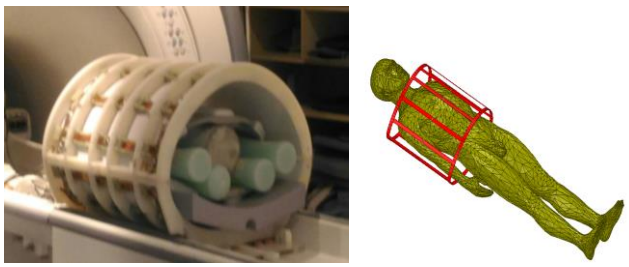

Figure 1: Asymmetrical Birdcage with the array inside and 3D of the coil

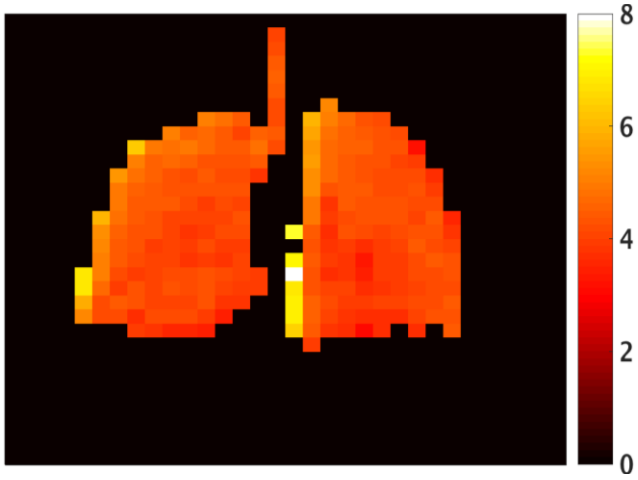

Figure 2: Coronal FA maps

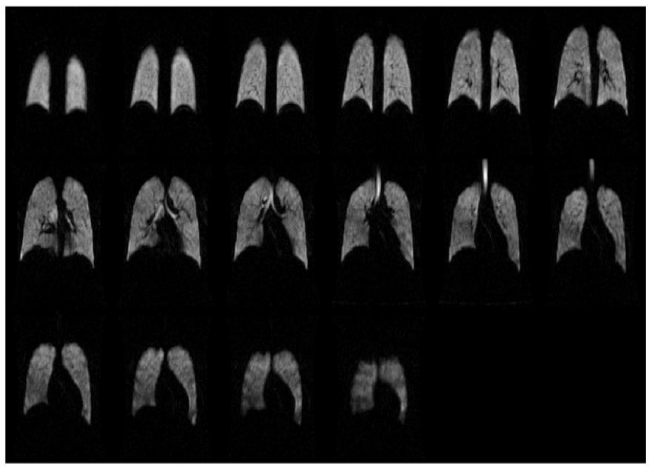

Figure 3: Ventilation images with birdcage Tx-Rx configuration

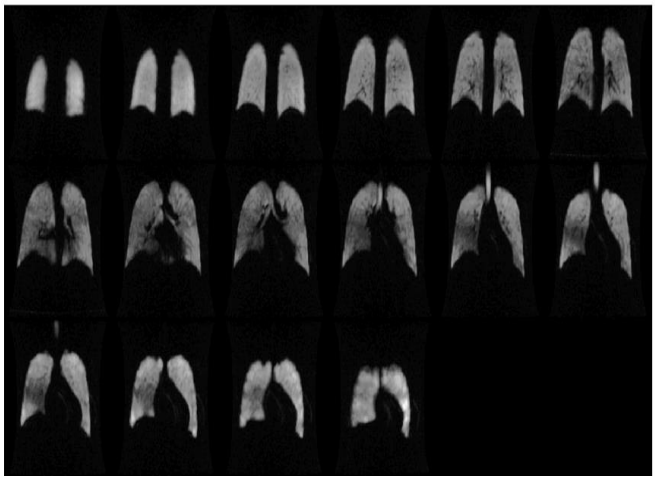

Figure 4: Ventilation images with Birdcage Tx /Array Rx