Birdcage Array for Lower Extremity Imaging

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INTRODUCTION

Birdcage coils provide high SNR and homogeneity[1]. In this study, we investigate the use of shielded birdcages dedicated to imaging the calves[2].

The array consists of two birdcage coils placed on cylindrical formers that fit around the legs. The coil array has the ability to image both legs simultaneously over a 36 cm longitudinal field of view (FOV). Experiments using phantoms show an increase in SNR through the center of the coil over the standard GE head coil and 12 channel peripheral vascular (PV) coil. Preliminary data show that the birdcage array provided more vascular details in angiographic images than the head coil.

METHODS

The birdcage array consists of two transmit/receive, eight rod, low-pass birdcage coils and two RF shields built on cylindrical formers that fit around the calves (Fig. 1). The coils were designed to fit the calf as tight as possible while made large enough to accommodate a wide variety of patients. For the prototype, the birdcages are 15.2 cm in diameter and 36 cm in length.

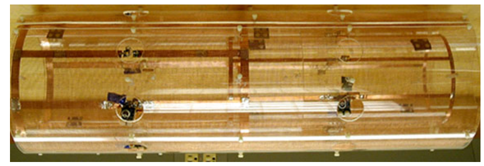

Figure 1. Photograph of the coil.

Reduction of coil coupling between adjacent coils is a challenge when designing a coil array for the lower extremity. Unshielded birdcages placed near one another will couple heavily, resulting in reduced coil sensitivity and homogeneity and increased chance of patient injury due to induced currents. RF shields were placed coaxially around the birdcages to reduce interaction between laterally adjacent coils, allowing both legs to be imaged simultaneously. The shields were designed such that the performance of the coils was not substantially degraded.

A circuit was constructed to operate the birdcages in quadrature mode during excitation and phased-array mode during signal reception.

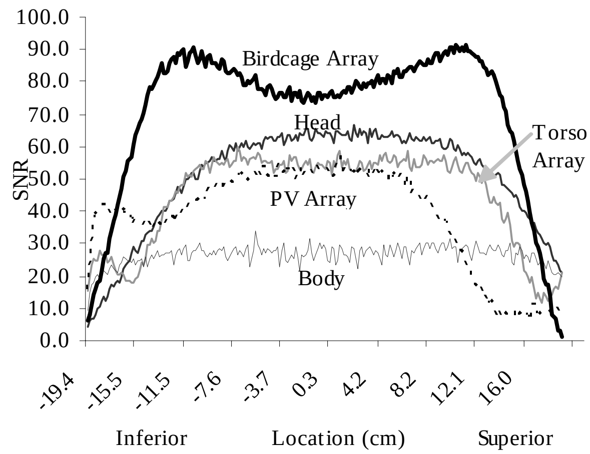

Figure 2. SNR profiles measured across the central A/P coronal slice.

EXPERIMENTS

Preliminary comparisons were made between the birdcage coils and four commercially available coils: standard GE head coil, 4-channel GE torso array, PV array (USA Instruments), and the body coil. A coronal image was acquired at the A/P center of the phantom. Coil sensitivity was measured along the center of two uniform cylinders mimicking two legs (d=12cm, T1=80ms) and a gradient echo sequence with low flip angle (α=5º), long TR (>>T1) on a GE 1.5T scanner (CVi). The noise level was determined by computing the standard deviation of a large ROI placed in the noise background of the image. Using this data, the average SNR over the full-width at half-maximum (FWHM) FOV was computed. A 2D time-of-flight (TOF) examination was performed using peripheral gating (PG) and a fast spoiled gradient pulse sequence (SPGR).

RESULTS

Coronal images showed that the birdcage coils achieved improved SNR compared to other coils (Fig. 2). The average SNR over the full-width at half-maximum (FWHM) FOV of the calf birdcage was 41% greater than the head coil and 72% greater than the PV array. Images obtained with the birdcage array enabled visualization of the secondary arteries that were more difficult to see with the head coil (Fig. 3).

Figure 3. Example frontal MIP from 2D TOF protocol.

References

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2. Rossman PJ, et al. Proc. ISMRM, p869, 2002.