# DEDICATED NEONATAL CARDIAC COIL – PRELIMINARY RESULTS

Michael S Hansen[1], Russel R Cross[2], Laura J Olivieri[1,2], Kendall O'Brien[1,2], Hui Xue[1], Matthew R DiPrimio[3], Paul Taylor[3], Tsinghua Zheng[3], Xiaoyu Yang[3], Matthew Finnerty[3], and Peter Kellman[1]

*[1]National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, MD, United States, [2]Children's National Medical Center, Washington, D.C., United States, [3]Quality Electrodynamics, Mayfield Village, OH, United States*

TARGET AUDIENCE: Clinicians and scientists involved in pediatric cardiac imaging.

PURPOSE: To develop a cardiac phased array coil dedicated to the smallest infants. Dedicated cardiac MRI coils are typically designed for adult patients and pediatric cardiac studies are most often done with general-purpose coils that were not designed for cardiac imaging. The aim of this work was to improve neonatal cardiac MRI using a dedicated phased array coil.

METHODS: A dedicated neonatal cardiac phased array coil was designed and built (Quality Electrodynamics, Mayfield Village, OH) with two paddles (front and back), each with 6 coil elements. Mechanical supports were developed such that a small infant could be placed in the coil without having the coil rest directly on the patient. A conceptual drawing of the coil with mechanical supports is seen in Fig. 1 and the coil element layout for each panel is shown in Fig. 2. A 3x2 element configuration was used and the dimension of each coil element was 5.7 cm by 4 cm. Combined size of each panel was 16.6 cm by 7.6 cm. Phantom studies were conducted with a cylindrical phantom (diameter 12cm). An axial plane through the center of the coil was imaged with a gradient echo sequence: FOV 150mm, Matrix 128x128, FA 15 degrees, TR 26.94ms, TE 4.73ms. The phase encoding direction was placed either in the anterior-posterior (AP) or right-left (RL) direction and parallel imaging factors from 1 (no acceleration) to 4 were used. A GRAPPA type reconstruction was used and 32 lines separate lines of k-space were acquired for calibration. Images were reconstructed using the Gadgetron[1] and an SNR scaled reconstruction[2] such that the noise standard deviation in each pixel was equal to the g-factor and g-factor maps were reconstructed. With local IRB approval and written informed consent, a 5.6 kg infant was imaged using the neonatal array. Real-time cine images were acquired in a 4-chamber view using a steady state free precession sequence: FOV 228mm x 171mm, Matrix 128x96, 62.5% phase resolution, TR 2.66ms, TE 1.12, BW 1000 Hz/pixel, parallel imaging rate 4 (TSENSE), temporal resolution 39.9 ms per frame. Images and g-factor maps were reconstructed.

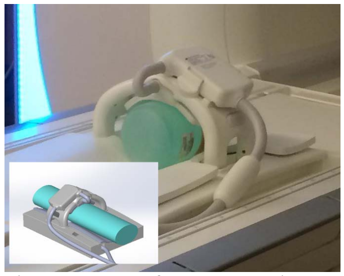

Figure 1. Photo of neonatal cardiac coil. Concept drawing as picture insert.

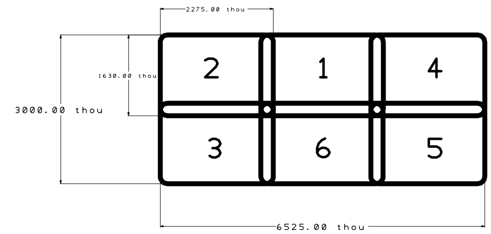


Figure 2. Coil element layout in both top and bottom part of the coil.

RESULTS: Figure 3 shows the phantom images and g-factor maps for acceleration factors 1-4 in both AP and RL directions. For high parallel imaging factors the g-factor is higher for acceleration in the AP direction as expected. For acceleration in the RL direction, maximal g-factors in the range of 2-2.5 are achievable with a parallel imaging factor of 4. Figure 4 shows in vivo real-time cine imaging in a 4-chamber view where a maximum g-factor in the heart of less than 2.5 was achieved.

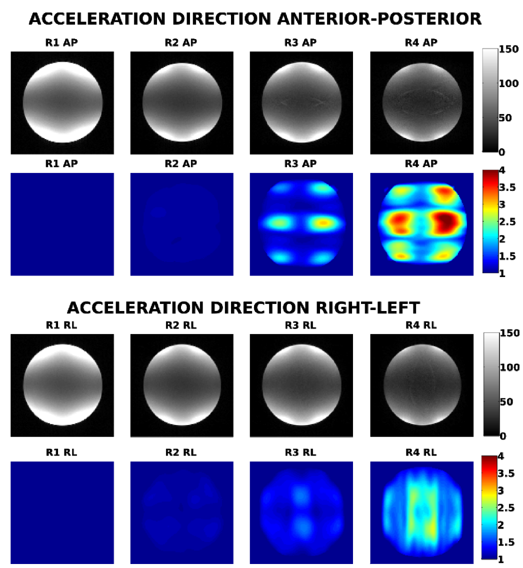


Figure 3. Phantom images and g-factor measurements for parallel imaging acceleration factors R1-4.

DISCUSSION: The designed coil provides a relatively large number of coil elements distributed around the heart of a small infant. The phantom measurements demonstrate that high parallel imaging factors can be achieved with such a design and in vivo parallel imaging with rate 4 was acquired with good g-factor performance. In the presented example, the use of dedicated neonatal coil enabled real-time imaging in a small baby with a temporal resolution of 40ms per frame. The designed geometry is suited for the smallest infants only, thus dedicated designs will be needed for larger babies and young children. Such designs are the subject of future work. These results show preliminary experience with the coil. Further testing is needed to evaluate parallel imaging performance in other imaging views and to explore the coil performance for 2-dimensional parallel imaging.

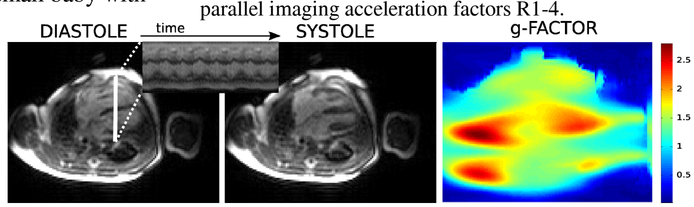


Figure 4. Example real-time 4-chamber cine images acquired with parallel imaging acceleration factor 4. Temporal resolution 39.9ms per frame

CONCLUSION: A dedicated neonatal cardiac imaging array has been designed and built and preliminary in vivo testing shows that high parallel imaging factors can be achieved with good g-factors.

REFERENCES: 1. Hansen MS, Sørensen TS. Gadgetron: An Open Source Framework for Medical Image Reconstruction. Magn Reson Med. 2013 Jun;69(6):1768-76. 2. Kellman P, McVeigh ER. Image Reconstruction in SNR Units: A General Method for SNR Measurement. Magn Reson Med. 2005 Dec; 54:1439–1447.