Design of a 32 Channel Cardiac Array for Parallel Imaging

D. Spencer[1], J. Akao[1], R. Duensing[1], D. Rimkunas[1], C. Saylor[1], T. Niendorf[2,3], D. K. Sodickson[3], N. Rofsky[3]

[1]Diagnostic Imaging, Invivo Corporation, Gainesville, Florida, United States, [2]Applied Science Laboratory, GE Healthcare Technologies, Boston, MA, United States, [3]Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, United States

Introduction

The 32 Element Cardiac Array is a high SNR coil, which supports parallel imaging with one-dimensional speedup factors of three to four in oblique slices typically used in cardiac MR. It has a wide field of view, enabling MR angiography and 3D whole heart imaging. Reduction in the number of channels used for reconstruction is also feasible. A description of the coil geometry and preliminary results are presented. The geometrical distribution of coil elements supports accelerations for any arbitrary direction by a factor of three to four. Acceleration in any 2 orthogonal directions using multi-oblique imaging planes is also feasible. By using acceleration factors of R=8 and beyond e, a whole heart 3D acquisition becomes feasible for single breath-hold scans [1]. Highly accelerated free breathing acquisitions are also supported.

Methods

The 32 Element Cardiac Array consists of a flexible anterior section that conforms to the patient's body and a rigid posterior section as shown in Figure 1. Each section has 16 elements in a 4 x 4 hexagonal array as shown in Figure 2. The coil has a large field of view of 400mm LR x 400mm SI that supports studies in angiography in addition to coverage of the heart itself. The coil consists of elements whose nearest neighbors are inductively isolated using overlap of the elements. The next-nearest neighbor elements are isolated only using local low impedance preamplifiers as shown in Figure 3. For systems with fewer than 32 channels, the preamps also allow the use of the EIGENCOIL® [2] or similar means of channel reduction while preserving most of the SNR and speed-up capabilities. CMRA was conducted on normal volunteers. ECG gated, fat saturated 3D FIESTA was performed using: FOV=41 cm, data matrix=256x256, TE=1.9 ms, TR=3.7 ms. An overall acceleration factor of R=8 (4x2) was used. For the whole heart acquisitions straight axial 3D slabs (12 cm S-I coverage, slice thickness = 2 mm, 60 slices) were prescribed without using extra localizer scans. Images were reconstructed using the generalized encoding matrix (GEM) approach (3). For comparison the unaccelerated conventional targeted slab approach was used.

Figure 1 – coil prototype in place

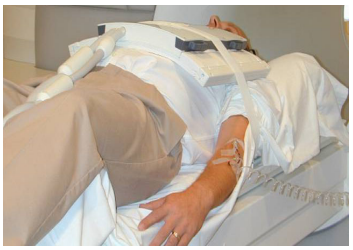


Figure 2 – Schematic design of the 32 channel array optimized for cardiovascular applications

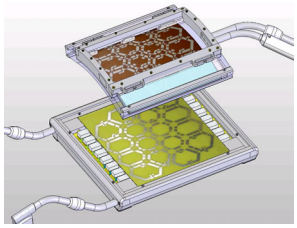
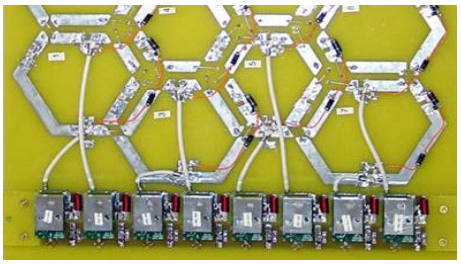


Figure 3 – detail showing individual coil elements together with the preamplifier



Results

Factor 8 accelerated whole heart imaging was achieved in a single breath-hold with acceptable image quality. A representative slice reformatted from a 3D data set shows the two-chamber long axis view to illustrate the whole heart coverage (Fig 4). To assess the ability of this method to produce acceptable coronary artery images, a reformatted view of the right coronary artery (RCA - MIP), obtained from an eight-fold (R=4x2) accelerated single breath-hold whole heart coverage acquisition (slab thickness= 12.0 cm, slice thickness = 2mm, 60 slice partitions in the reconstructed data) was generated, as shown in Figure 5. For comparison a reformatted view of the RCA (MIP) obtained from a conventional unaccelerated single breath-hold thin targeted slab acquisition covering the tree of the right coronary artery only (slab thickness= 2.4 cm, slice thickness=2 mm, 12 slice partitions) is shown in Figure 6.

Figure 4 -reformatted two chamber long axis view illustrating the whole heart coverage (S-I coverage 12 cm)

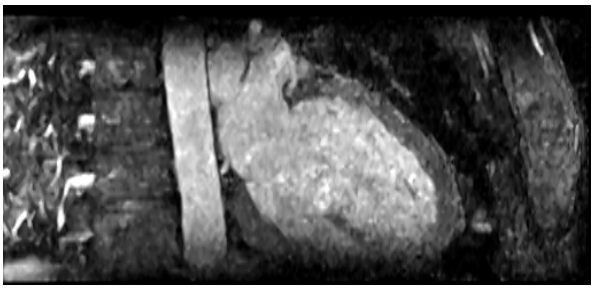


Figure 5 – reformatted RCA obtained from 8 fold accelerated 3D data set

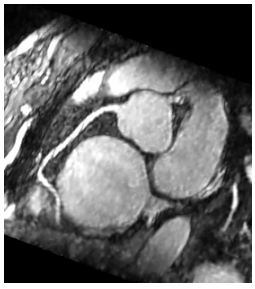
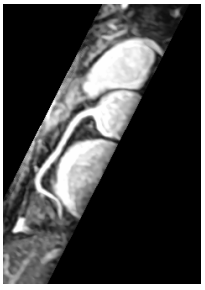


Figure 6 – reformatted RCA derived from a thin targeted slab



Discussion

The 32 channel cardiac array shows capability to enable single breath-hold 3D whole heart imaging with accelerations of at least 8 while the image quality is competitive with that achieved with unaccelerated conventional targeted slab acquisition. .

References

[1] Niendorf T et al, ISMRM, 703 (2004)
[2] King, S. et. al. Proc. ISMRM 11:712 (2003).
[3] Sodickson,DK et al, Med Phys 28, 1629 (2001)