3D Respiratory Triggered T2-Weighted Imaging of the Kidneys with 3D-FSE-Cube

J. W. Currie[1], R. F. Busse[2], T. Winter[1], A. C. Brau[3], P. J. Beatty[3], J. H. Brittain[2], and S. B. Reeder[4]

[1]Department of Radiology, University of Wisconsin, Madison, WI, United States, [2]MR Applied Science Lab, GE Healthcare, Madison, WI, [3]MR Applied Science Lab, GE Healthcare, Menlo Park, CA, [4]Departments of Radiology, Medical Physics, Biomedical Engineering, and Medicine, University of Wisconsin, Madison, WI

Introduction: Magnetic resonance imaging of the kidneys is an advanced technique for the evaluation of both renal masses and urological abnormalities of the renal collecting system. T2 weighted imaging is essential for characterization of renal masses [1] as well as for examination of the fluid filled collecting system of the kidneys [2,3]. Evaluation for transitional cell carcinoma can also be performed with MRI [2,4]. Unfortunately, 2D fast spin-echo (FSE) T2 weighted imaging is limited by relatively thick slices and suffers from partial volume averaging, making it difficult to fully evaluate detailed structures in the collecting system or differentiate morphological characteristics of cystic renal neoplasms. The purpose of this work was to perform 3D T2 weighted imaging of the kidneys using a volumetric spin-echo based technique, 3D-FSE-Cube, which uses a variable refocusing flip angle eXtended Echo Train Acquisition (XETA [5]) and 2D-accelerated autocalibrating parallel imaging (ARC [6]) to acquire large 3D volumes with high resolution in clinically practical scan times.

Methods: Scanning was done at 1.5T and 3T (Signa HDx, GE Healthcare, Waukesha, WI) using an 8-channel cardiac phased array coil. Ten normal volunteers were imaged after obtaining institutional IRB approval and informed consent. Respiratory triggered imaging was performed with the following imaging parameters: TR=1 respiratory period, TE = 95-420ms, Bandwidth = ±83.3kHz, FOV = 320mm, slice thickness 1.4-2.0mm, matrix = 320×320×128 zero-filled to 512×512×256 and net parallel imaging acceleration factors of 3.6-3.8. Images were acquired with different T2 weightings in order to best visualize cortical-medullary signal differences. Additional images were acquired with more hydrographic weighting to delineate the collecting system for evaluation of calyceal or renal pelvis abnormalities.

Results: Figure 1 shows a coronal section acquired with a moderate TE of 95ms. Figure 2 shows magnified multi-plane reformatted images from a normal volunteer at a higher TE of 120ms, demonstrating the near isotropic resolution of 1×1×1.4mm^3. Total acquisition time for these scans depended on the respiratory rate, with the range varying from approximately 4 to 6 minutes. Figure 3 shows a thin slab maximum intensity projection (MIP) image oriented obliquely through the collecting system of the kidney, demonstrating excellent visualization of the collecting system at longer echo times of 220 and 420 ms.

Discussion: 3D-FSE-Cube with eXtended Echo Train Acquisition (XETA) utilizes variable flip refocusing [7], optimized to be less sensitive to motion and therefore more readily applied in the body [5]. This work demonstrates the feasibility of volumetric spin echo imaging with the 3D-FSE-Cube sequence for obtaining high quality, near isotropic resolution 3D T2 weighted images of the kidneys. Further work will investigate the ability of this method to provide accurate depiction of the renal collecting system, as well as cystic renal neoplasms.

Acknowledgments: We wish to thank GE Healthcare for their support.

References: [1] Tello et al. AJR 2000 p1017. [2] Rothpearl et al. Radiology 1995 p125 [3] Klein et al. Urology 1998 p602 [4] Rholl et al. Radiology 1987 p117 [5] Busse et al. ISMRM 2007 p1702. [6] Beatty et al. ISMRM 2007 p1749 [7] Mugler et al ISMRM 2000 p687 [8] Wang et al. MRM 2006; 56:1389-1396

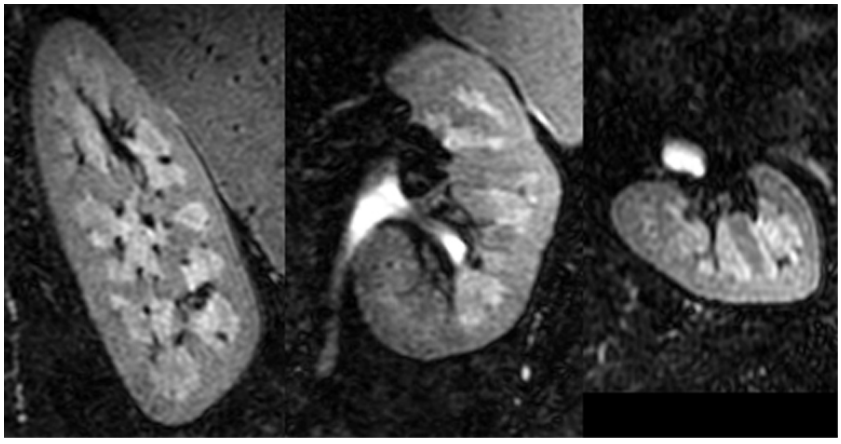

Figure 2 Near isotropic resolution of the 3D acquisition is demonstrated in oblique sagittal (left), oblique coronal (middle) and axial (right) images through the left kidney of a normal volunteer. Voxel size = 1.0 x 1.0 x 1.4mm^3, TE=120ms.

Figure 1: Full FOV coronal acquisition through the kidney of a normal volunteer acquired in 5 minutes with 320x320x120 matrix and 1.0x1.0x2.0mm^3 resolution, and TE=95ms.

Figure 3: Excellent visualization of the renal collecting system is demonstrated on oblique coronal thin section maximum intensity projection (MIP) images, with TE = 220ms (above), and TE = 440ms (below).