Introduction: Contrast enhanced MRI can differentiate scar from healthy tissue using late gadolinium enhancement (LGE) [1]. LGE is generally performed using breath held 2D inversion recovery (IR) with an inversion time (TI) chosen to null healthy myocardium. The optimal TI varies considerably based on dosing, time since administration, and agent utilized [2]. Thus TI scout scans must be performed prior to imaging and the operator must heuristically increase the TI between subsequent slices to achieve optimal myocardium nulling. 3D LGE has recently been proposed utilizing a single breath-hold which mitigates these errors [3]; however most patients undergoing LGE are unable to breath hold for such a scan. Radial k-space acquisitions sample the center of k-space each TR, which has a TI averaging effect in the central parts of k-space, thereby permitting longer scans and the use of respiratory gating. Sampling the center of k-space each TR also permits several TIs to be reconstructed from each acquisition as shown in 2D [4]. In this work, we investigate a free breathing, 3D radial acquisition with retrospective TI selection and isotropic spatial resolution for LGE imaging.

Acquisition and Reconstruction: Imaging is performed using a 3D spoiled gradient echo (SPGR) IR sequence with 3D radial k-space sampling [5]. Data acquisition is centered about a predicted TI for normal myocardial nulling. Using an interleaved, bit-reversed projection ordering, sliding window reconstruction can be performed around any inversion time that occurs during the data acquisition window. Respiratory motion is mitigated by utilizing a modified diminishing variance algorithm (DVA) with 50% efficiency [6].

Methods: Using a HIPPA compliant and IRB approved protocol, 1 normal volunteer and 9 patients were scanned with a multi-slice 2D Cartesian LGE and a 3D radial LGE exam. Five exams were performed at 3T and five at 1.5T. Acquisition and Reconstruction: Imaging is performed using a 3D spoiled gradient echo (SPGR) IR sequence with 3D radial k-space sampling [5]. Data acquisition is centered about a predicted TI for normal myocardial nulling. Using an interleaved, bit-reversed projection ordering, sliding window reconstruction can be performed around any inversion time that occurs during the data acquisition window. Respiratory motion is mitigated by utilizing a modified diminishing variance algorithm (DVA) with 50% efficiency [6].

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Results: Myocardium nulling was not significantly different (3.3±0.8 for 2D vs. 3.1±0.3 for 3D). Of the total 170 (10 x 17) segments, the 3D radial acquisition had only 3 segments with incomplete nulling while the 2D acquisition had 29 with incomplete nulling. One or more images from 6 of the 9 patients had respiratory motion artifacts for the 2D Cartesian acquisition, resulting in motion corrupted images or the appearance of incomplete nulling (etching). The respiratory gated 3D radial acquisition did not display respiratory induced artifact. Both methods detected the presence of infarct in the same 15 segments and thrombus in one segment.

Discussion and Conclusions: The free breathing 3D radial LGE technique is a promising alternative for the assessment of myocardial viability when patients have difficulty sustaining breath-holds for 2D Cartesian acquisitions. The respiratory gated 3D radial exam, which has the ability to retrospectively choose the TI and reformat to arbitrary orientations without loss of spatial resolution simplifies the entire exam, is shorter to acquire, and reduces patient discomfort when compared with the current clinically-used 2D LGE method.

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