

3D late gadolinium enhancement imaging with dynamic-TI in patients with atrial fibrillation

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Purpose

3D LGE image quality in patients with atrial fibrillation (AF) is often poor. Unlike conventional 2D LGE studies, these are performed with single R-wave gating so as to reduce the acquisition duration and the effects of gadolinium wash-out through the acquisition period.¹ However, this increases the sequence sensitivity to R-R interval variations which result in variable magnetization recovery between sequence repeats and ghosting of blood pool and unsuppressed fat. A dynamic inversion recovery preparation (dynamic-TI) has previously been demonstrated to improve image quality in phantoms and in 2D acquisitions in vivo.² In this study, we extend the dynamic-TI algorithm to 3D LGE imaging in patients with AF.

Methods

An inversion-prepared segmented gradient echo sequence was modified so that the inversion time (TI) varied automatically from beat-to-beat (dynamic-TI) based on the time since the last sequence repeat.² Standard navigator-gated 3D LGE imaging (32–36 slices, 1.5x1.5x4mm; reconstructed to 64–72 slices, 0.7x0.7x2mm) with single R-wave gating was performed on a Siemens Avanto 1.5T scanner 15 minutes after gadolinium administration in 6 patients scheduled for RF ablation of AF and in 1 patient 3 months post RF ablation of AF who continued to have arrhythmia. Following a scouting acquisition to determine the updated TI to null normal myocardium, acquisitions were then repeated with the dynamic-TI algorithm incorporated. Written, informed consent was obtained from all patients prior to the studies. Paired datasets were viewed by 2 independent observers and the dynamic-TI acquisition rated as better, the same, or worse than the standard acquisition. For each subject, with and without dynamic-TI, the blood-artefact ratio was determined by dividing the atrial blood pool signal intensity by the signal intensity in a region of free space adjacent to the chest wall (which includes ghosting artefact due to variable longitudinal magnetisation recovery between sequence repeats). Blood-artefact ratios with and without the dynamic-TI algorithm were compared using paired t-testing.

Results

In 5 of the 7 patients, subjective image quality was improved by using the dynamic-TI algorithm while in the remaining 2, it was unaffected. In those patients where the dynamic-TI algorithm did not improve image quality, breathing patterns were erratic and residual respiratory ghosting made assessment of the effects of the dynamic-TI algorithm difficult. Selected images from 3D datasets acquired both with and without the dynamic-TI algorithm in 3 example patients are shown in Figure 1 which demonstrates that the dynamic-TI algorithm results in less ghosting and less smearing out of signal in the left-right phase encoding direction. Blood pool signal to noise ratios would be expected to be less in acquisitions with dynamic-TI as these were always performed second (after the clinical scan had been completed). Blood-artefact ratios, however, were higher with the dynamic-TI algorithm due to a proportionately greater decrease in the levels of background ghosting (6.9 +/- 1.2 vs 4.7 +/- 2.0, p < 0.05).

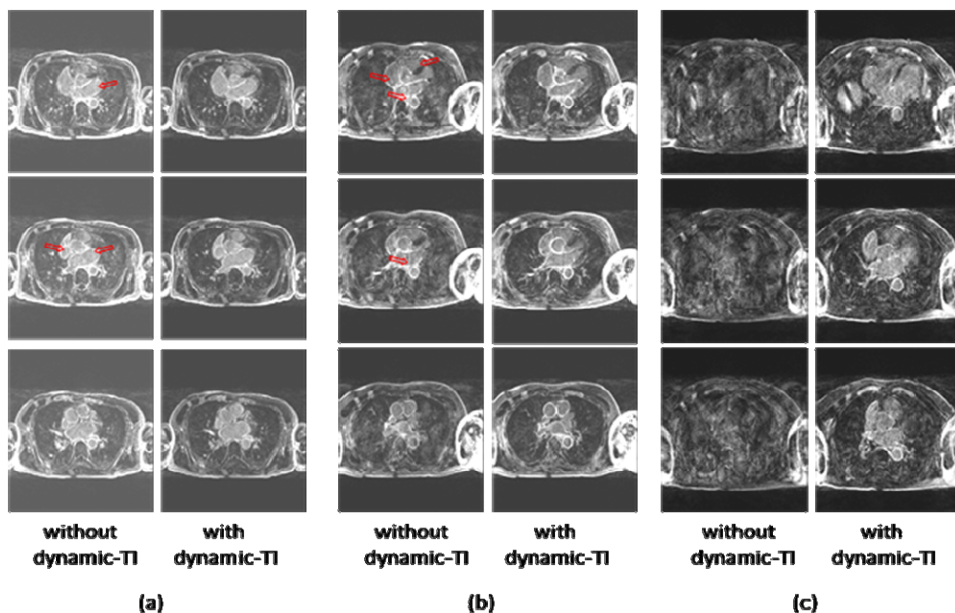


Figure 1:

Three example slices from 3D LGE datasets acquired without (left) and with (right) dynamic-TI in three patients ((a), (b) and (c)). The dynamic-TI algorithm results in fewer ghosts (open arrows) and less smearing out of signal in the left-right phase encoding direction. This is particularly apparent in the lung fields and in the spaces adjacent to the chest wall.

Discussion and Conclusion

Dynamic adaptation of the inversion time on a beat-to-beat basis results in significantly reduced artefact and can improve the image quality of 3D LGE acquisitions in patients with heart rate variability. This improved image quality will assist automatic atrial segmentation and late enhancement quantification in the atria in this difficult patient population.

References: ¹Peters et al, Radiology 2007; ²Keegan et al, ISMRM 2012