

## Free-breathing Delayed-enhancement 3D MRI With and Without Phase-sensitive Inversion-Recovery

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### Introduction

Free-breathing 3D delayed-enhancement MRI (DE-MRI) has been developed to improve the spatial resolution of the DE-MRI, to generate multi-planar reconstruction, and to eliminate the laborious breath-holds. However, the gadolinium washout during the 4-11-min (mean, about 7 min) scan of the free-breathing 3D DE-MRI may reduce the image contrast because of gadolinium washout from the myocardium and blood. Phase-sensitive inversion-recovery (PSIR) can in theory improve the contrast of the 3D DE-MRI, even when using high-field MRI and navigator-gating. The purpose of this study was to compare the image quality of free-breathing 3D DE-MRI between with and without PSIR at 3.0 T.

### Methods

27 patients with a wide variety of cardiac diseases were enrolled. All MRI examinations were performed using a 3.0 T unit (Achieva 3T, Philips). Ten minutes after a 0.15 mmol/kg gadolinium injection, a T1-scout myocardial Look-Locker MRI was performed to determine the null point of the normal myocardium. Thereafter, a breath-hold 2D DE-MRI was performed as the reference standard. Lastly, a free-breathing 3D DE-MRI was performed using the imaging parameters: TR 3.0 ms, TE 1.4 ms; flip angle 15 degrees; in-plane resolution, 1.67 – 1.98 x 2.16 – 2.52 mm; 2.5-3.0 mm slice thickness; slice partition, 30-40; and one signal averaging. A k-space weighted and centric navigator gating was used to acquire the central data of k-space during the initial 1/4 of the scan time, when the patients' breathing rhythm might be regular. Sensitivity encoding (SENSE) with a reduction factor of 1.5 - 2.0 was employed in the y-direction. The null point of the 3D DE-MRI was empirically determined as the null point of the normal myocardium on Look-Locker MRI plus 15 - 20 ms.

One blinded reader scored the image quality (1: poor – 4: excellent) and the presence or absence of the hyperenhancing myocardium (-2: definitely absent - +2: definitely present) of the 3D DE-MRI with and without PSIR. The absolute values of the latter scores were defined as the confidence of the presence of the hyperenhancing myocardium. The contrast-to-noise ratio (CNR) between the normal myocardium and blood and the CNR between the normal and hyperenhancing myocardium were also compared between the images with and without PSIR.

### Results

There were no significant differences in the image quality between the 3D DE-MRI with and without the phase-sensitive reconstruction (mean score: 3.0 vs. 3.2). The reconstruction improved the image quality in 6 patients owing to the correction of the image contrast, whereas 4 patients had the higher score of the image quality on the 3D DE-MRI without PSIR, because the misregistration errors were seen on the images with PSIR. There was a significant difference between the 3D DE-MRI with and without PSIR in the confidence of the presence of the hyperenhancing myocardium ( $P = 0.016$ ; arrow in figures). It was improved in 10 patients following PSIR. Also, the CNR between the normal myocardium and blood was significantly higher in the images with PSIR ( $P = 0.043$ ). No significant difference was found for the CNR between the normal and hyperenhancing myocardium.

### Discussion

This study demonstrated that free-breathing 3D DE-MRI sequence using 3.0 T provided the DE-MRI images with sufficient diagnostic capability, irrespective of the use of PSIR. Nonetheless, using PSIR, the confidence for the presence of the hyperenhancing myocardium and the CNR between the myocardium and blood were significantly improved on the 3D DE-MRI. Conversely, we found the misregistration artifact on the free-breathing 3D DE-MRI with PSIR in some patients. Because the diaphragm motion occurs even during the breath-holds, the misregistration between the 3D DE-MRI and reference images during free-breathing was prominent in a few patients.

In conclusion, PSIR was feasible for free-breathing 3D DE-MRI at 3.0T, because PSIR improved the confidence for the presence of the hyperenhancing myocardium and the image contrast. However, the 3D DE-MRI without PSIR could not be omitted in some patients, because of its fewer image artifacts.

**REFERENCES** 1. Peters DC. Radiology 2007; 243: 690-695. 2. Kellman P. MRM 2002; 47: 372-383.

