High Resolution 3D Viability Imaging

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Introduction: Imaging using the Gd-DTPA delayed enhancement technique provides a spatial map of myocardial infarction and viability (1). Higher spatial resolution may have an important role in improving viability assessment; detecting and characterizing the presence of scar in the RV; and characterizing other cardiomyopathies. However, low SNR and breath-holding limit the spatial resolution which is achievable. Here we present a 3D free-breathing, navigator-gated method with a goal of increasing spatial resolution. This approach is an adaptation of free-breathing contrast-enhanced coronary artery imaging methods (2). 3D free-breathing viability techniques have been employed by several investigators (3,4,5), but our technique differs because our objective is to increase spatial resolution, rather than improve patient cooperation.

Methods: 20-40 minutes following administration of 0.1 to 0.2 mmol/kg of Gd DTPA, 2D and then 3D images were acquired. For 3D imaging, an inversion recovery prepared Cartesian gradient echo acquisition was used. Navigator-gating and tracking (5mm acceptance window) was used for motion compensation. Imaging was performed in late diastole. Typical scan parameters were: 180º RF applied every RR, spoiled gradient echo imaging, 16 views per segment, TR/TE/θ= 5.2/1.8/15º, elliptical centric acquisition order, 32 cm FOV, 224 x 224 x 13 Nz, 5 mm slice thickness (zero-filled to 2.5 mm), 120 Hz/pixel, fat saturation, 5 element cardiac coil. Scan time was about 3 minutes for 50% navigator efficiency. The 2D images were acquired with similar acquisition parameters, except: TR/TE=4ms/1.3ms, 160 x 160 matrix, 10 mm slices, no fat saturation., ~7 second breath-hold. The nominal voxel size of the 3D scans was 3.5x smaller than that of the 2D scans. Imaging was performed in 5 patients with scar (all males, age 58 ±9). The inversion time for both scans was determined separately using 2D scans. SNR and CNR (infarct-blood) were estimated using ROIs placed in blood, myocardium, infarct and air-space on the magnitude images of a central slice where infarct was present. An experienced cardiologist compared matching slices of the 2D and 3D data sets, and graded them overall, and on level of spatial details observed (ratings of 1-4, 1 = worst, 4 = best).

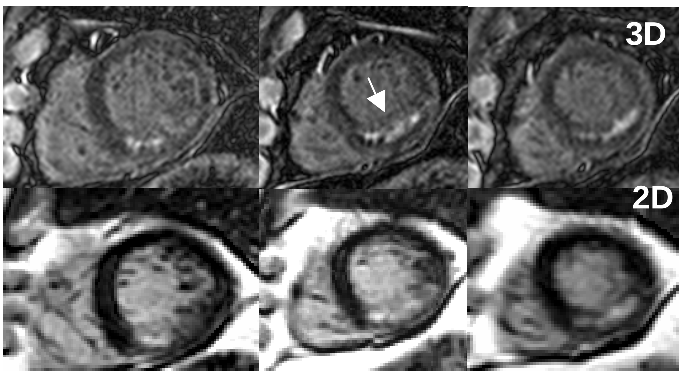

Figure 1: Matched viability slices from (top) 3D free-breathing with1.5 x 1.5 x 5 mm resolution; and (bottom) 2D breath-hold with 2 x 2 x 10 mm. Scar demarcation is improved with 3D imaging.

Results: Figure 1 shows a comparison between the 3D high spatial resolution method (top) and 2D method (bottom). The improvement in scar (arrow) demarcation with 3D is readily apparent. Fat saturation reduces the epicardial definition of the free wall, but increases the apparent wall thickness. The SNR (SNRi for infarct, SNRb for blood), CNR (infarct-blood pool) and subjective gradings are shown in Table 1. The SNR was lower for 3D imaging ($P<0.05$), but the spatial resolution was slightly better. The CNR was better for 3D (NS).

Conclusions: This application of navigator-gating and 3D imaging to viability imaging provides increased spatial resolution. Compared with 2D scans, the 3D images have good CNR, but lower SNR. SNR may be insufficient to support further increases in spatial resolution. The improvement in spatial resolution achieved with our technique permits an enhanced visualization of scar, with important potential applications in clinical cardiac imaging.

Table 1: Subjective scoring and SNR and CNR (N=5).

	Overall	Spatial details	SNRi	SNRb	CNR
3D	**2.2**	**3.0**	**13±3**	**11±5**	**2±3**
2D	**3.5**	**2.2**	**18±3**	**17±2**	**1±2**

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