

LV Infarct Size and Peri-Infarct Zone Measurements: A Comparison of High Resolution 3D and Conventional 2D Late Gadolinium Enhancement Imaging

D. C. Peters¹, E. A. Appelbaum¹, R. Nezafat¹, Y. Han¹, K. V. Kissinger¹, B. Goddu¹, and W. J. Manning^{1,2}

¹Cardiovascular Division, Beth Israel Deaconess Medical Center, Boston, MA, United States, ²Department of Radiology, Beth Israel Deaconess Medical Center

Introduction: Due to the efficacy of implantable cardioverter defibrillators (ICD) and ventricular tachycardia (VT) ablation therapies in preventing sudden death, there is increased interest in improved risk-assessment for those with arrhythmic substrate (prior infarct/scar). Several studies have demonstrated that arrhythmias and mortality are related to increased infarct and peri-infarct volumes[1,2,3]. We have developed a high spatial resolution 3D cardiovascular MR (CMR) late gadolinium enhancement (LGE) (delayed enhancement) sequence to better visualize scar volume in subjects.

Methods: Seven subjects (1 female) with prior infarctions and positive delayed enhancement images were studied, with age of 57±

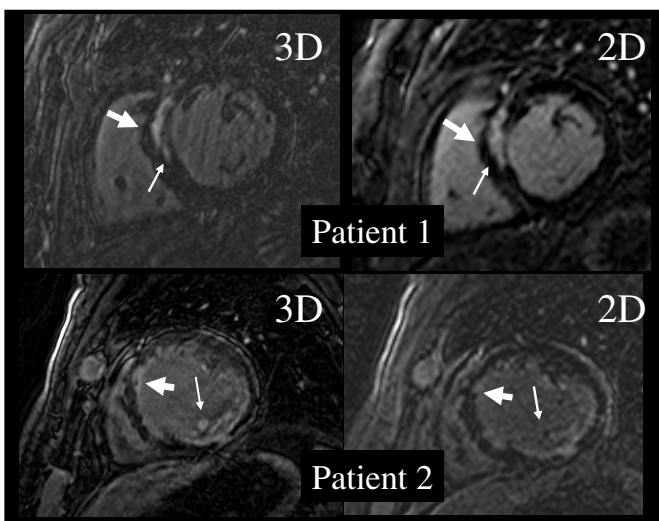


Figure 1: 3D and 2D matched slices, in two patients with CAD. In Patient 1, an island of scar can be observed only on the 3D image (thin arrow), and the transmurality of the scar (thick arrow) appears different. In Patient 2, septal scar is visualized (thick arrow), and the papillary scar (thin arrow) is clearer on the 3D vs. 2D image (thin arrow). Images from Patient 1 shows increased scar-blood CNR, reflecting a later delay time for the 3D scan.

13 years and left ventricular ejection fraction of 50±14%. 2D images were acquired about 15 minutes post injection of 0.2mmol/kg Gd-DTPA, followed by 3D imaging on a 1.5 T Philips MR scanner, equipped with a 5-element cardiac coil. Imaging parameters for the LGE studies were: 2D gradient echo inversion recovery, with 160 x 160 matrix, 320 cm FOV, 8 mm slices, with 2 mm gaps, TR/TE/θ = 4.3/1.5/20°, fat saturation. ECG-gating in late-diastole and breath-holding were used to reduce motion artifacts. The imaging parameters for the 3D LGE sequence were similar, except: 224 x 224 Ny x 35 Nz matrix, TR/TE/θ = 5.7/2.7/25°, with ECG-gating and Navigator-gating (5mm window) to reduce motion artifacts. The true spatial resolutions of the 2D and 3D LGE sequences were 2 x 2 x 8mm and 1.3 x 1.3 x 5 mm, respectively. To quantify scar, endocardial and epicardial myocardial borders were drawn on all short-axis slices for each subject, using a cardiac software package (ViewForum 5.1, Philips, Best NL). Papillary muscle scar was visually assessed, but not quantified. After measuring the peak scar signal in the images, scarred myocardium was identified as having signal > 50% of the peak scar signal (4). Peri-infarct regions were identified as myocardium with signal > 3 standard deviations above normal myocardium, but below the cut-off for scar [1]. 2D images were acquired at 15 minutes after Gd-DTPA injection, followed by 3D images.

Results: SNR estimates for blood, myocardium and scar for the 2D images were 13, 2 and 19, respectively; for the 3D images SNRs were 18, 5 and 28, respectively. Figure 1 shows comparisons of 2D and 3D images in matched slices, for two subjects. Note finer detail of scar in the 3D images. In Patient 1, there is an island of viability only observable on the 3D image, and the transmurality is different. In Patient 2, septal endocardial scar can only be appreciated on the 3D image. Papillary scar is more easily observed on the 3D image. Papillary scar was observed on 4/7 subjects on 3D imaging, and 2/7 subjects on 2D imaging. Figure 2A compares 2D and 3D LGE scar volume with excellent correlation. Figure 2B compares the peri-infarct zone measured by 2D and 3D LGE. The peri-infarct zone was larger by the 2D measurements (with p = 0.21, NS). Bland-Altman analysis shows that the mean bias ±2Ds for scar and grey zone are 0.5±8mls and 6.8 ±19mls respectively.

Conclusions: High spatial resolution 3D imaging improves the visualized pattern of infarct/scar. While there was good agreement with total infarct volume, 2D imaging provided higher estimates of the peri-infarct zone, possibly related to partial-voluming of scar and normal myocardium. Additionally, for small areas of infarct (e.g. in the papillary muscles), conventional 2D imaging (and short delay time from injection) may lead to false negative results as compared to 3D imaging. Higher resolution 3D imaging may be an important step towards further characterizing the arrhythmic substrate with CMR.

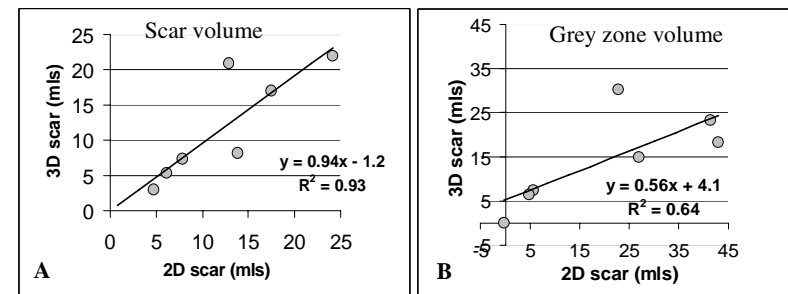


Figure 2. Scar volume agrees well between 2D and 3D methods, but grey zone volume is larger with 2D methods.

1. Yan, A. T, Kwong R. Y. et al. *Circulation* 2006;114:32-39. 2. Bello D et al, *JACC* 45(7) 2005: 1104. 3. Schmidt, A. et al. *Circulation* 2007;115:2006-2014. 4. Amado LC, et al. *JACC* 2004; 44: 2383–238.9