Initial Clinical Evaluation of a Substraction Delayed Enhancement Technique in Myocardial Infarction

A. B. REDHEUIL[1,2], P. HERVO[3], S. PEYRARD[4], T. FOO[5], E. MOUSSEAUX[6]

[1]Cardiovascular Imaging, HEGP - European Hospital Georges Pompidou - University of Paris-Descartes, PARIS, France, [2]U678, INSERM, PARIS, PARIS, France, [3]GE Healthcare Technologies, General Electric, Buc, Ile de France, France, [4]Clinical Investigation Center - Biostatistics Department, European Hospital Georges Pompidou - University of Paris-Descartes, PARIS, France, [5]GE Global Research, General Electric, Niskayuna, New York, United States, [6]Cardiovascular Imaging, European Hospital Georges Pompidou - University of Paris-Descartes, PARIS, France

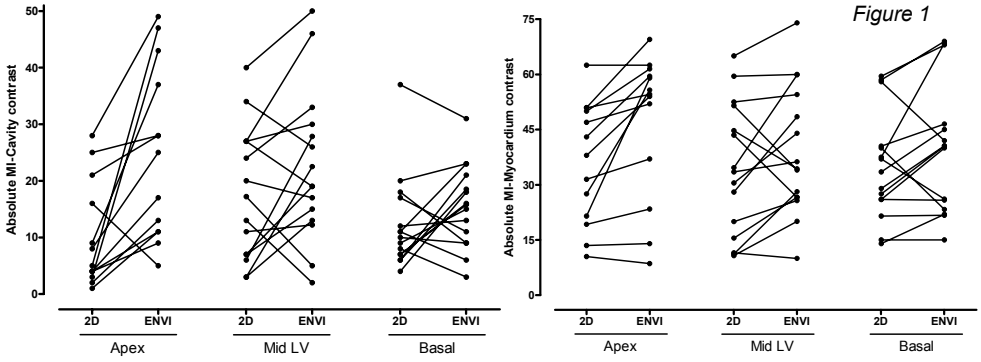
Purpose: To qualitatively and quantitatively assess in the clinical setting a dual inversion time substractive technique called “ENVI” (ENhanced Viability Imaging) aimed at improving infarct-cavity and infarct-normal myocardium contrast in delayed contrast-enhanced MRI evaluating myocardial infarction.

Introduction: Delayed hyper-enhancement following administration of gadolinium is well accepted as a method to non-invasively detect and quantify myocardial infarction [1,2]. However, routine evaluation remains visual and to distinguish between infarct and cavity (blood) and normal myocardium can be a challenge. ENVI is a gated, segmented, fast gradient-recalled echo acquisition with an inversion-recovery preparation, which acquires two images at two different TI times for each slice location. The first image is acquired at a long TI, selected by the user (around the null point of healthy myocardium: 250 ms) and the second image at a shorter TI (around the null point of enhancing infarct:50 ms). An automatic magnitude substraction of the images produces the ENVI image. This technique has recently been described on an animal model [3].

Material and methods: 20 patients (mean age: 48 +/- 15 yrs; 15 male, 5 female) with a history of recent myocardial necrosis (chest pain, ECG changes and troponin elevation) underwent MR imaging. 17 had recent myocardial infarction and 3 acute myocarditis
Contrast-Enhanced MRI was acquired in all patients 10 to 15 minutes after Gd-DTPA double dose injection using a 1.5T Signa TwinSpeed (GE Medical Systems, Waukesha, Wi, USA) with 33 mT/m gradients using ECG gating and a thoracic phased array surface coil.
The same 3 short axis slice levels were successively acquired first in routine 2D delayed enhancement inversion-recovery (IR) sequence then using the ENVI technique. Long and short TI amplitude images were substracted to provide the final ENVI image.
Qualitative analysis: an independent expert observer was first asked to visually estimate the quality of infarct-cavity and infarct-myocardium contrasts on ENVI images as superior, inferior or equal to the routine sequence, then to decide if ENVI images were superior or not to routine images in the detection and quantification of infarcted myocardium. Data were analysed by descriptive statistical tools.
Quantitative analysis: for all patients and slice levels mean signal amplitudes were studied in both sequences (2D and ENVI) inside regions of interest placed: inside the LV cavity (blood signal), on the infarcted myocardium and on the adjacent non infarcted myocardium. Infarct-cavity contrast and Infarct-myocardium contrast were defined as the difference between infarct contrast and respectively intracavitary and adjacent myocardium signal amplitudes. The mean absolute contrast differences (both infarct-cavity and infarct-myocardium) between 2D and ENVI sequences were studied using Wilcoxon’s paired test.

Results: Qualitative results: Infarct-cavity contrast was superior on ENVI images compared with the routine sequence in 17 patients (85%), inferior in 2 (10%) and equal in 1 (5%). Infarct-myocardium contrast was superior on ENVI images compared with the routine sequence in 11 patients (55%), inferior in 3 (15%) and equal in 1 (30%). The detection of infracted areas was judged superior on ENVI images compared to the routine sequence in 18 patients (90%), inferior in 2 (10%).
Quantitative results: A contrast increase is found in a majority of cases for each slice when considering both infarct-cavity and infarct-myocardium contrast by pairs with ENVI images compared to the routine sequence as summarized on *Figure 1*. The mean and median contrast differences between ENVI and the routine sequence are significantly different for the apical slices considering both infarct-cavity and infarct-myocardium contrast as shown in *Table 1*.

Figure 1



Increase/total cases Apex 10/11 Mid-LV 9/11 Basal 7/12 Apex 7/10 Mid LV9/15 Basal 8/13

Table 1.

	Diff (ENVI - 2D)					
Infarct-cavity	***Apex***		***Mid-LV***		***Basal***	
Mean (SD)	14.85 (14.88)	p<0,005	4.76 (11.29)	ns	3.29 (8.31)	ns
Median (Q1;Q3)	11 (7;21)	p<0,005	8 (-8;12)	ns	3 (-5;12)	ns
Infarct-Myoc.						
Mean (SD)	9.89 (11.60)	p<0,005	2.89 (12.42)	ns	3.13 (12.05)	ns
Median (Q1;Q3)	7 (3;13)	p<0,005	4 (-2;11)	ns	3 (7 ;10)	ns

Conclusion: The ENVI technique provides significant qualitative improvement over the routine delayed enhancement IR sequence in terms of both Infarct-blood and Infarct-normal myocardium contrasts in the evaluation of myocardial infarction in the clinical setting. Quantitative results support this finding and are very encouraging to conduct a larger validation study on the quantification of infarct size. The issue of optimizing short and long TI choice should also be addressed.

References:

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