Dual Manganese- and Gadolinium-Enhanced Cardiac MRI Delineates the Peri-Infarct Region in Patients with Severe Ischemic Cardiomyopathy

Rajesh Dash[1], Yuka Matsuura[1], Paul J Kim[1], Hadas Shiran[1], Phillip Harnish[2], Michael V McConnell[1,3], and Phillip C. Yang[1]

[1]*Stanford University, Stanford, CA, United States,* [2]*Eagle Vision Pharmaceutical Corporation, PA, United States,* [3]*Engineering, Stanford University, Stanford, CA, United States*

Introduction:

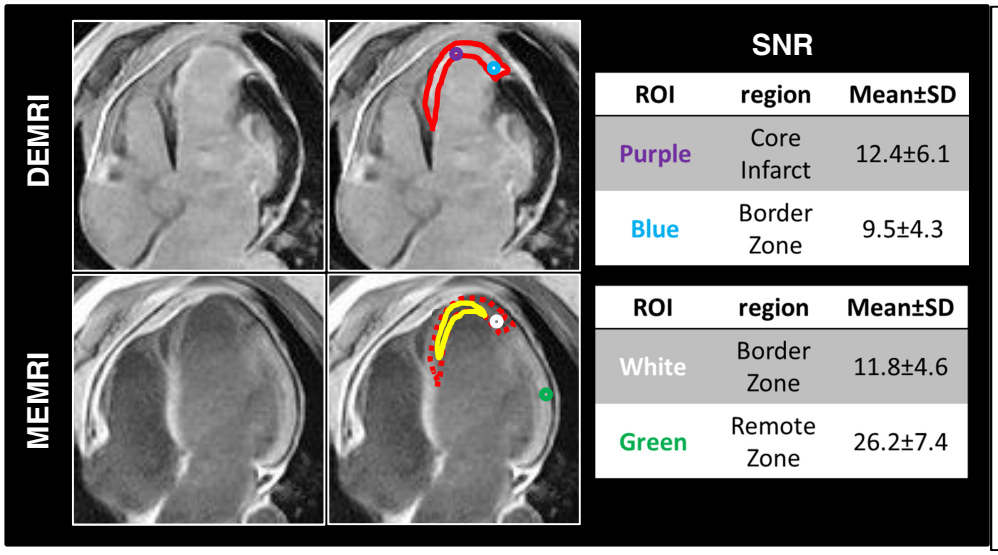
Delayed Gadolinium (Gd) Enhancement MRI (DEMRI) overestimates infarct size. Manganese enters only live, active cells, and its T1 signal is *specific to live cardiomyocytes*. We combined DEMRI and Manganese-enhanced MRI (MEMRI) in humans with ischemic cardiomyopathy to test if MEMRI provides unique infarct characterization.

Methods:

5 patients with ejection fraction (EF) <45%, Class I-III ischemic CHF, were enrolled (5 male, age 63±3 years). 2 cardiac MRIs (Signa 3THDx, 8-channel cardiac coil, GE HealthCare) were done for left ventricular (LV) function & DEMRI (day 0) and MEMRI (day 7). DEMRI: 10-20min after 0.2 mmol/kg intravenous Gd (Magnevist, Bayer HealthCare, Germany). MEMRI: 20-40min after 1mmol/kg intravenous SeeMore™ manganese (Eagle Vision Pharmaceutical Corp). Image analysis: (CMR42, Circle CV Imaging Inc) LV volumes traced semi-automatically; infarct volumes obtained using >3 standard deviations (SDs) above mean (DEMRI) and >2 SDs below mean (MEMRI signal defect = scar). % Infarct to total LV mass was calculated.

Results:

Results: The average LVEF was 32±4%. The percentage of LV volume of the enhanced volume on DEMRI (39±11%) was significantly ($p<0.01$) greater than defected volume on MEMRI (16±3%) in all patients. The SNR of the border zone, the heterogeneously-enhanced regions on the periphery of the DEMRI signal and MEMRI defect areas, trends lower than the SNR of the core zone of DEMRI, and was significantly lower than the remote zone of the MEMRI defect (n=7 matched slices of DEMRI and MEMRI in 5 patients; Figure 1).



SNR

ROI	region	Mean±SD
Purple	Core Infarct	12.4±6.1
Blue	Border Zone	9.5±4.3

ROI	region	Mean±SD
White	Border Zone	11.8±4.6
Green	Remote Zone	26.2±7.4

Fig 1. ***Ischemic CM Patients - MEMRI***
Left: 4ch images showing differing infarct patterns of DEMRI (upper) & MEMRI (lower).
Middle: Enhanced area of DEMRI (red tracing) is visibly greater than MEMRI defect area (yellow tracing).
Colored circles ROI: The border zone of DEMRI region (blue ROI), the core zone of DEMRI (purple ROI), the border zone of MEMRI (white ROI) and the remote zone of MEMRI (green ROI). Cardiac MRI sequences: LV function: (SSFP TR 3.7ms/TE1.7/flip angle(FA)45/ slice thickness (ST) 8mm/matrix224x224/FOV35); DEMRI /MEMRI (FGRE-IR, TR6ms /TE2.8ms /TI200-700ms /FA15 /ST8mm /matrix /224x192).

Discussion:

Non-viable myocardium volume, appearing as MEMRI defect, was significantly smaller than the injured volume by DEMRI enhancement. Concurrent use of DEMRI and MEMRI dual-contrast may thereby delineate the peri-infarct region, or "area-at-risk". Further studies on the ability of this dual contrast approach to delineate area-at-risk and to predict viability and outcomes from revascularization are necessary.