ASE2023
June 23-26, 2023
National Harbor, MD

# Early Assessment of Global Circumferential Strain from Three-Dimensional Echocardiography Predicts Late Left Ventricle Remodeling in a Chronic Porcine Model of Reperfused Myocardial Infarction

N. Guerrera[1], S.L. Thorn[1], S. Ahn[2], R. Burns[1], S. Lee[1], A. Alashi[1], B. Vermillion II[1], F.G. Spinale[3], P. Heerdt[4], J.A. Burdick[5], J.S. Duncan[2,6], A.J. Sinusas[1,2,6]

[1]Department of Medicine (Cardiovascular Medicine), Yale School of Medicine, New Haven, CT; [2]Department of Biomedical Engineering, Yale University, New Haven, CT; [3]Department of Cell Biology & Anatomy, University of South Carolina School of Medicine, Columbia, SC; [4]Department of Anesthesia, Yale School of Medicine, New Haven, CT; [5]Biofrontiers Institute, University of Colorado Boulder, Boulder, CO; [6]Department of Radiology and Biomedical Imaging, Yale University School of Medicine, New Haven, CT

Yale Translational Research Imaging Center

*Authors have no disclosures

## INTRODUCTION

- Myocardial infarction (MI) leads to left ventricular (LV) remodeling, heart failure (HF) and increased mortality.[1]
- Three-dimensional (3D) speckle tracking echocardiography (ECHO) can assess the complex regional and global LV mechanics following MI.[2]
- Previous studies have demonstrated that patients with a higher global longitudinal strain (GLS) are at greater risk for major adverse events.[3]
- Global circumferential strain (GCS) has been used to predict LV remodeling.[4]
- The optimal strain indices for risk stratification post-MI remains controversial.

## AIM

- To evaluated the prognostic value of rest and low-dose dobutamine (DOB) stress 3D global strain for prediction of late LV remodeling in a chronic porcine model of reperfused MI.

## METHODS

- N=7 male Yorkshire pigs (21-30 kg) were evaluated over a 5-week period (Fig 1)

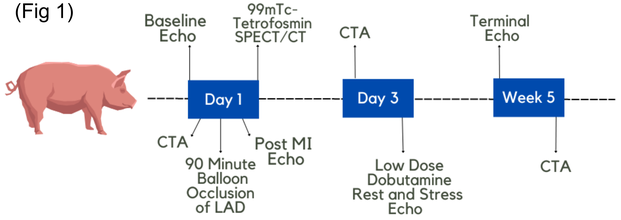


**Figure 1: Experimental timeline**

- Reperfused MI was created in swine by 90-min balloon occlusion of the left anterior descending coronary artery after the first diagonal branch (Fig 2)

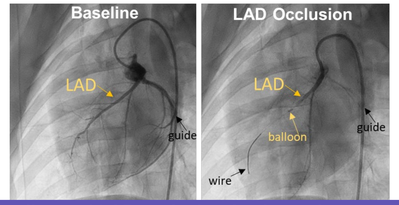


**Figure 2: Baseline and LAD occlusion Angiography**

- $^{99m}$Tc-Tetrofosmin was injected during occlusion to assess the area at risk using SPECT/CT imaging (GE Discovery 570 NM/CT) performed post reperfusion (Fig 3)

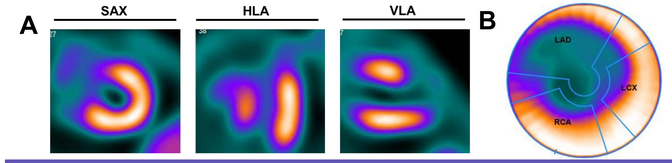


**Figure 3: $^{99m}$Tc-Tetrofosmin SPECT images (A) and polar maps (B) demonstrating the area at risk in the anterior-septal region induced by LAD occlusion.**

- At baseline, 3-days and 5-weeks post-MI, a high-resolution, ECG-gated contrast cineCT was used to assess LV remodeling with measurement of end-diastolic volume (EDvol) (AW Workstation, GE) (Fig 4)

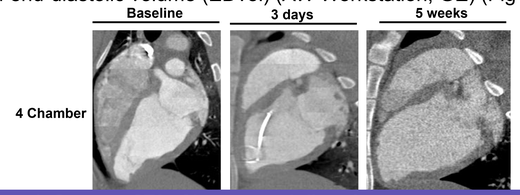


**Figure 4: Contrast CTA of heart at end-diastole**

- TTE or TEE 3D ECHOs (EPIQ CVxi, Philips) were acquired at baseline, immediately post-MI, 3-days and 5-weeks post MI at a frame rate of 40-60 fps to assess regional and global function
- 3-days post-MI, 3D ECHOs were acquired at rest and during a low-dose DOB stress protocol (2.5 µg/kg/min for 3 min, 5.0 µg/kg/min for 4 min) to assess GCS and GLS functional reserve (Fig 5 A-C)

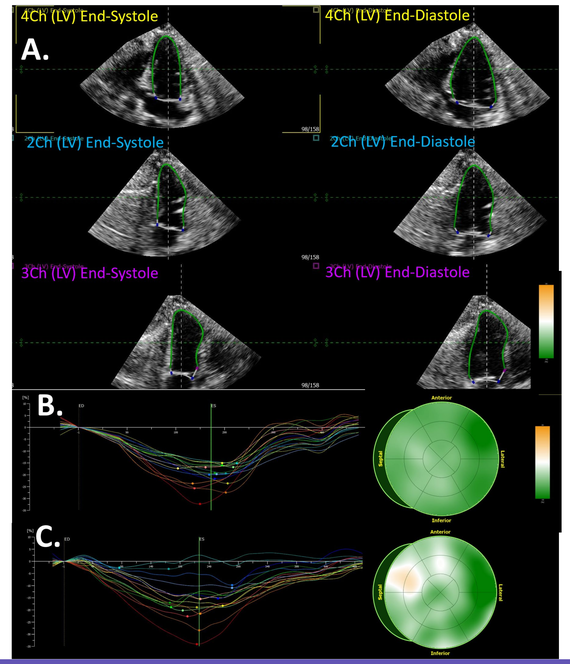


**Figure 5: 3D strain analysis using TOMTEC software. 4DLV tracking of 3D dataset (A). Curves of segmental 3D circumferential strain values with polar maps in pig at rest (B) and 5 µg/kg/min dobutamine (C). Dobutamine induced dyskinesis in the central MI region in this pig.**

## RESULTS

- $^{99m}$Tc-Teterofosmin area at risk was 46.71 ± 5.86%, with no significant variation noted across the population
- GLS 3-days post-MI (rest: -9.20±3.59; DOB: -9.62±3.14, p = 0.83) (Fig 6A)
- GCS 3-days post-MI (rest: -11.92±4.05; DOB: -15.20±3.57, p < 0.05) (Fig 6B)
- The DOB-induced change in GCS 3 days post-MI correlated with EDvol corrected to body weight at 5 weeks post-MI ($R^2$ = 0.68) (Fig 6D), while DOB-induced change in GLS ($R^2$ = 0.0114) (Fig 6C) was not predictive of LV remodeling

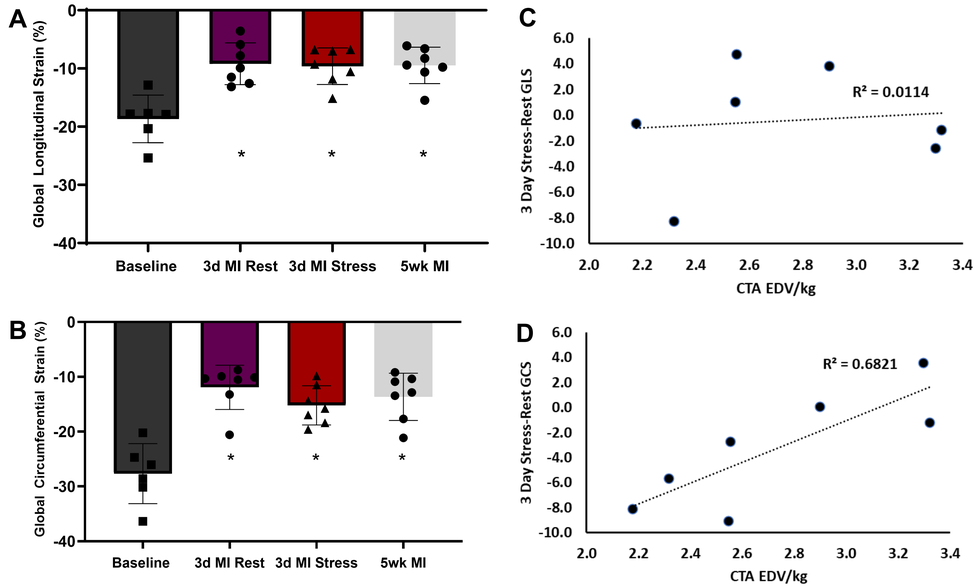


**Figure 6:** GLS and GCS were significantly reduced from baseline following MI induction at all subsequent time points (A, B).The difference between stress and rest GCS at 3 days following MI had a significant correlation (PCC=0.83) with the end-diastolic volume as measured by contrast CT at 5 weeks post-MI (D), while there was no correlation with GLS (C). * P<0.05 vs baseline (ANOVA)

## CONCLUSIONS

- Rest/low dose DOB stress-induced changes in GCS on 3D ECHO 3 days post-MI predicted late LV remodeling determined by changes in ED volume at 5 weeks post-MI.
- Low dose DOB-induced changes in GCS were better than changes in GLS for prediction of post-MI remodeling.
- Assessment of regional and global LV mechanics with 3D ECHO is emerging as a robust tool for assessment of regional myocardial strain and prediction of LV remodeling and may permit evaluation of novel therapeutic interventions including future local delivery of theranostics.

## REFERENCES

1. Bhatt, A.S., et al. Adverse Remodeling and Reverse Remodeling After Myocardial Infarction. *Curr Cardiol Rep* **19**, 71 (2017). 2. Xu, L., Huang, et al. (2017). Value of three-dimensional strain parameters for predicting left ventricular remodeling after ST-elevation myocardial infarction. The international journal of cardiovascular imaging, 33(5), 663–673. 3. Abate, E., et al. (2012). Value of three-dimensional speckle-tracking longitudinal strain for predicting improvement of left ventricular function after acute myocardial infarction. *The American journal of cardiology*, *110*(7), 961–967.4. Marwick, T. H.; Abraham, T. P. (2021). ASE's Comprehensive Strain Imaging . Elsevier.