

CHANGES IN LONGITUDINAL AND RADIAL STRAIN AFTER CORONARY EMBOLIZATION DETECTED ON VELOCITY ENCODED PHASE CONTRAST MAGNETIC RESONANCE IMAGING

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INTRODUCTION: Microembolization is a common clinical problem, occurring in almost one fourth of the vast patient population who undergo coronary intervention. Velocity-encoded phase contrast MR (PC-MR) imaging has the ability to measure strain after myocardial infarction but has not been used in the setting of microembolization.

PURPOSE: To determine the ability of PC-strain to detect the functional effects on left ventricular radial and longitudinal strain after microembolization in the LAD coronary artery.

MATERIALS AND METHODS: Six pigs (34±1kg) underwent coronary catheterization of the left anterior descending coronary artery (LAD) and imaging using a hybrid combination of X-ray fluoroscopy and a 1.5T MR scanner. A 3F-catheter was placed distal to the first diagonal and the perfusion territory was determined on first pass perfusion MR-imaging during injection of 10ml 10% Gd-DOTA (Dotarem®, Guerbet, France) through the catheter. Microembolization was created by injection of an embolic agent (Embosphere®, Biosphere Medical, Rockland, MA, USA, n=7500, 100-300 µm) in the coronary catheter. MR-images were obtained before microembolization (baseline) and 1 hour (acute) as well as 1 week (subacute) after microembolization. Strain was quantified on PC-MR images obtained in three long axis planes using a phase velocity encoded sequence (TR/TE/flip angle=23.4ms/4.8ms/15°, slice thickness=7mm, FOV=40x30cm, matrix size=256x192, no slice gap, heart phases=16 and VENC = 20 cm/s, presaturation bands were applied on each side of the imaging slice). Velocity data was acquired in two in-plane directions (right-left, anterior-posterior, or feet-head). Short-axis cine MR was also used for assessment of radial strain. Cine images were acquired using a ssfp sequence with a TR/TE/flip angle=3.5ms/1.75ms/70°, slice thickness=10mm, FOV=25x25cm, matrix size=160x152, no slice gap, and heart phases=16. Delayed enhancement (DE) MRI (IR-GRE, TR/TE/α=5ms/2ms/15°) were acquired 5-10 min after 0.15 mmol/kg Gd-DOTA administration. All images were evaluated by Segment v1.699b (<http://segment.heiberg.se>). A semi-automated assessment of strain was carried out by delineating myocardial contours on the end diastolic timeframe using the long-axis cine SSFP images as a guide. Subsequently, automated myocardial contour tracking was performed through all time frames of the cardiac cycle using the acquired velocity data. Approval was obtained from the Institutional Committee on Animal Research and the study was performed in concordance with the Guide for the Care and Use of Laboratory Animals.

RESULTS: The area at risk for microembolization was 35±2% of the LV. Comparison of radial strain by PC-MR compared to cine at baseline, 1-hour and 1-week showed low bias (-0.16±17.8%) and the peak radial strain values did not differ between the methods ($P=0.96$). At baseline the average peak radial strain at the basal regions were 35.7±6.0% on PC-MR and 38.4±5.1% on cine. At baseline, no significant differences in regional longitudinal strain were measured between the remote myocardium and AAR in basal (-18.2±8.5% vs. -13.5±5.0%, $P=0.66$), mid (-9.5±1.5% vs -11.0±2.9% vs., $P=0.67$) or apical regions (-11.1±4.0% vs. -11.5±3.2%, $P=0.95$). Regional longitudinal strain in the AAR declined in the apical (0.18±2.5% at 1-hour, $P=0.05$ and -3.9±1.1% at 1-week, $P=0.05$) and mid levels (-3.6±2.4% at 1-hour, $P=0.17$ and -2.8±1.5% at 1-week, $P=0.05$) after embolization. There was no significant change in longitudinal strain in the remote myocardium.

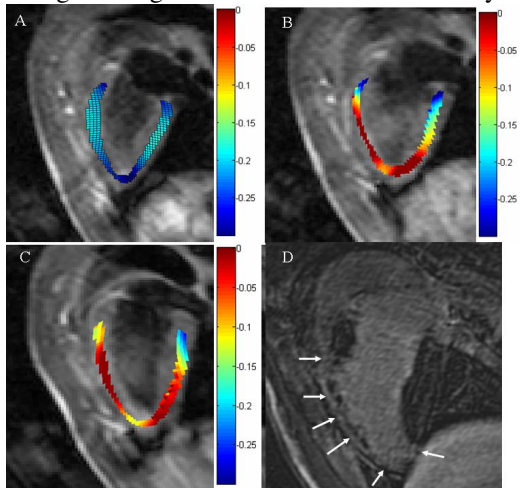


Figure 1. Peak systolic regional longitudinal strain values are shown pixel by pixel in the two-chamber view. A) At baseline, normal longitudinal strain is observed in all regions (blue). B) At 1-hour, a marked decrease in longitudinal strain (reddish-brown) is noted in the area at risk. C) At 1-week, the observed decrease in longitudinal strain extends beyond the extent of microinfarction, as depicted in the corresponding DE-MR image D).

CONCLUSION: The main findings of this study are that: 1) PC-MR imaging is sensitive in assessing changes in longitudinal and radial strain after selective LAD coronary embolization; 2) longitudinal strain of the hyperenhanced patchy microinfarction declined from baseline to 1-hour after embolization, a decline that persisted at 1 week and 3) radial strain declined acutely 1-hour after LAD embolization and worsened at 1 week post-embolization.

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