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Meeting abstract

1015 Quantitative assessment of the dark rim artifact in first pass perfusion images: effect of stress and rest

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Introduction

The dark rim artifact (DRA) presents a significant challenge to the quantification of myocardial perfusion from cardiac MR images for the detection of ischemic heart disease. The DRA manifests as a rim of dark pixels at the boundary between the myocardium and blood. This signal loss in the endocardium impacts negatively on the measurement of the signal time course which is integral to perfusion model estimation. The occurrence of the DRA has been reported in contrast agent (CA) enhanced single shot TrueFISP (TFI) and TurboFLASH (TFL) first pass perfusion images, but its origin is poorly understood. The artifact may be caused by a combination of factors one of which is the chemical shift susceptibility from high CA concentration. To further analyze the DRA, it's important to quantify the severity and duration of the artifact. This report is a quantitative description of the occurrence of the DRA in Gadolinium enhanced CMR images.

Methods

This study was approved by the institutional review board. Myocardial perfusion images were acquired in 14 volunteers (9 female) with normal cardiac function using a saturation recovery TrueFISP pulse sequence and Gadodiamide (0.05 mM/kg), under adenosine (140 ug/kg/min) stress followed by rest scans. The image parameters were as follows: body coil, TR 160 ms, TE 1.03 ms, FA 50, matrix 192 × 108; three long axis planes (HLA, VLA, and LVOT) of 10 mm slice thickness were recorded. Images were analyzed for the presence of DRA using ImageJ to measure the intensity profile across the myocardium as shown in Figure 1. Data were analyzed and displayed using Microsoft Excel as shown in Figure 2. DRA was identified in images showing signal loss in endocardium which coincides with the arrival of the CA in the LV and showing similar time course as the passage of the bolus. The DRA was defined as 20% or more decrease in image intensity in the sub-endocardium relative to the adjacent myocardium in the same frame. The severity of the DRA is a percentage signal loss in the artifact relative to adjacent myocardium in the same image. The frequency of occurrence is the percentage of images with artifacts in a series of 50 images.

Results

Both rest and stress images are affected by the DRA with similar frequency: 264 or 12.5% (rest) and 214 or 10.2% (stress) of the total of 2100 images show DRA. The mean signal loss per image is 32.9% (rest) and 31.5% (stress) with the most severe artifact showing a 90% signal loss. The images showing the most severe signal losses in the DRA occur at the same time as the greatest concentrations of CA in the LV as shown in Figure 3.

Conclusion

The coincidence of the maximum signal loss in the DRA with the maximum contrast intensity in TrueFISP images suggests that the susceptibility difference at the boundary between blood and myocardium may play a role in the origin of the artifact.

Figure 1
Three chamber views of the left ventricle in rest and stress images showing the line across the myocardium used to extract the intensity profile.

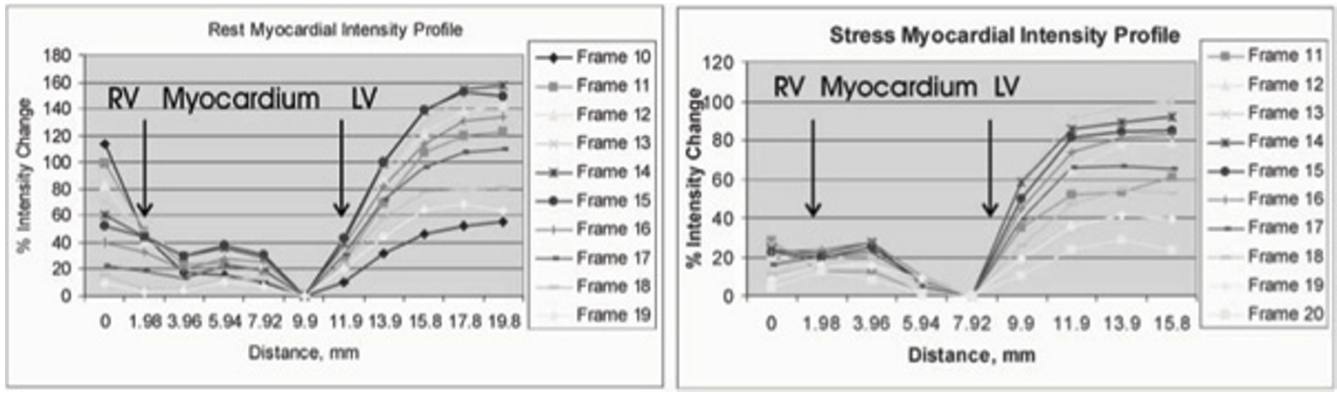

Figure 2
Plots of the intensity profile in a series of 10 consecutive image frames for rest and stress. We quantified the Dark Rim Artifact in first pass perfusion images. Rest and stress images show similar artifact frequency (12.5% of the rest and 10.2% of stress images) and severity (signal loss of 32.9%, rest and 31.5%, stress).

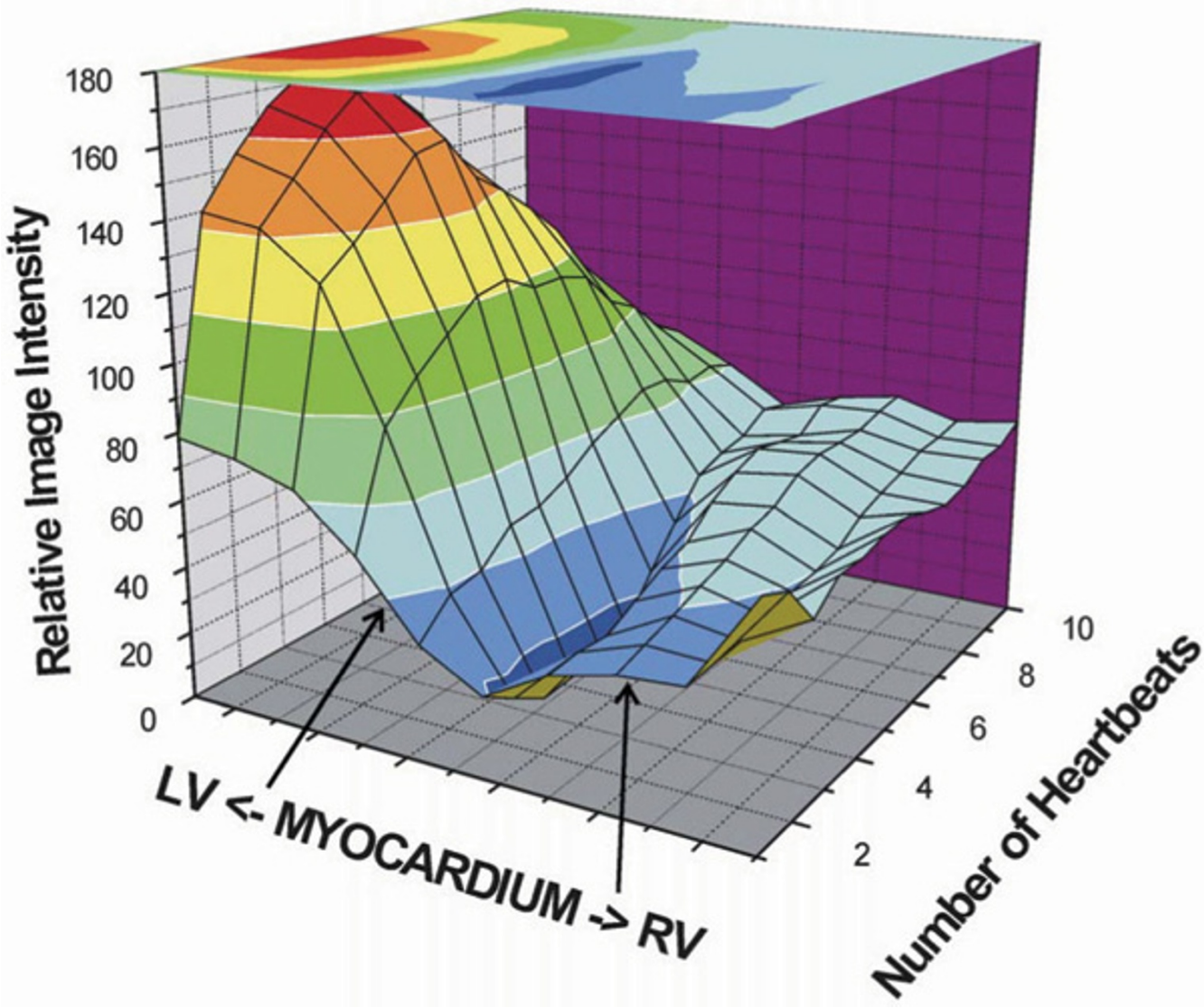

Figure 3
3D plot of the intensity profile across the myocardium from LV to RV showing the time evolution of the artifact. The severity of signal loss in the DRA coincides with the highest concentrations of CA in the LV.

Table 1: Mean, standard deviation, minimum and maximum measurements taken from the intensity profile across the myocardium.

	Rest No. of artifact images	Stress No. of artifact images	Rest Frequency, % of total images	Stress Frequency, % of total images	Rest Severity, % signal loss Rest per image	Stress Severity, % signal loss Stress per image	Rest Maximum Severity, % signal loss	Stress Maximum Severity, % signal loss
Mean	9.0	8.0	20	20	32.9	31.5	49.6	49.0
SD	2.5	2.1	0	0	9.5	10.3	16.1	14.9
Min	5.0	3.0	10	10	18.0	15.8	26.0	22.0
Max	14.0	12.0	30	20	59.1	54.8	90.0	84.0