

## Dark Regions of No-Reflow on LGE-MRI Result in Permanent Scar Post Atrial Fibrillation Ablation

C. J. McGann<sup>1</sup>, E. G. Kholmovski<sup>1</sup>, J. J. Blauer<sup>1</sup>, S. Vijayakumar<sup>1</sup>, T. S. Haslam<sup>1</sup>, J. E. Cates<sup>1</sup>, N. W. Akoum<sup>1</sup>, E. V. Dibella<sup>1</sup>, N. S. Burgon<sup>1</sup>, A. J. Alexander<sup>1</sup>, M. Prastawa<sup>1</sup>, D. Parker<sup>1</sup>, R. MacLeod<sup>1</sup>, and N. F. Marrouche<sup>1</sup>

<sup>1</sup>CARMA Center, Salt Lake City, Utah, United States

### Introduction

Cardiac MRI has been applied to image tissue injuries in patients after undergoing ablation procedures for atrial fibrillation (AF). In the months following ablation injury, late gadolinium enhancement (LGE) shows the resulting scar formation, which has been associated with procedure outcomes. When LGE imaging is performed immediately post-ablation, heterogeneous injury is seen with both bright (hyperenhancing) and dark (non-enhancing) lesions. The relationship between the acute injuries seen on LGE and late scar formation has not been well studied.

### Methods

Ten patients presenting for AF ablation underwent 3D LGE MRI immediately post ablation (IPA) and three months post-ablation (3moPA) on a 3T scanner. High resolution LGE images of the LA were acquired 15 minutes after contrast agent injection (0.1 mmol/kg, Multihance (Bracco Diagnostic Inc., Princeton, NJ)) using a 3D respiratory navigated, IR prepared GRE pulse sequence with voxel size=1.25x1.25x2.5 mm. The IPA injuries were evaluated and categorized as either hyperenhancing (HE) or non-enhancing (NE) lesions and compared to scar 3moPA. Close registration of the IPA and 3moPA images was possible by applying a 3D non-rigid deformation processing method, which enabled us to determine the amount of scar resulting from either acute HE or NE lesions.

### Results

Ablated tissue demonstrates regions of differing contrast with bright, HE, as well as dark, NE regions (Figure 1). The non-enhancing lesions demonstrate

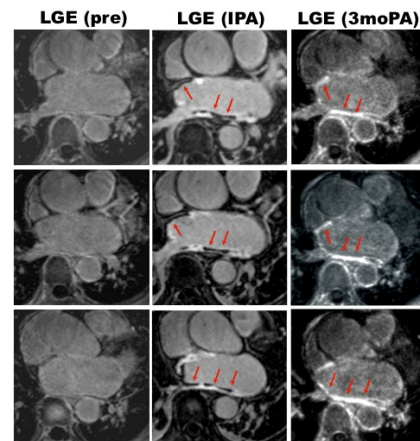


Figure 1. Comparison of IPA to 3moPA LGE scans. IPA, both bright hyper-enhancing and dark non-enhancing LA wall injuries are seen. 3moPA, Permanent LA wall scarring results. Serial LGE imaging studies are shown with closely matched slice Pre, IPA, and 3moPA.

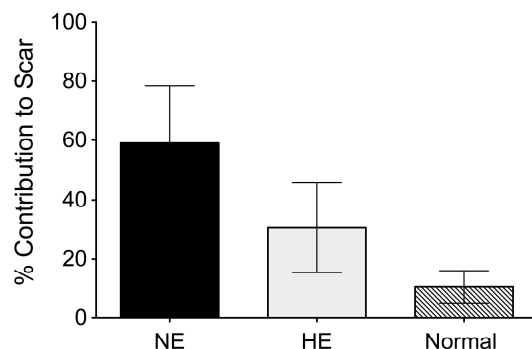


Figure 2. Immediate-post Injury Comparison to 3-month Scar

'no-reflow' phenomena. On the IPA imaging, when LGE MRI is timed 15 minutes post-contrast injection, the LA wall showed similar amounts of NE, HE, and normal tissue ( $35.9 \pm 15\%$ ,  $36.3 \pm 11\%$ , and  $27.8 \pm 13\%$  respectively, NS). At three months follow-up,  $59.0 \pm 19\%$  of scar resulted from NE tissue,  $30.6 \pm 15\%$  from HE tissue, and  $10.4 \pm 5\%$  from tissue identified as normal ( $p < 0.0001$ ) (Figure 2). Thus, permanent scar was best predicted by NE lesions with nearly two-fold more scarring resulting from NE compared to HE injury ( $p < 0.03$ ).

### Discussion

Radiofrequency ablation results in heterogeneous injury on LGE MRI with both HE and NE lesions seen in the LA wall. The NE lesions demonstrate 'no-reflow' characteristics and may improve prediction of final scar at 3 months.