COMPARISON BETWEEN MULTI-CONTRAST LATE ENHANCEMENT MAGNETIC RESONANCE IMAGING AND ELECTROANATOMICAL VOLTAGE MAPPING, FOR VENTRICULAR TACHYCARDIA SUBSTRATE CHARACTERIZATION, USING A REAL-TIME MR-GUIDED ELECTROPHYSIOLOGY SYSTEM

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Introduction:

Catheter ablation of ventricular tachycardia (VT) is preceded by characterization of the myocardial substrate. The endocardial substrate is examined via electroanatomical voltage mapping (EAVM) to identify ablation targets, usually represented by scar-related reentrant circuits. However, conventional approaches to define the VT substrate via EAVM have some limitations: mischaracterization of normal myocardium as low-voltage areas (due to poor catheter-tissue contact) and non-transmural scar regions with higher peak voltages as normal myocardium [1]. The purpose of this study was to characterize the relationship between chronic myocardial scar detectable by multi-contrast late enhancement (MCLE) MRI [2] and EAVM obtained under a MR-guided EP procedure in potentially arrhythmogenic regions.

Methods:

Real-time MR-guided EAVM was performed in 4 chronically infarcted porcine hearts (due to transient occlusion -- 60 or 90 minutes – of the left ascending artery), with the system described in [3] in a 1.5T GE Signa system. High-density maps were acquired to obtain endocardial voltage, particularly in infarct regions. MCLE images were acquired just before catheter insertion. The sequence uses a segmented SSFP readout following an inversion pulse that is applied once per heartbeat, yielding 20 cardiac-phase-resolved images at different effective T1. Classification of the infarct core and gray zone was then performed on the MCLE images using an automated data clustering algorithm previously described [2] and results classification maps were incorporated into the image guidance for EAVM.

Results:

In the 90-minute porcine model, EAVM (average of 324 ± 43 points per LV) showed that low-voltage regions matched well with regions classified as infarct and/or gray zone by MCLE. In the 60-minute model, where the infarct is generally more heterogeneous and not always transmural the EAVM did not detect low-voltage areas (< 1.5mV) in areas classified as infarct. Additionally, in the severe-injury model percentage transmurality of the infarct corresponds well with bipolar voltage measurements; however in the 60-minute model bundles of viable myocytes mixed within the scar appear to contribute to increases in the voltage signal, resulting in misclassification by EAVM.

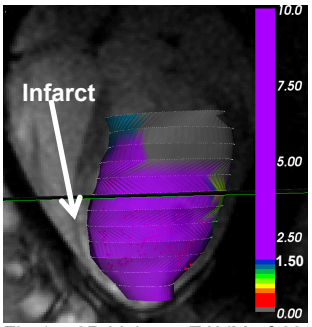

Fig 1a: 3D Voltage EAVM of 60-minute infarct model in mV

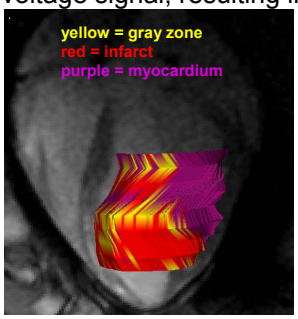

Fig 1b: 3D MCLE classification calculated at 1 pixel (1.4x1.4x5 mm) on endocardial border

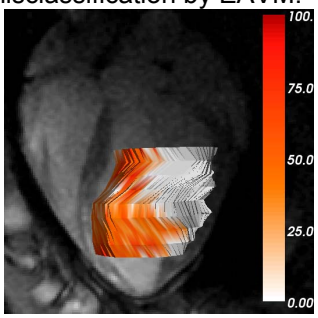

Fig 1c: 3D Transmurality % (infarct only) across wall thickness

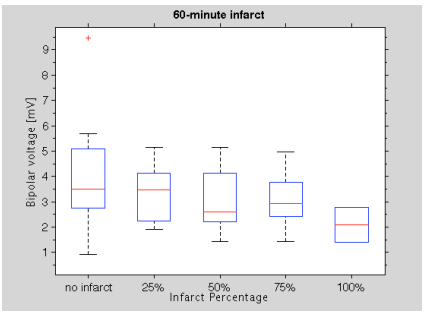

Fig 1d: Median bipolar voltage measurement vs. infarct percentage transmurality for 60-minute model

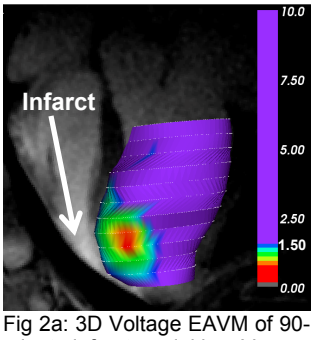

Fig 2a: 3D Voltage EAVM of 90-minute infarct model in mV

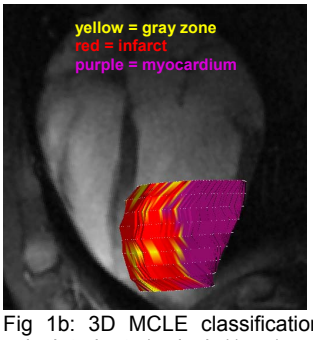

Fig 1b: 3D MCLE classification calculated at 1 pixel (1.4x1.4x5 mm) on endocardial border

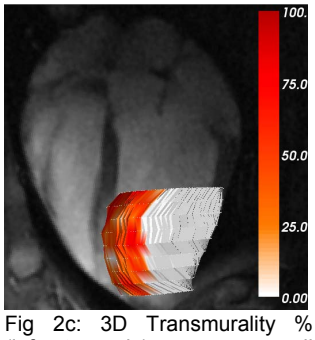

Fig 2c: 3D Transmurality % (infarct only) across wall thickness

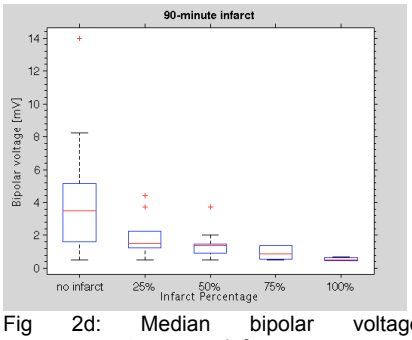

Fig 2d: Median bipolar voltage measurement vs. infarct percentage transmurality for 90-minute model

Conclusion: Integration of MRI-derived scar maps with EAVM is feasible. MCLE imaging identifies transmural and non-transmural infarct regions, particularly potentially arrhythmogenic regions not detected by EAVM bipolar measurements. These observations have implications for catheter ablation of VT and for targeting the delivery of future therapies to scarred regions. **References**:[1] Nakahara Hearth&Rhythm 2011 vol.8(7) [2]Detsky IEEE-TMI 2009 vol.28(10) [3] Oduneye ISMRM2011 #3888.