

ORAL PRESENTATION

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Voltage-based electroanatomic mapping system for MR-guided cardiac electrophysiology: preliminary swine validations

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Background

MRI produces images that serve as luminal, edema, & scar maps to assist in the Electrophysiological (EP) treatment of ventricular and atrial arrhythmias [1]. Until MR-compatible EP devices are widely available, there will be a need to perform EP partially in the MRI for imaging, and partially outside the MRI for ablation, puncture & navigation. An MR-conditional voltage-based Electroanatomic Mapping (EAM) system would allow MR-guided EP in MRI & registration-free EP to be performed outside the MRI during X-ray, Intra-Cardiac-Echo (ICE) or EAM guidance. Previously a 1.5T MR-conditional St. Jude Medical EnSite Velocity (Velocity) voltage-based EAM system was presented [2]. The study objective was to conduct a multi-catheter registration free EAM (localization & intra-cardiac Electrogram (EGM) measurement) both in & outside of the MRI.

Methods

An MR-conditional Velocity was constructed to prevent MR gradient from reducing tracking accuracy. The system utilized an electronic switching circuit, RF-filtered electrical lines, modified surface electrode patches, & MR-conditional EP catheters [2]. Trans-septal punctures were made in 5 intubated swine under X-ray & ICE guidance. The swine were moved to a GE 1.5T MRI suite equipped with the Velocity. Prior to the procedure, 3D ECG-gated MR Angiography (MRA) provided navigational roadmaps. Three voltage-tracked EP catheters, with 4 tracked electrodes each, were navigated simultaneously inside the MRI to acquire EAM of the heart's left & right sides, with a coronary sinus

catheter providing a physiological reference (Fig1). Imaging & voltage tracking were tested simultaneously (Fig2a). To measure Velocity's catheter tracking accuracy during MR imaging, catheters were navigated to specific anatomic regions, & the change in location was observed during imaging over 10-sec increments.

Results

EAM & catheter navigation of the swine models were performed both in & outside the MRI at >20 frames-per-second without re-registration (Fig1). Imaging was conducted simultaneously with tracking (Fig2a), & catheter position remained stable during the entire imaging session (Fig1a). The median catheter electrode locations changed by 0.33-0.37 mm, while the standard deviation (SD) of the locations increased by only 0.23-0.45 mm (Fig2b). Since some of the positional SD was due to respiratory or cardiac motion, this slight increase in positional oscillation was hard to visually detect in EAM. Concurrent imaging & tracking were successful during sequences with TR>32 ms, capturing cardiac tissue during critical procedural stages. Image quality reduction of <5% was shown in FSE & GRE sequences. High-fidelity Intra-cardiac EGMs were obtained even during imaging (Fig2c). Electrode heating was <1°C under sequences of 4 Watt/kg.

Conclusions

MRI-conditional voltage tracking allows simultaneous catheter tracking & MR imaging, permitting registration-free EAM in& outside MRI during EP procedures.

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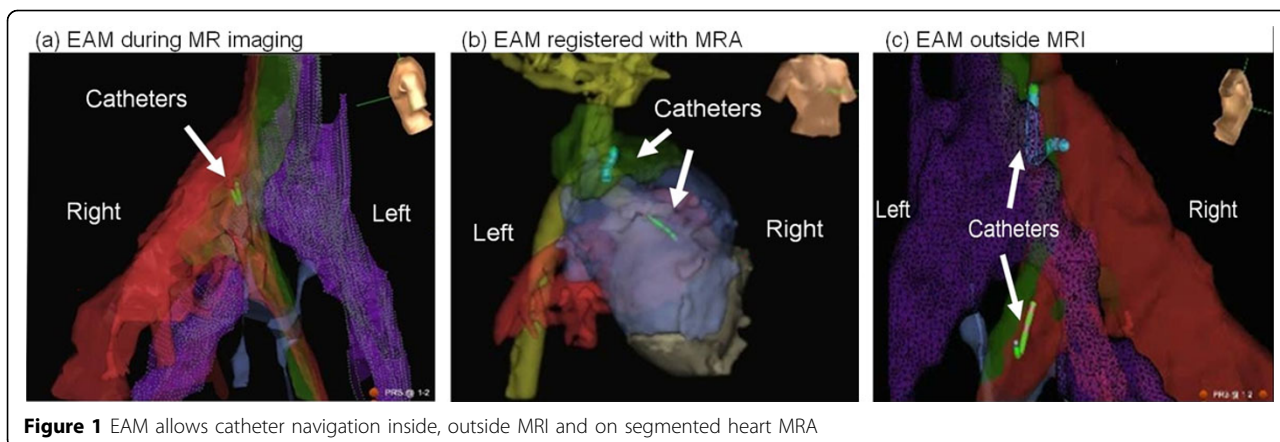


Figure 1 EAM allows catheter navigation inside, outside MRI and on segmented heart MRA

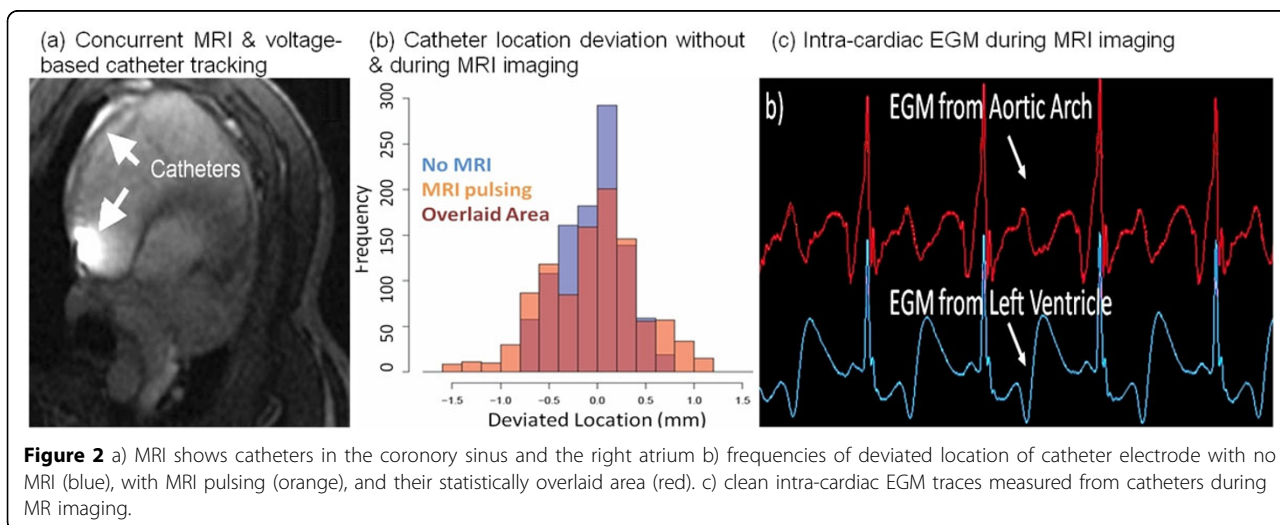


Figure 2 a) MRI shows catheters in the coronary sinus and the right atrium b) frequencies of deviated location of catheter electrode with no MRI (blue), with MRI pulsing (orange), and their statistically overlaid area (red). c) clean intra-cardiac EGM traces measured from catheters during MR imaging.

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References

1. Saikus CE. *JACC* 2009, *1*mg.
2. Tse ZTH. *ISMRM* 2012.

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