Quantitative Myocardial T1 and T2 mapping In a Swine Model of Ventricular Tachycardia

Sébastien Roujol[1], Tamer A. Basha[1], Cory Tschabrunn[1], Kraig V. Kissinger[1], Warren J. Manning[1,2], Mark E. Josephson[1], Elad Anter[1], and Reza Nezafat[1]
[1]*Department of Medicine, Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, United States,* [2]*Department of Radiology, Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Massachusetts, United States*

Target Audience

Scientists/clinicians interested in myocardial tissue characterization.

Purpose/Introduction

Ventricular tachycardia ablation reduces the incidence of implantable cardioverter defibrillator (ICD) therapy in patients with history of myocardial infarction[1]. However, a high recurrence rate of VT is observed after ablation in these patients[1]. Therefore, the development of new techniques to identify the VT substrate may have important clinical impact. In this perspective, we have recently developed a swine model of re-entrant VT, where sustained monomorphic re-entrant VT can be induced in all animals. In this study, we sought to provide in-vivo characterization of this model using myocardial tissue characterization techniques of T_1, T_2 and high-resolution LGE.

Materials and Methods

All imaging was performed using a 1.5 T Philips scanner. A model of re-entrant VT was induced in 11 Yorkshire swine using a 180 minutes balloon occlusion of the mid left anterior coronary artery. In-vivo CMR was performed at 52±13 days after infarction. Subsequently, each animal underwent an electrophysiology study with programmed stimulation to assess for VT inducibility.

In-vivo CMR Protocol: In-vivo CMR was performed with sedation, intubation and mechanical ventilation of each animal. Pre-contrast imaging included native T_1 mapping (using MOLLI[2]) and T_2 mapping[3]. Post-contrast imaging was performed after bolus injection of 0.2 mmol/kg of gadobenate dimeglumine and included post-contrast T_1 mapping (using MOLLI[2]) and high resolution late enhancement (LGE)[4].

Imaging Sequences: Quantitative myocardial tissue characterization sequences (T1/T2 mapping) used an ECG-triggered single shot acquisitions with balanced-SSFP imaging readout and the following parameters: (TR/TE=4.3/2.1ms, flip angle=35°(T_1 mapping)/85°(T_2 mapping), FOV=360×276 mm^2, voxel size=2×2 mm^2, slice thickness=8 mm, 10 slices (T_1 mapping)/5 slices(T_2 mapping), SENSE factor=2).

High resolution LGE (3) was performed using a free breathing navigator-gated inversion recovery gradient echo sequence with the following parameters (TR/TE/α=6.5/3.0ms/25°, FOV=270×270×112 mm^3, voxel size=1×1×1 mm^3, compressed sensing factor=4).

Data Analysis: Analysis was performed offline using an in-house platform. The areas of hyper-enhancement in LGE data was used to visually guide a manual segmentation of the corresponding areas in all T_1 and T_2 maps. A similar approach was used to delineate an area of healthy myocardium all T_1 and T_2 maps. T_1/T_2 maps with artefacts were discarded from the analysis. Native T_1 times and T_2 times are reported for both "remote area" and "area of hyper-enhancement in LGE".

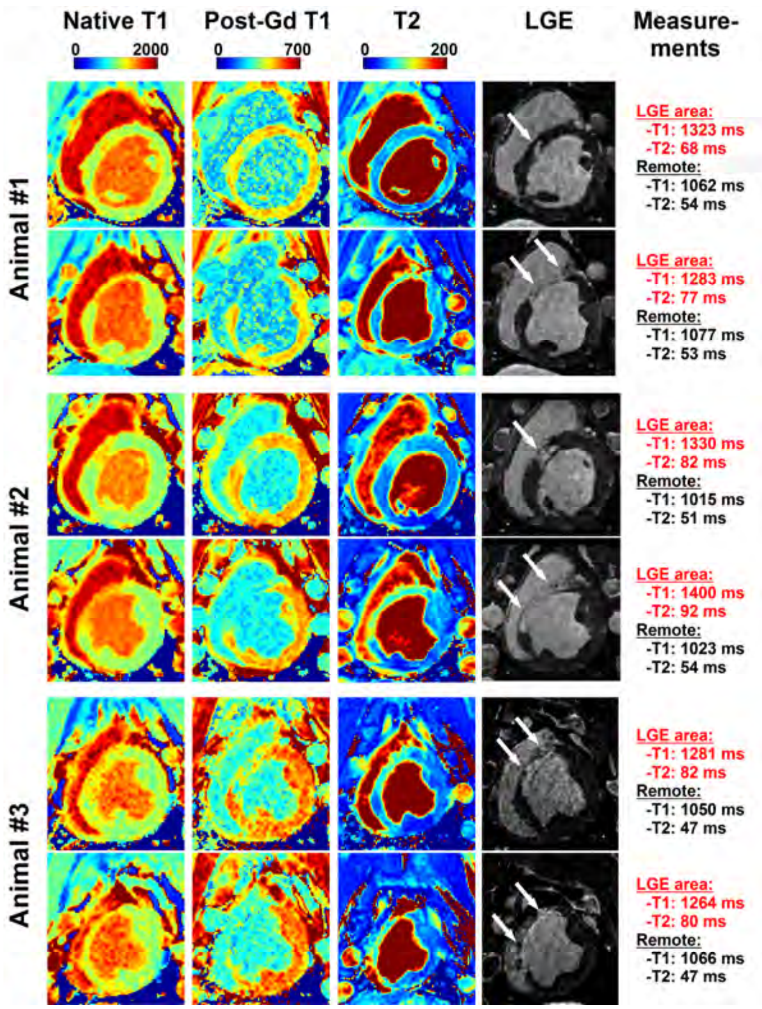

Figure 1. *Native T_1 maps, post-contrast T_1 maps (post-Gd T_1), T_2 maps and LGE obtained in 3 swine. Elevated native T_1 times and T_2 times can be observed in the area of LGE hyper-enhancement.*

Results

Sustained re-entrant VT was induced in all animals. Areas of elevated native T_1 times and T_2 times corresponded well to areas of reduced post-contrast T_1 times and LGE hyper-enhancement (Figure 1). These findings were found reproducible over all animals (Figure 2) where areas corresponding to LGE hyper-enhancement had higher native T_1 times (1276±45 vs. 1047±29, $p<0.001$) and T_2 times (85±6 vs. 52±4, $p<0.001$) than remote area.

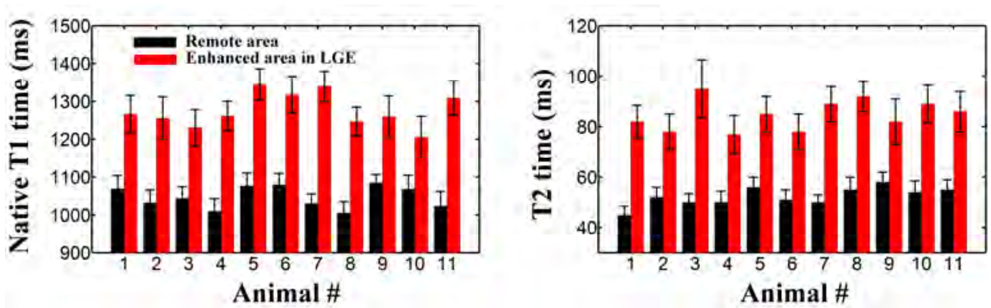

Figure 2. *Native T_1 times and T_2 times measured in area corresponding to LGE hyper-enhancement (red) and in remote area (black). Higher T_1 times and T_2 times were obtained in area corresponding to LGE hyper-enhancement ($p<0.001$).*

Conclusions

Areas corresponding to LGE hyper-enhancement have elevated native T_1 times and T_2 times in the developed swine model of re-entrant VT.

Acknowledgements

Grant support from NIH R01EB008743-01A2 and Boston Scientific.

References

[1]Reddy,NEJM,2007; [2]Messroghli,MRM,2004; [3]Akçakaya,MRM, 2014; [4]Akçakaya,Rad.,2012