

Omnipolarity Applied to Equi-Spaced Electrode Array for Ventricular Tachycardia Substrate Mapping

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Supplemental methods:

Swine infarct model:

Male Yorkshire pigs with weights ranging 40 to 50kg were sedated using Ketamine (25mg/kg) and Atropine (0.05mg/kg) injected intramuscular (IM) and then mechanically ventilated with 1-3% Isoflurane. Buprenorphine (0.05mg/kg) was administered IM pre- and post-operatively and Metacam (0.2mL/kg) PO twice daily for pain management. During the initial procedure a closed-chest myocardial infarction (MI) was performed on 7 out of 10 pigs. The left main coronary artery was engaged using a 6Fr JL 3.0 guiding catheter. An angioplasty wire was progressed to the distal left anterior descending artery and after the 1st diagonal branch an angioplasty balloon was inflated for a total occlusion of the vessel during 90 minutes.

Cardiac Magnetic Resonance Imaging:

CMR was performed with a 3T whole body scanner at baseline and post-intervention. Using a steady-state free-precession (SSFP) method in cine mode, cardiac function was evaluated. Further, T1-weighted inversion, recovery gradient echo sequence was used to assess myocardial infarction. LGE imaging was initiated at 8-10 min post injection of contrast agent. Post-processing of MRI images was done using Seg3D2™ software (University of Utah, Utah, USA). A semiautomated analysis of the distribution of the LGE area was done by manually contouring the boundaries of the LV endocardium. Two types of LV endocardial surfaces were generated for each pig: one for the healthy region and one for the infarcted region affected by LGE. Surface area of the infarcted regions

was calculated from the sum of the product of each MR image slice thickness and the length of the line that span the LGE-affected areas on each of the image slices.

Electroanatomical mapping:

Each pig underwent electroanatomic mapping (4 weeks after MI induction of the 7 pigs). Endocardial mapping of the LV was performed via retrograde transaortic access (Supplemental Figure 1) with the aid of a long steerable sheath (Agilis™, Abbott Laboratories, Minneapolis, MN, USA) in 2 cases or without it in 8 cases. Heparin was given during the procedure (100 units/kg bolus initially followed by 1000 units every 30 minutes).

Statistical analysis:

Voltage mapping with Bipolar EGMs vs Omnipolar EGMs:

For statistical comparisons, we used a hierarchical mixed effect and random intercept (HME-RI) model to provide the best fit model accounting for nested clustering (beats within cliques within hearts and within healthy and/or scar areas) and repeated measures per pig. Marginal predictions were used to perform pairwise comparisons between OTVmax values and BiEGM Vpps from AL and AC as well as Max-Bi. Statistical analysis was performed using Stata Version 12 and was done within a 95% confidence interval. Results from difference tests using the HME-RI model that yield a range of confidence intervals beyond the zero-crossing were deemed to be statistically significant while those that cross zero are not (S for significant and NS for non-significant).

Beat by beat consistency between Bipolar EGMs and Omnipolar EGMs:

We used a standard paired t-test for statistical analysis of the CoV values of OTVmax and BiEGM AL and AC Vpp values over 10 beats, within each clique, over either healthy or infarcted areas, for each pig. Graphpad Prism 6 was used for this analysis. Statistical

analysis for this study were done within a 95% confidence interval with p-values from comparisons with less than or equal to 0.05 as statistically significant (S) while p-values from comparisons with higher than 0.05 are non-significant (NS).

Supplementary Figure Legends

Supplementary Figure 1. Suitability for Retrograde Aortic Deployment of the Equi-Spaced Catheter Array. access to the artery with the Advisor™ HD grid was achieved by inserting and folding the catheter into the insertion tool and advancing it into a conventional 8.5Fr sheath. Access to the LV was achieved via retrograde transaortic approach. A knuckle in the descending aorta was created by flexing the catheter and it was then progressed to the aortic valve. With gentle pressure and counterclock or clock torque we were able to cross the valve without difficulties in all 10 animals repeatedly. None of the animals experienced any complications related to catheter manipulation and none of the catheters was damaged or was trapped during the mapping experiments with all the electrodes and splines being intact at the end of all procedures, there was no evidence of any clot being formed between the splines of the catheter.

Supplementary Figure 2. Local Activation Time Map Comparison between Bipoles and Omnipole. Local activation time (LAT) maps were derived for both bipolar orientations (along and across the splines of an HD grid) and omnipoles while pacing with a quadripolar catheter within the septum of the right ventricle (RV) Because of the fractionated nature of the bipolar electrograms (EGM), we used the LATs from the absolute dV/dt of each of the collected bipolar EGMs. Supplemental Figures 2a and 2b show the LAT maps derived from along and across the spline of the HD grid while Supplemental Figure 2c show the LAT map derived from omnipoles. The spread of activation is very similar between bipoles and omnipole. This indicates that omnipoles could be a viable tool for complete substrate analysis. We also included videos of wave propagation for both bipolar (along and across) and omnipolar LAT maps in Supplemental Videos 1, 2, and 3, respectively.