Unipolar Intracardiac Signal Morphology as a Parameter for Catheter Contact Evaluation

Ivana Jovicic, Deepak Padmanabhan, Alan M Sugrue, Vaibhav R Vaidya, Branislav Vlajinic, Lora Mikolaitis, Djordje Krstic, Tom Foxall, Sina Fakhar, Budimir S Drakulic, K L Venkatachalam, Samuel J Asirvatham

***Abstract*—During electrophysiology (EP) studies, contact between catheter tip and myocardial tissue affects the accuracy of cardiac maps and the efficacy of ablation energy delivery. We hypothesized that the morphology of a unipolar signal can provide incremental information in contact evaluation.**

I. Introduction

Optimal catheter tissue contact must provide spatial and temporal stability. Presently, contact force (CF) in grams together with force-time integrals (FTI) are used for evaluation of temporal stability, whereas spatial stability is judged by imaging technologies [1]. We have developed the PURE EP™ System with the ability to record high quality unipolar signals referenced to the Wilson Central Terminal (WCT) [2]. High quality unipolar electrograms are difficult to obtain as the tip of the intracardiac catheter is inside or on the surface of the heart, while the WCT is derived from ECG electrodes on the surface of the body. When the reference electrode is on the second catheter, results are generally better, but an additional catheter is needed.

II. Methods

We performed acute experimental studies in eleven mongrel dogs (30-50 kilograms). Each study involved the endo/epicardial mapping of cardiac chambers via venous and arterial access. During all the experiments we used standard electrophysiology catheters such as Blazer II, ThermoCool Smart Touch and PentaRay.

III. Results

When evaluating the morphology of the unipolar signals obtained with PURE EP, we found that irrespective of the catheter used (non CF or CF), there was a correlation between changes in the PR and ST segment amplitudes (represented as current of injury) and value of contact force. These changes were specific for myocardium and not present when contact was made with other cardiac structures. For example, when the CF catheter was used and the catheter made contact with the atrium (white arrow Fig. 1), the morphology of the local signal and amplitude of the PR segment changed with increased CF until a plateau was reached (Figure 1, Table I).

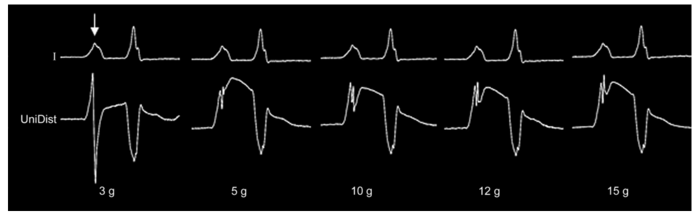
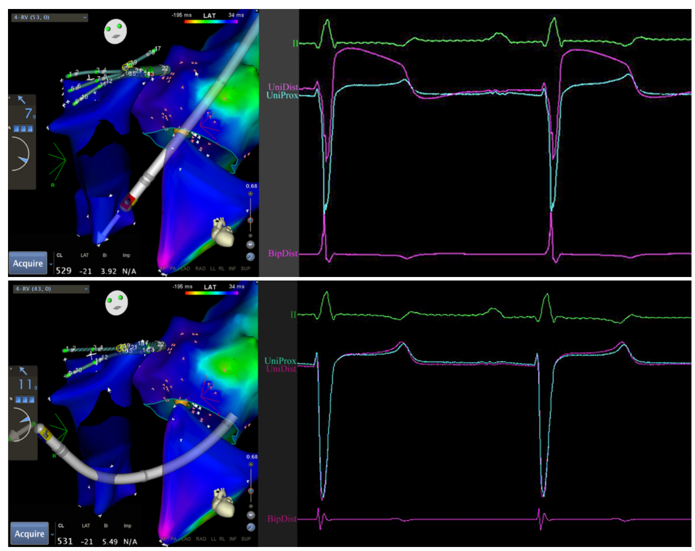


Figure 1. Lead I and unipolar distal (UniDist) pressure changing 3-15 g

TABLE I. Summary of increased force vs. PR elevation

Force (g)	3	5	10	12	15
PR elevation (mV)	0.73	3.38	2.45	2.71	3.00

In another example, when the distal electrode was in stronger contact with the ventricle, UniDist changed in proportion and demonstrated ST elevation corresponding to the increased CF pressure (Figure 2a). When both distal (UniDist) and proximal (UniProx) electrodes were in equal contact with the tissue, signals were almost identical (Figure 2b).



Figures 2a-top and 2b-bottom. Lead II-green, unipolar distal (UniDist-pink), unipolar proximal (UniProx-blue) and bipolar distal (BipDist-pink).

IV. Conclusion

We intend to quantify observed differences.

Deepak Padmanabhan, Alan M Sugrue, Vaibhav R Vaidya, Samuel J Asirvatham are with Division of Cardiovascular Diseases, Mayo Clinic, Rochester, MN.

K L Venkatachalam is with Division of Cardiovascular Diseases, Mayo Clinic, Jacksonville, FL.

Ivana Jovicic, Branislav Vlajinic, Lora Mikolaitis, Djordje Krstic, Tom Foxall, Budimir S Drakulic are with BioSig Technologies Inc, Los Angeles, CA.

References

[1] D.C. Shah and M. Namdar, "Real-Time Contact Force Measurement: A Key Parameter for Controlling Lesion Creation with RF Energy," *Circ Arrhythm Electrophysiol*, vol. 8, pp. 713-721, 2015

[2] A.Killu et al, "Enhanced Electrophysiology Recording System," poster presented at the IEEE EMBC 2016 Orlando, FL.