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Evaluation of Real Time Catheter Tissue Contact Using Unipolar Intracardiac Signal Morphology

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***Abstract* - During electrophysiology (EP) studies one of the most challenging objectives is to achieve and maintain optimal contact between the catheter tip and myocardial tissue. The recent availability of real time contact force (CF) sensing catheters has reinvigorated the EP field. We evaluated the morphology of unipolar intracardiac signals as an additional real time marker for contact evaluation.**

I. INTRODUCTION

Extracellular electrograms, recorded directly from the heart, are the hallmark of invasive cardiac electrophysiology. These electrograms are generated by depolarization of cardiomyocytes creating transmembrane current in extracellular space. For unipolar intracardiac recordings the positive input of the recording amplifier is connected to the exploring electrode, while the negative input is connected to the Wilson Central Terminal (WCT) or an indifferent intravascular electrode that is remote from the exploring electrode. We have developed the PURE EP™ System with the ability to record high-quality unipolar signals referenced to the WCT [1], [2]. During preclinical studies we observed that variation in catheter contact force would significantly change the morphology of unipolar signals. These changes were only present when recorded from viable myocardium and could therefore also assist in the differentiation between myocardium vs. non-myocardium tissue.

II. METHODS

We performed acute experimental studies in twelve mongrel dogs and four pigs. Each study involved the endo/epicardial recordings and mapping of all cardiac chambers via venous and arterial access. During these experiments, we used standard CF (ThermoCool Smart Touch) and non CF catheters such as Blazer II and PentaRay. We used CARTO 3 (Biosense Webster) for mapping and to obtain average force in grams when using CF catheter.

III. RESULTS

We evaluated the morphology of unipolar signals when changing contact force (both increasing force from low to high, and decreasing force from high to low) over different cardiac structures, and over time segments from a few minutes to 10 minutes. We found that irrespective of the catheter used, there was correlation between changes in PR (for Atria) and ST (for Ventricles) segments and the value of force applied to the myocardium. For example, when the catheter was in the RV and force was gradually increased from initial contact of a few grams (A) to contact of 20-25g (C), the unipolar distal lead demonstrated dramatic changes in ST elevation from 0.2mV to 3.5mV. With catheter in the same position, when force was decreased back to a low value 1-3g (E), ST went to 0.1mV (Figure 1).

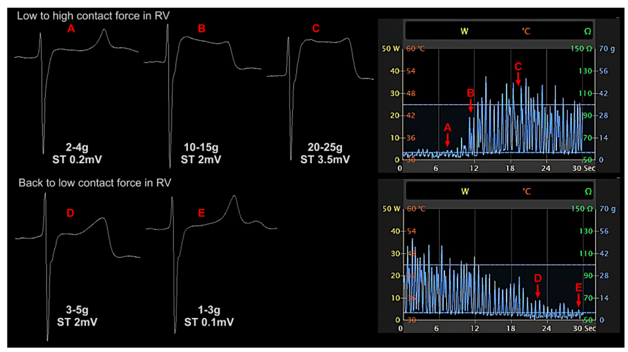

Figure 1: Low to high CF and back to low in RV

In another example, when the catheter was in the RA, the morphology of the signal changed as force gradually increased from initial contact 1-2g (A) to 15-20g (D) and correlated well with average force displayed by Carto (Figure 2).

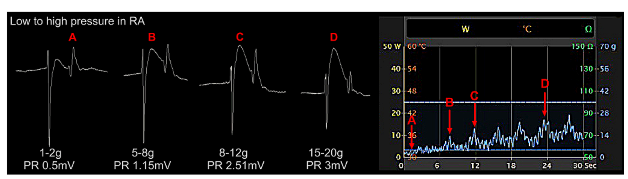

Figure 2: Low to high CF in RA

IV. CONCLUSION

We observed that there is a correlation between the PR/ST segment of unipolar intracardiac signals and catheter contact force. This observation was repeatable in various chambers in the heart during increasing/decreasing catheter contact force and during longer recordings.

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