Use of a Novel Electrogram Filtering Algorithm to Visualize Conduction Tissue Signals in the Ventricle in Sinus Rhythm and Arrhythmia: An Acute Canine Study

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Abstract

Background: Conduction tissue in the ventricles is closely intertwined with myocardium. Owing to high velocity of conduction, there is near simultaneous activation of the two, making it difficult to discern. Restricted sampling rates and limited dynamic range make real time signal processing challenging for these signals in routine recording systems.

Objectives: We aimed to use novel signal processing techniques in a new system to isolate the conduction tissue signals from the rest of the myocardial activation.

Methods: We used the PURE-EP™ (BioSig Technologies, MN) signal processing system to record endocardial and epicardial signals from 6 anesthetized canines in an acute study setting. A novel filter based on proprietary algorithms to isolate the high frequency signal was applied at sites where the electrogram signals were thought to have a conduction tissue component to them. . In addition, ventricular fibrillation (VF) was induced at the end of the experiment and signals were then recorded from the endocardium and the conduction system.

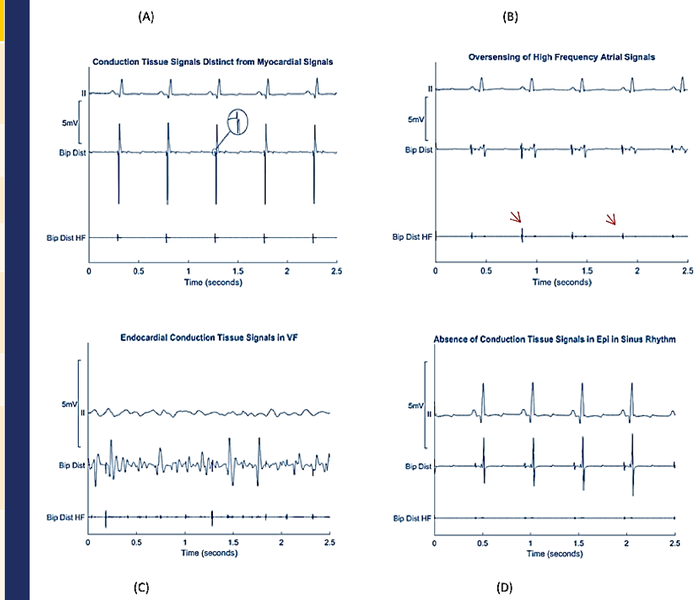
Results: This filter was successfully able to isolate conduction tissue signals in the myocardium from those of the ventricular muscle. It did over sense atrial signals at the basal left ventricular septum owing to the high frequency components of the atrial signal at this location. When applied to epicardial signals, it did not pick up any conduction tissue signals. In VF, we could discern signals originating from the conduction system endocardially. (**Figure 1**)

Conclusions: This filter can isolate conduction tissue signals from those of the myocardium and may prove to be a useful adjunct in mapping arrhythmias originating near the conduction system.

System Comparison

	System A	Pure-EP ™
Bandwidth	0.05-500Hz (Based on 977s/s)	0.05-1000Hz
Sampling rate	977 samples/sec	2000 samples/sec
Dynamic Range	Not published	105dB
A.D converter	12-bit	24-bit
Minimum CMRR at 60Hz	100dB	110dB
Input impedance	>1GΩ	>0.5GΩ
Noise	Noise unknown	1μV RMS
Hardware gain	Programmable- (From 50-10,000 in 8 steps)	Fixed at 10

Figure



Intracardiac electro grams obtained from the PURE EP™ system.

(A) The PURE-EP™ system demonstrated high-frequency signals that correlated with Purkinje potentials using the novel filter (high-pass filter 300Hz with post processing) Note that the PURE-EP™ bipolar filter settings are 30Hz-1KHz.

(B) Over sensing noted at base of the left ventricular septum (red arrows)

(C) Endocardial conduction tissue signals noted during ventricular fibrillation (VF)

(D) No signals present over the epicardium in sinus rhythm; Bip: Bipolar ; Dist: Distal Epi: Epicardium HF: high frequency filter

Results

- Conduction tissue within the distal ventricles remains intimately associated with the muscle. Mapping these signals with a bipolar electrode is difficult because there is fusion and overlapping of signals originating from the muscle and the conduction system. Arrhythmias originating from the conduction system, therefore, are more difficult to map since annotation of the smaller signal within the bigger myocardial signal needs considerable experience and may not always be possible. Assessment of ablation lesions targeting any of these two components remains problematic.
- A distinguishing feature of signals from the conduction system is their high frequency content. This difference allows these signals to be selectively displayed by using a high pass filter.
- However, one of the problems in using a simple linear filter is the transient response to impulse-like signals produced by the myocardium. Large local sharp spikes produced during depolarization will cause the filter to 'ring' at its resonant frequency and produce false positives. Additional processing is required to suppress these unwanted transient responses.
- In the PURE EP system, this can be done as a separately displayed item to show the presence of signals from the conduction system.

Conclusions

- The Bio Sig PURE EP system can be used to simultaneously display the conduction tissue and myocardial signals in normal rhythm and arrhythmia.
- This has great potential in being able to map and ablate complex rhythms arising from the conduction tissue.

Disclosures

D Padmanabhan, A M Killu, C Witt, N Naksuk, C DeSimone, A Sugrue, D Ladewig, S Suddendorf, J Powers – None

T Foxall G - Officer, Trustee, Director, Committee Chair, or Any Other Fiduciary Role; 1; BioSig Technologies

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