Enhanced Electrophysiology Recording Improves Signal Acquisition & Differentiation

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Disclosures

- BioSig Technologies
  - Tom Foxall
  - Sina Fakhar
  - Budimir Drakulic

- Consultants
  - Samuel Asirvatham
  - K L Venkatachalam
Introduction

• Success rate of ablation inadequate
  • Suboptimal ablation techniques
  • Signal acquisition systems
Introduction

• Information from recording system fundamental to diagnosis of arrhythmias
Radiofrequency Interference

Infusion Pump

ECG

Pulse Oximeter

Electroanatomic Mapping System

Data Acquisition System

Ablation Generator

120-240V 50/60 Hz

Earth Ground

Noise current flowing through capacitance and patient

Capacitive coupling from patient to ground
Introduction

150 Hz LPF

1000 Hz LPF

Signal amplitude change with LPF

Signal amplitude change with notch

J.M.T. de Bakker et. al. Circ Arrhythm Electrophysiol. 2010;3:204-213
Introduction

• Current recording systems
  • Restricted dynamic range
  • Low sampling rate
• Amplification
  • Saturation
• Artifact
Aim

To test a new signal recording system (PURE-EP™) against traditional recording system
Typical data acquisition system

64 to 128 Channels

From catheters

Instrumentation Amplifier → Variable Gain Amplifier → High Pass Filter → Low Pass Filter

To Display & Printer

Micro-Processor & Memory → Analog-Digital Converter

From ECG amplifiers

Fix Gain Amplifier → Notch Filter
# System comparison

<table>
<thead>
<tr>
<th></th>
<th>System A</th>
<th>PURE-EP™</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bandwidth</strong></td>
<td>0.05-500 Hz (Based on 977 s/s)</td>
<td>0.05-1,000 Hz</td>
</tr>
<tr>
<td><strong>Sampling rate</strong></td>
<td>977 Samples/sec</td>
<td>2,000 Samples/sec</td>
</tr>
<tr>
<td><strong>Dynamic range</strong></td>
<td>N/A (Noise unknown)</td>
<td>105 dB</td>
</tr>
<tr>
<td><strong>A/D converter</strong></td>
<td>12-bit</td>
<td>24-bit</td>
</tr>
<tr>
<td><strong>Minimum CMRR @ 60 Hz</strong></td>
<td>100 dB</td>
<td>110 dB</td>
</tr>
<tr>
<td><strong>Input impedance</strong></td>
<td>&gt;10⁹ Ω</td>
<td>&gt;500 MΩ</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>1 μV RMS</td>
<td></td>
</tr>
<tr>
<td><strong>Gain</strong></td>
<td>Programmable (From 50-10,000 in 8 steps)</td>
<td>10</td>
</tr>
</tbody>
</table>
Methods

• Canine studies
  • Extensive mapping

• Unipolar & bipolar

• Blazer II 4mm RF catheter

• PURE-EP™ System vs. traditional system
  • Signals recorded simultaneously
## Results

3 acute canine studies

<table>
<thead>
<tr>
<th>Site mapped</th>
<th># times mapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atria</td>
<td>7</td>
</tr>
<tr>
<td>Ventricles</td>
<td>13</td>
</tr>
<tr>
<td>Pulmonary veins</td>
<td>4</td>
</tr>
<tr>
<td>Conduction system</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
</tbody>
</table>
Results

Pulmonary vein
Results

Papillary muscle
Results

Left ventricle

5mV

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

Time (sec)

PURE EP Uni
PURE EP Prox
PURE EP Dist
System A Uni
System A Prox
System A Dist
Results
LV pacing

![Graph showing LV pacing results for System A and PURE EP Uni.](image-url)
Conclusion

• Improved cardiac signal recording
  • Signal-to-noise ratio
  • Visualization of juxtaposed signals
• Likely of value in EP procedures
• Further work needed
Thank you

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Results

Left atrium
Methods
Supplementary RA appendage

Graph showing ECG waveforms labeled as "PURE Uni1," "PURE Bip Prox1," "PURE Bip Dist1," "PURE Uni2," "PURE Bip Prox2," and "PURE Bip Dist2."
Supplementary Papillary muscle
Simultaneous recording

- GE CardioLab
- Live View Monitor
- Review Monitor
- PURE EP System
- MATLAB

ECG/IC Signals

Simultaneous visualization of both recordings