New and Future Technology in the EP Lab

Michael Rochon-Duck, MD
Assistant Clinical Professor
Division of Cardiology, Department of Medicine
University of California, Irvine
Relevant Disclosures

• None!
Bradycardia Pacing
<table>
<thead>
<tr>
<th>Feature</th>
<th>Nanostim LCP</th>
<th>Micra TPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions, mm</td>
<td>42.0 x 5.99</td>
<td>25.9 x 6.7</td>
</tr>
<tr>
<td>Volume, cc</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Weight, g</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sheath Size, Fr</td>
<td>21 OD/ 18 ID</td>
<td>27 OD/ 23 ID</td>
</tr>
<tr>
<td>Battery Longevity, yrs</td>
<td>8.5 – 9.8</td>
<td>4.7 – 9.6</td>
</tr>
<tr>
<td>Fixation Mechanism</td>
<td>Helix</td>
<td>4 Nitinol Tines</td>
</tr>
</tbody>
</table>
Leadless Pacemaker With Atrial Sensing

MARVEL 2. JACC Clin Electrophysiol. 2020 Jan;6(1):94-106
Leadless Pacemaker for ATP
Physiologic Pacing
His-SYNC Pilot Trial

41 patients enrolled and underwent randomization
(1:1)

21 assigned to His-CRT
- 10 crossed over to BiV-CRT
  - Failure to achieve QRS narrowing <130ms = 3
  - No correction due to IVCD = 5
  - Inability to map His = 2

11 received His-CRT per-protocol
16 His-CRT as treatment-received

20 assigned to BiV-CRT
- 1 withdrawal after randomization
- 5 crossed over to His-CRT
  - Unable to cannulate = 2
  - Suboptimal CS target branch = 2
  - Vascular occlusion = 1

14 received BiV-CRT per-protocol
24 BiV-CRT as treatment-received

Heart Rhythm. 2019 Dec;16(12):1797-1807.
His-SYNC: On-Treatment Results

<table>
<thead>
<tr>
<th>Red. in QRS (ms)</th>
<th>CRT Type</th>
<th>Reduction (ms)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BiV-CRT</td>
<td></td>
<td>160 ± 20</td>
<td>0.82</td>
</tr>
<tr>
<td>His-CRT</td>
<td></td>
<td>170 ± 20</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate of echocardiographic response (&gt;5%)</th>
<th>CRT Type</th>
<th>Rate (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BiV-CRT</td>
<td>57%</td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>His-CRT</td>
<td>80%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median change in LVEF (%)</th>
<th>CRT Type</th>
<th>Median (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BiV-CRT</td>
<td></td>
<td>+5.9</td>
<td>0.17</td>
</tr>
<tr>
<td>His-CRT</td>
<td></td>
<td>+7.2</td>
<td></td>
</tr>
</tbody>
</table>

Heart Rhythm. 2019 Dec;16(12):1797-1807.
Conduction system pacing: challenges

- Technical difficulty of implantation
- High long-term thresholds: capture, bundle branch correction
- Need for bespoke device selection and programming
- Optimal patient selection
Left Bundle Branch Pacing

DEEP SEPTAL PACING

RAA
SEP
RV
LV

SCREWDRIVER EFFECT

ENTANGLEMENT EFFECT
Biologic Pacemakers

a) Functional re-engineering
- Ad-KIR2.1AAA
- Ad-HCN
- Ad-HCN+SKM1
- Ad-HCN+KIR2.1AAA

Episomal overexpression of ion channels

HCN channel

Kv2.1 channel

Cardiomyocyte

b) Stem cells
- Embryoid body or iPSCs

Capture by transplanted pacing cells

c) Hybrid gene-cell
- hMSC
- Spontaneous gap-junctional coupling

Cell fusion

Fibroblast

Ad-TBX18

d) Somatic reprogramming
- Reprogramming

iSAN cell

Connexin

Prevention of Sudden Death
Subcutaneous ICD

ImageReady™ MR-Conditional System*1,2
Approved for full-body scans, with no anatomical restrictions in 1.5 tesla MR environments. Device also has an automatic time-out feature available while in MRI protection mode.

*when conditions of use are met

AF Monitor™
Designed to assist in the detection of silent, new onset, or the progression of atrial fibrillation.1 LATITUDE alerts help physicians to monitor and appropriately manage patient's condition.

SMART Pass
SMART Pass is a high pass filter designed to reduce cardiac over-sensing. It has been shown to reduce inappropriate therapy due to cardiac over-sensing by 71% from the EMBLEM device.3
Substernal Extravascular ICD

Coil 1

Ring 1

Coil 2

Ring 2

Test Instrument for Sensing, Pacing, and Defibrillation
Substernal Extravascular ICD: ASD2 Study

- Adequate VF detection in all patients with 16.6 seconds time to therapy
- 80% first-shock defibrillation at 30 J; 95% success with 2 shocks
- All patients with active can emulator had success at 30 J
- Able to pace 97% of patients
- 1 death due to tamponade
Atrial Fibrillation: Diagnostics
STAR Mapping
STAR Mapping: Development in Focal AT

(A)

Left Atrial STAR-Map

Leading pole

Geodesic distance 6cm

(B)
STAR Mapping: Validation in Focal AT
STAR Mapping: Application to AF

- 35 pts
  - 3 pts SR
  - PVI
  - 32 pts
    - 170 maps (84 pre- and 86 post-PVI)
      - (2.4 ± 0.6 maps / pt at each stage)
    - 92 sites Identified
    - 83 Sites Targeted
      - 73/83 (88.0%) Effective
        - 2 in 11 patients
        - 3 in 14 patients
        - 4 in 7 patients
        - 9 ESA not targeted as an earlier site resulted in AF termination
        - 49 CL prolongation ≥30ms
          - 18 organization into AT
          - 6 termination to SR
    - 9 pts AT
    - 6 pts SR
    - 8 pts CL prolongation
STAR Mapping: Initial Results in AF
STAR Mapping: Ditching the Basket
Dipole Density Mapping

A
- Localization Patches & Analog Ground
- Ablation Catheter
- Electrical Reference
- AcQMap Catheter placed in RA/LA
- ECG Electrodes
- Aux Catheters (CS, Circular)

B
- Ablation Interface
- Ablation Generator
- AcQMap Console
- AcQMap Workstation

C
- 48 Low-Impedance High-Fidelity Electrodes
- 48 Ultrasound Transducers
- 10F shaft

D
- Two seconds
- 45 seconds
- 105 seconds
- Final post-processed anatomy

10.1172/jci.insight.126422
Dipole Density, Voltage, and Local Activation
Visual Activation Patterns in AF
Atrial Fibrillation: Therapeutics
Cardiac Electroporation: An Old New Energy Source

- Nonthermal energy source
- Applied current creates a local electrical field
- Circular or petal-like catheters
- Can use DC, AC, or pulsed DC
- Because of much different physics than RF, can create larger and deeper lesions
- Related to DC fulguration, the first energy source used for ablation

Electroporation is Relatively Cardioselective

10.1016/j.hrthm.2015.05.012

10.1161/CIRCEP.116.004672

10.1093/europace/eus171
Cardiac Electroporation
Epicardial Electroporation

A

B

C

D

Electroporation Ablation Effects

### Table 2: Procedural Characteristics of Endocardial and Epicardial Cohorts

<table>
<thead>
<tr>
<th></th>
<th>Endocardial Cohort (n = 15)</th>
<th>Epicardial Cohort (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure time</td>
<td>67.0 ± 10.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Mapping time</td>
<td>41.4 ± 9.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Catheter time</td>
<td>26.0 ± 4.3</td>
<td>50.7 ± 19.5</td>
</tr>
<tr>
<td>Ablation time</td>
<td>19.0 ± 2.5</td>
<td>25.0 ± 17.5</td>
</tr>
<tr>
<td>Fluoroscopy time</td>
<td>12.3 ± 4.0</td>
<td>6.6 ± 3.8</td>
</tr>
<tr>
<td>Isolation success</td>
<td>15/15 (100)</td>
<td>6/7 (86)</td>
</tr>
</tbody>
</table>

Wavefront Tuning Improves PV Isolation Durability

Very High Power, Short Duration

QDOT-FAST. 10.1016/j.jacep.2019.04.009

Near Critical Nitrogen

10.1177/2050312118769797

Heart Rhythm, Vol. 15, No. 5, May Supplement 2018

Lattice RF Catheter

10.1016/j.jacep.2020.01.002
Summary and Take Home Points

• Trends in device therapy toward leadless pacing for traditional pacing targets, currently VVI, shortly will be able to do VDD and DDD

• New pacing targets in the conduction system and endocardial LV

• As PVI has become more reliable in AF ablation, new diagnostic tools are being developed to identify and target arrhythmogenic substrate

• New modalities (esp. electroporation) and advances in RF and cryo to increase safety and efficacy of AF ablation