New Techniques Not Available in Korean Patients: Remote Monitoring, SubQ ICD, Leadless Pacemaker, and His Bundle Pacing

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Remote Monitoring of Health Care
Four sensor health monitoring system

- ECG
- Temperature
- GSR
- PPG

Microcontroller
- ECG trace, HR, HRV
- BP
- Temperature
- GSR
- RR
- SpO₂

Galvanic skin response (GSR)
Wireless Body Area Network (WBAN) for wearable medical sensors

Cardiovascular measurement unit
Measures ECG, HR, HRV

Central BAN node
Collects data from BAN connected sensors
Limited storage and processing
Transmits data to home gateway

Knee Joint monitoring unit
Monitors joints using IMUs, GSR, and temperature

PPG measurement unit
Measures SpO₂, pulse rate and BP

Activity monitoring unit
Measures activity related signal using on body IMUs
Monitors activities.

Home Gateway
Mobile Health for Physical Activity and Atrial Fib.

McConnell, M.V. et al. JACC 2018;71(23):2691-701
# Examples of m Health applications (apps) approved by FDA

<table>
<thead>
<tr>
<th>Mobile applications™</th>
<th>Manufacturer</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Health</td>
<td>Samsung Electronics Co., Ltd.</td>
<td><strong>Step count (pedometer), physiological measurements (HR, BP, weight, SpO2)</strong></td>
</tr>
<tr>
<td>Medapps 2.0 remote patient monitoring system, healthpal, healthcom, mobile link</td>
<td>Medapps Inc., dba Alere connect</td>
<td>Physiological measurements (BP, SpO2). remote health status monitoring (reminders)</td>
</tr>
<tr>
<td>My healthpoint telehealth manager</td>
<td>Entra health systems</td>
<td>Physiological measurements (BP, ECG, body composition/weight SpO2), remote health status monitoring (reminders)</td>
</tr>
<tr>
<td>Healthinterlink beacon</td>
<td>Healthinterlink, LLC.</td>
<td>Physiological measurements (BP, weight, SpO2); remote health status monitoring</td>
</tr>
<tr>
<td>Verizon wireless converged health management device</td>
<td>Cellco partnership d/b/a verizon wireless</td>
<td>Physiological measurements (BP, weight, SpO2); remote health status monitoring</td>
</tr>
<tr>
<td>Vitalconnect platform (consisting of vitalconnect sensor, relay software library and secure server software library)</td>
<td>Vital connect Inc.</td>
<td>Activity (including step count), physiological measurements (HR, ECG, SpO2, RR); remote health status monitoring</td>
</tr>
<tr>
<td>AVIVO™</td>
<td>Medtronic Inc.</td>
<td>ECGs and physiological data including heart rate, heart rate variability, respiration rate, body fluid status, activity and posture</td>
</tr>
<tr>
<td>Mobile Patient Management (MPM) System</td>
<td>Visicu, Inc.</td>
<td>Physiological measurements (including weight, BP, pulse, SpO2, transthoracic impedance)</td>
</tr>
<tr>
<td>Ecare coordinator (ECC)</td>
<td>Optum health care solutions, Inc.</td>
<td>Physiological measurements (BP, SpO2, HR, weight)</td>
</tr>
</tbody>
</table>

Mobile Heart Rhythm Monitors

(A) Leadless patch ECG monitor (Zio, iRhythm Technologies, San Francisco, California), which is placed over the patient’s left pectoral region and can provide continuous ECG monitoring for several weeks. (Image courtesy of iRhythm Technologies.)

(B) An investigational smartphone app (Cardio Rhythm, Cardio, Cambridge, Massachusetts) uses the camera for photoplethysmography (PPG) measurements from the finger. Examples of PPG recordings from a patient in sinus rhythm (top) and a patient in atrial fibrillation (bottom). Adapted with permission from Chan et al. (82).

(C) A Food and Drug Administration–approved wristband (Kardia Band, AliveCor, Mountain View, California) that attaches to a smartwatch (Apple Watch, Apple, Cupertino, California) contains electrodes to acquire a single-lead ECG for arrhythmia detection (image courtesy of AliveCor).

(D) An investigational smartwatch (Verily Study Watch, Verily Life Sciences, San Francisco, California) that combines continuous PPG with electrodes for on-demand single-lead ECG acquisition (image courtesy of Verily Life Sciences).
Cardiogram and AliveCor’s Kardia Band, two existing efforts to bring clinical-grade heart monitoring to the Apple Watch.
High-level data flow making use of m-Health technologies.

Representative Data Flow
Tailoring ICD Remote Monitoring System to Patient Requirements

Proposed Flowchart for Initiation of Remote Monitoring in ICD Candidates

- ICD candidate
- Screening
  - Young/Active patient
  - Need of VT burden monitoring
- CRT
- Traveler
- Choice of the device with attention to RM system available
- Implantation
  - RM activation-Education-Informed consent
  - Tailoring the RM alerts adapted to the patient condition
  - ASAP post implantation
- Generator Change with ICD lead under advisory


CHA Bundang Medical Center, CHA University
Subcutaneous ICD
What is the Subcutaneous ICD?
CHA Bundang Medical Center, CHA University
Outcomes Comparison of S-ICD & TV-ICD Therapy: Device-Related Complications

S-ICD vs. TV-ICD

Advantages
- Extra-vascular

Disadvantages
- No pacing capability
- No advanced diagnostics
- Time to defibrillation

Equivalents
- Pocket infections
- Pulse generator complications
- Inappropriate shocks

Unknowns
- Device longevity
- Long-term safety profile

Recommendations for Subcutaneous Implantable Cardioverter-Defibrillator

References that support the recommendations are summarized in Online Data Supplement 55.

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-NR</td>
<td>1. In patients who meet criteria for an ICD who have inadequate vascular access or are at high risk for infection, and in whom pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated, a subcutaneous implantable cardioverter-defibrillator is recommended (S11.1-1—S11.1-5).</td>
</tr>
<tr>
<td>IIa</td>
<td>B-NR</td>
<td>2. In patients who meet indication for an ICD, implantation of a subcutaneous implantable cardioverter-defibrillator is reasonable if pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated (S11.1-1—S11.1-4).</td>
</tr>
<tr>
<td>III: Harm</td>
<td>B-NR</td>
<td>3. In patients with an indication for bradycardia pacing or CRT, or for whom antitachycardia pacing for VT termination is required, a subcutaneous implantable cardioverter-defibrillator should not be implanted (S11.1-1—S11.1-4,S11.1-6—S11.1-8).</td>
</tr>
</tbody>
</table>

Factors affecting pts selection for the S-ICD

Optimal S-ICD candidate

- Strong indication
  - Young age
  - Primary prevention
  - Poor vascular access
  - Previous infection
  - Infection risk (mechanical valves, diabetes, renal dysfunction)

Relative contraindication
- Need for ATP (difficult to define clinically)

Contraindicated
- Pacing indication (bradycardia or CRT)
- Failed screen (high inappropriate shock risk)

Complication

<table>
<thead>
<tr>
<th>Complication</th>
<th>Patients (n = 882)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device removal for infection</td>
<td>14 (1.6%)</td>
</tr>
<tr>
<td>Systemic blood infection or endocarditis</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Device removal for erosion</td>
<td>6 (0.7%)</td>
</tr>
<tr>
<td>Hematoma requiring evacuation</td>
<td>4 (0.5%)</td>
</tr>
<tr>
<td>Syncope*</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Pocket revision for device migration</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Premature battery depletion</td>
<td>5 (0.6%)</td>
</tr>
<tr>
<td>Inability to communicate with device</td>
<td>3 (0.3%)</td>
</tr>
<tr>
<td>Lead fracture</td>
<td>0 (0.0%)</td>
</tr>
</tbody>
</table>
**EFFORTLESS**: Inappropriate shock  
→ SVT/AF: 1.5% at 1 year, 2.3% at 3 years

Kadish A, Dyer A et al., NEJM 2004; 350: 2151-2158  
Pocle JE et al. NEJM September 4, 2008; 359: 1009-1017  
Netherlands Heart Journal December 2018, Volume 26, Issue 12, pp 612-619
The PRAETORIAN score

- **Step 1)**
  Determine the number of coil widths of fat tissue between the nearest half of the S-ICD coil and the sternum or ribs.
  - $\leq 1$ coil-widths: 30
  - $>1 \leq 2$ coil-widths: 60
  - $>2 \leq 3$ coil-widths: 90
  - $>3$ coil-widths: 150

- **Step 2)**
  Determine the position of the S-ICD generator in relation to the mid-line (red line).
  - Generator is on or posterior of the mid-line $\times 1$
  - Entire generator is anterior of the mid-line $\times 2$
  - Entire generator is $>1/2$ length anterior $\times 4$

- **Step 3)**
  Determine the amount of fat tissue between the nearest point of the generator and the thoracic wall.
  - $<1$ generator-width $\times 1$
  - $\geq 1$ generator-width $\times 1.5$

**Final PRAETORIAN score**

- $<90$: Low risk of conversion failure
- $90 < 150$: Intermediate risk of conversion failure
- $\geq 150$: High risk of conversion failure

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CHA Bundang Medical Center, CHA University
Chest radiography requirements to apply the PRAETORIAN score
S-ICD coil position in patients with a high BMI.

A: Suboptimal S-ICD coil placement, resulting in a high PRAETORIAN score (150).

B: Optimal S-ICD coil placement, resulting in a low PRAETORIAN score (30–.90).
Leadless pacemaker
An Overview of the History of Cardiac Pacing

Paradigm Shifts in Cardiac Pacemakers

1950s
AC-powered pacemakers tethered to an extension cord (Furman)

1950s
Battery-powered transistorized “wearable” pacemakers (Lillehei/Bakken)

1958
First fully implantable pacemaker (Elmqvist/Senning)

2015
Implantable pacemaker—basic system had not evolved significantly

2016
Leadless pacemaker—the entire device is placed within cardiac chambers

Future
Batteryless devices, which harvest cardiac motion to power pacing circuits

Mulpuru, S.K. et al. JACC 2017; 69(2) : 189-210
### Overview of leadless pacemaker systems and implant

#### Nanostim LCP
- **Dimensions (mm)**: 42.0 x 5.99
- **Volume (cc), weight (g)**: 1.2
- **Sheath size (French)**: 18 (id)/ 21 (od)
- **Fixation mechanism**: Screw-in helix
- **Pacing mode**: VVI(R)
- **Rate Response Sensor**: Temperature
- **Communication**: Conductive (250kHz)
- **Battery longevity (yrs)**: 8.5-9.8

#### Micra TPS
- **Dimensions (mm)**: 25.9 x 6.7
- **Volume (cc), weight (g)**: 0.8, 2
- **Sheath size (French)**: 23 (id) / 27 (od)
- **Fixation mechanism**: Nitinol tines
- **Pacing mode**: VVI(R)
- **Rate Response Sensor**: 3-axis accelerometer
- **Communication**: Radio-frequency
- **Battery longevity (yrs)**: 4.7-9.6

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# Overview of Retrieval Data of Leadless Pacemaker Therapy

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Leadless Pacemaker</th>
<th>Year of Publication</th>
<th>First Author</th>
<th>Number</th>
<th>Time LP in situ (mean)</th>
<th>Extraction Success Rate</th>
<th>Reason Unsuccessful Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-clinical</td>
<td>Nanostim</td>
<td>2014</td>
<td>Koruth</td>
<td>10</td>
<td>160 days</td>
<td>100 %</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.3 years</td>
<td>100 %</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2014</td>
<td>Bonner</td>
<td>4</td>
<td>28 months</td>
<td>75 % (3)</td>
<td>Complete encapsulation of device</td>
</tr>
<tr>
<td>Clinical</td>
<td>Nanostim</td>
<td>2016</td>
<td>Jung</td>
<td>1</td>
<td>506 days</td>
<td>100 %</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Nanostim</td>
<td>2016</td>
<td>Reddy</td>
<td>5</td>
<td>&lt;6 weeks</td>
<td>100 %</td>
<td>The docking feature could not be reached.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>&gt;6 weeks</td>
<td>91 % (10)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nanostim</td>
<td>2017</td>
<td>Lakkireddy</td>
<td>73</td>
<td>1.7 years</td>
<td>90.4 % (66)</td>
<td>The docking button could not be reached in six cases. In one case, the docking button detached.</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2017</td>
<td>Tjong and Reddy</td>
<td>10</td>
<td>229 and 259 days*</td>
<td>80 % (8)</td>
<td>Unable to be removed due to fluoroscopy malfunction</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2016</td>
<td>Karim</td>
<td>1</td>
<td>3 weeks</td>
<td>100 %</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2016**</td>
<td>Giocondo</td>
<td>1</td>
<td>228 days</td>
<td>0 %</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2016</td>
<td>Koay</td>
<td>1</td>
<td>1 month</td>
<td>100 %</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Micra TPS</td>
<td>2016</td>
<td>Gerdes</td>
<td>1</td>
<td>Intraprocedural</td>
<td>100 %</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*LP = leadless pacemaker; N/A = not applicable; TPS = transcatheter pacing system. *In unsuccessful attempt cases used source: Micra Transcatheter Pacing System, 2016.* **Heart Rhythm Society, 2016.**
Kaplan-Meier curve illustrates that pts with LCPs were at a lower risk of experiencing a complication than were patients with TVPs.

Adjusted HR: 0.44; 95% CI (0.32-0.60); p<0.001
Short-term complication rates presented per category for patients with leadless pacemaker and patients with transvenous pacemaker.

**Short-term Complications (Within 1 Month of Implant)**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Nanostim™ Leadless Pacemaker (Leadless II IDE)</th>
<th>Transvenous Pacemaker (MarketScan®)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrode Dislodgement</td>
<td>0.97%</td>
<td>3.27%</td>
</tr>
<tr>
<td>Vascular</td>
<td>0.42%</td>
<td>3.62%</td>
</tr>
<tr>
<td>Cardiac Perforation/Pericardial Effusion</td>
<td>0.35%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Generator Complication</td>
<td>0.70%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Thoracic Trauma</td>
<td>1.53%</td>
<td>1.74%</td>
</tr>
<tr>
<td>Lead Complication</td>
<td>0.00%</td>
<td>0.42%</td>
</tr>
<tr>
<td>Infection</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Pocket Complication</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
Mid-term complication rates presented per category for patients with leadless pacemaker and patients with transvenous pacemaker.
## Overview of implantation outcomes & safety data

<table>
<thead>
<tr>
<th></th>
<th>LEADLESS, n</th>
<th>%</th>
<th>LEADLESS II, n</th>
<th>%</th>
<th>Micra TPS, n</th>
<th>%</th>
<th>Micra postapproval registry, n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>33</td>
<td></td>
<td>526</td>
<td>504</td>
<td>725</td>
<td>719</td>
<td>795</td>
<td>792</td>
</tr>
<tr>
<td>Implantation success</td>
<td>32</td>
<td>97.0</td>
<td>504</td>
<td>95.8</td>
<td>719</td>
<td>99.2</td>
<td>792</td>
<td>99.6</td>
</tr>
</tbody>
</table>

### Electrical performance

<table>
<thead>
<tr>
<th></th>
<th>LEADLESS, n</th>
<th>%</th>
<th>LEADLESS II, n</th>
<th>%</th>
<th>Micra TPS, n</th>
<th>%</th>
<th>Micra postapproval registry, n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline R-wave amplitude, mV</td>
<td>8.3</td>
<td></td>
<td>7.8</td>
<td></td>
<td>11.2</td>
<td></td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Follow-up R-wave amplitude, mV</td>
<td>10.6 (3 months)</td>
<td>9.2 (12 months)</td>
<td>15.5 (24 months)</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Complications

<table>
<thead>
<tr>
<th></th>
<th>LEADLESS, n</th>
<th>%</th>
<th>LEADLESS II, n</th>
<th>%</th>
<th>Micra TPS, n</th>
<th>%</th>
<th>Micra postapproval registry, n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac effusion or perforation</td>
<td>1</td>
<td>3.0</td>
<td>6</td>
<td>1.1</td>
<td>11</td>
<td>1.5</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>requiring intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep vein thrombosis or pulmonary</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
<td>0.2</td>
<td>2</td>
<td>0.3</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>embolism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vascular complications</td>
<td>NA</td>
<td></td>
<td>7</td>
<td>1.3</td>
<td>5</td>
<td>0.7</td>
<td>6</td>
<td>0.8</td>
</tr>
<tr>
<td>Device dislocation</td>
<td>0</td>
<td>0.0</td>
<td>6</td>
<td>1.1</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Pacing threshold elevation requiring</td>
<td>0</td>
<td>0.0</td>
<td>4</td>
<td>0.8</td>
<td>2</td>
<td>0.3</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Major indications & contraindications of leadless pacemakers

Indications
- Chronic atrial fibrillation with AV block or significant pauses
- Sinus rhythm with high grade AV block with low level of physical activity
- Sinus bradycardia with infrequent pauses
- Unexplained syncope with abnormal electrophysiological findings such as prolonged HV interval

Contraindications
- Mechanical tricuspid valve
- Pre-existing endocardial pacing or defibrillation leads
- Inferior vena cava filter
- Hypersensitivity to dexamethasone acetate
- Unfavorable femoral venous anatomy
- Morbid obesity preventing implanted device from obtaining telemetry communication
- Pacemaker syndrome
- Pre-existing severe pulmonary hypertension
His Bundle Pacing
His Bundle Pacing: Conduction System and Outcomes

A. The Conduction System

B. Combined Endpoint of Death, Heart Failure Hospitalization, or Upgrade to Biventricular Pacing
Potential of His Bundle Pacing

Intrinsic Cardiac Activation
(Narrow or Broad QRS)

Available Pacing Options

- RV Pacing
  (Never narrow QRS (~160-180ms))

- BiV Pacing
  (Never narrow QRS (~120-140ms))

- His-Bundle Pacing
  (Maintenance/Restore narrow QRS (~90-120ms))

Narrow QRS
Left Bundle Branch Block
Narrow QRS Long PR interval

Improvements in QRS duration, LV activation time and ventricular synchrony
Anatomic Variations of the His Bundle
Atrioventricular node ablation (AVNA) site in relation to HBP electrodes

Schematic representation of the successful ablation sites is shown. Two patients required left-sided ablation. HBP, His bundle pacing lead; TV, tricuspid valve; CS, coronary sinus.
Longitudinal Dissociation Within the His Bundle
## Permanent His Bundle Pacing in AV Node Ablation/AV Block

<table>
<thead>
<tr>
<th>First Author, Year (Ref. #)</th>
<th>Design</th>
<th>Follow-up (Months)</th>
<th>N</th>
<th>Indication</th>
<th>Success (%)</th>
<th>Important Characteristics</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deshmukh et al., 2000 (5)</td>
<td>Observational</td>
<td>36</td>
<td>18</td>
<td>AV node ablation</td>
<td>66</td>
<td>Chronic AF, LVEF &lt;40%, QRS duration &lt;120 ms</td>
<td>Improvement in LV dimensions, NYHA functional class, and LVEF</td>
</tr>
<tr>
<td>Deshmukh et al., 2004 (35)</td>
<td>Observational</td>
<td>42</td>
<td>54</td>
<td>AV node ablation</td>
<td>72</td>
<td>Chronic AF, LVEF &lt;40%, QRS duration &lt;120 ms</td>
<td>Improved LVEF, NYHA functional class, peak VO₂</td>
</tr>
<tr>
<td>Occhetta et al., 2006 (36)</td>
<td>Randomized, 6 months, crossover RVP vs. HBP</td>
<td>12</td>
<td>18</td>
<td>AV node ablation</td>
<td>94</td>
<td>Chronic AF, QRS &lt;120 ms</td>
<td>Improvement in NYHA functional class, 6MWT, QOL, and hemodynamics</td>
</tr>
<tr>
<td>Huang et al., 2017 (28)</td>
<td>Observational</td>
<td>20</td>
<td>52</td>
<td>AV node ablation</td>
<td>81</td>
<td>Chronic AF, CHF</td>
<td>Improvement in LV dimensions, NYHA functional class, and LVEF</td>
</tr>
<tr>
<td>Vijayaraman et al., 2017 (37)</td>
<td>Observational</td>
<td>19</td>
<td>42</td>
<td>AV node ablation</td>
<td>95</td>
<td>Paroxysmal or persistent AF, CHF</td>
<td>Improvement in NYHA functional class, LVEF</td>
</tr>
<tr>
<td>Barba-Pichardo et al., 2010 (41)</td>
<td>Prospective</td>
<td>&gt;3</td>
<td>91</td>
<td>AV nodal 65 infranodal 26</td>
<td>68</td>
<td>182 patients with AV block mapped with EP catheter</td>
<td>5% lead failure</td>
</tr>
<tr>
<td>Kronborg et al., 2014 (40)</td>
<td>Randomized crossover HBP vs. RVSP</td>
<td>24</td>
<td>38</td>
<td>AV nodal block</td>
<td>84</td>
<td>AV block, baseline narrow QRS, LVEF &gt;40%</td>
<td>Improvement in LVEF, no significant improvement in functional class, 6MWT, QOL</td>
</tr>
<tr>
<td>Pastore et al., 2015 (58)</td>
<td>Retrospective</td>
<td>12</td>
<td>148</td>
<td>AV nodal 100 infranodal 48</td>
<td></td>
<td>High-grade AVB, Paroxysmal AF</td>
<td>HBP associated with lower risk of AF progression compared with RV pacing</td>
</tr>
<tr>
<td>Vijayaraman et al., 2015 (29)</td>
<td>Observational</td>
<td>19</td>
<td>100</td>
<td>AV nodal 46 infranodal 54</td>
<td>93</td>
<td>High-grade AV block, no back-up RV pacing</td>
<td>High success in infranodal block. Lead failure 5%</td>
</tr>
</tbody>
</table>

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Thank You For Your Attention!