Indications, Implant Strategies and Evolving Role of His Bundle Pacing

Jinhee Ahn, MD.
Pusan National University Hospital
Contents

• **Background** of His bundle pacing

• **How to implant** a His bundle lead & **EGM/ECG**

• **Ideal candidate** for His bundle pacing based on **clinical data**
Contents

• **Background** of His bundle pacing

• How to implant a His bundle lead & EGM/ECG

• Ideal candidate for His bundle pacing based on clinical data
Current common ventricular pacing modes

• RV apical pacing
  • Still the most common form of pacing

• RV septal pacing
  • Due to concern related to RV apical pacing

• Biventricular pacing
  • Mainly derived from HF and LBBB patients
Atrial-based (AAI or DDD) vs. ventricular-based pacing

Atrial fibrillation rate

<table>
<thead>
<tr>
<th>Study</th>
<th>Physiologic</th>
<th>Ventricular</th>
<th>Wt %</th>
<th>HR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danish</td>
<td>26/110</td>
<td>40/115</td>
<td>4.5</td>
<td>0.54 [0.33, 0.89]</td>
</tr>
<tr>
<td>CTOPP</td>
<td>224/1094</td>
<td>367/1474</td>
<td>40.3</td>
<td>0.8 [0.68, 0.95]</td>
</tr>
<tr>
<td>PASE</td>
<td>35/203</td>
<td>38/204</td>
<td>5.3</td>
<td>0.91 [0.57, 1.44]</td>
</tr>
<tr>
<td>MOST</td>
<td>217/1014</td>
<td>270/996</td>
<td>34.9</td>
<td>0.79 [0.66, 0.94]</td>
</tr>
<tr>
<td>UKPACE</td>
<td>98/1012</td>
<td>111/1009</td>
<td>15.1</td>
<td>0.88 [0.67, 1.16]</td>
</tr>
<tr>
<td>Overall</td>
<td>600/3433</td>
<td>826/3798</td>
<td>100</td>
<td>0.8 [0.72, 0.89]</td>
</tr>
</tbody>
</table>

Association: chi-square = 17.71, p = 2.6e-05

Favor atrial-based pacing

Stroke rate

<table>
<thead>
<tr>
<th>Study</th>
<th>Physiologic</th>
<th>Ventricular</th>
<th>Wt %</th>
<th>HR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danish</td>
<td>12/110</td>
<td>21/115</td>
<td>7.5</td>
<td>0.54 [0.27, 1.1]</td>
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<tr>
<td>CTOPP</td>
<td>62/1094</td>
<td>90/1474</td>
<td>36.2</td>
<td>0.92 [0.67, 1.27]</td>
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<td>PASE</td>
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<td>7/204</td>
<td>2.5</td>
<td>0.55 [0.16, 1.88]</td>
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<tr>
<td>MOST</td>
<td>41/1014</td>
<td>49/996</td>
<td>22</td>
<td>0.82 [0.54, 1.25]</td>
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<td>UKPACE</td>
<td>58/1012</td>
<td>72/1009</td>
<td>31.7</td>
<td>0.8 [0.56, 1.12]</td>
</tr>
<tr>
<td>Overall</td>
<td>177/3433</td>
<td>239/3798</td>
<td>100</td>
<td>0.81 [0.67, 0.99]</td>
</tr>
</tbody>
</table>

Association: chi-square = 4.44, p = 0.035

Favor atrial-based pacing

Circulation 2006;114:11-17.
Worse effects of higher V pacing burden (40%)

**HF hospitalization (DDDR)**

**AF rate (DDDR)**

**ICD without pacing lx, EF < 40%**

<table>
<thead>
<tr>
<th>ECG (6 mo After Randomization)</th>
<th>VVI (n = 137)</th>
<th>DDDR (n = 140)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus, No./total (%)</td>
<td>133/137 (97.1)%</td>
<td>58/138 (42.0)%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Paced, No. (%)</td>
<td>5 (3.6)</td>
<td>100 (71.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Atrial</td>
<td>2 (1.5)</td>
<td>83 (59.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Ventricular</td>
<td>4 (2.9)</td>
<td>78 (55.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Atrial fibrillation/flutter, No. (%)</td>
<td>0</td>
<td>3 (2.1)</td>
<td>.09</td>
</tr>
<tr>
<td>PR, mean (SD), ms</td>
<td>189 (43)</td>
<td>174 (34)</td>
<td>.004</td>
</tr>
<tr>
<td>QRS, mean (SD), ms</td>
<td>117 (29)</td>
<td>134 (39)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>QTc, mean (SD), ms</td>
<td>434 (38)</td>
<td>452 (56)</td>
<td>.002</td>
</tr>
</tbody>
</table>

**Death or HF (DDDR-70 > VVI-40)**

*Circulation* 2003;107:2932-7; *JAMA* 2002;288:3115-23.
RV apical pacing

• Mechanisms by which RV apical pacing causes HF and AF.
RV apical vs. non-apical (septal or OT) pacing

• In meta-analysis, non-apical pacing showed
  • Similar complication rate
  • Better LVEF (+4.27%) after >12mon, but only in LVEF < 45%
  • Exercise capacity, functional class, QoL – inconclusive
  • “non-apical pacing site” - heterogeneous

• 2013 ESC pacing guideline says,
  “The Task Force is unable to give definite recommendations regarding pacing site until the results of larger trials become available.”

*Europace 2012;14:81-91; Europace 2010;12:1739-44; EHJ 2015;36:856-62; 2013 ESC pacing guideline*
Benefits from BiV-CRT (cardiac resynchronization therapy)

- Recommendation / evidence level for BiV-CRT implantation
  - SR, EF ≤ 35%, NYHA II-IV, **LBBB**, QRS ≥ 150ms - IA
  - SR, EF ≤ 35%, NYHA II-IV, LBBB, QRS ≥ 120ms - IB
  - SR, EF ≤ 35%, NYHA II-IV, non-LBBB, QRS ≥ 150ms - IIaB
  - SR, EF ≤ 35%, NYHA II-IV, non-LBBB, QRS ≥ 120ms - IIbB

- 1/3 of BiV-CRT : non-responders

*Circ AE 2014;7:968-77; Circulation 2011;123:1061-72; 2013 ESC pacing guideline; 2012 ACC/AHA guideline*
Needs for more “physiologic” pacing site

“His Bundle Pacing (HBP)”

- Conduction through native H-P system
- Most physiological form of ventricular pacing
- No pacing induced dyssynchrony

[Cardiac conduction system]
First clinical HBP case series

### Permanent, Direct His-Bundle Pacing

A Novel Approach to Cardiac Pacing in Patients With Normal His-Purkinje Activation

Pramod Deshmukh, MD; David A. Casavant, MS; Mary Romanyszyn, CRNP; Kathleen Anderson, BSN

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Preablation Heart Rate, bpm</th>
<th>Native QRS Width, ms</th>
<th>Paced QRS Width, ms</th>
<th>H-V Interval, ms</th>
<th>Vp-V Interval, ms</th>
<th>Sensed Potential, mV</th>
<th>Voltage at 0.5 ms, V</th>
<th>Resistance, ohms</th>
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<tbody>
<tr>
<td>1</td>
<td>160</td>
<td>86</td>
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<td>469</td>
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<tr>
<td>2</td>
<td>58</td>
<td>92</td>
<td>88</td>
<td>78</td>
<td>72</td>
<td>1.4</td>
<td>2.5</td>
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<tr>
<td>3</td>
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<td>74</td>
<td>72</td>
<td>58</td>
<td>62</td>
<td>1.4</td>
<td>3.7</td>
<td>513</td>
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<td>120</td>
<td>100</td>
<td>52</td>
<td>60</td>
<td>3.4</td>
<td>2.0</td>
<td>505</td>
</tr>
<tr>
<td>7</td>
<td>109</td>
<td>88</td>
<td>90</td>
<td>72</td>
<td>74</td>
<td>1.4</td>
<td>1.6</td>
<td>549</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>110</td>
<td>106</td>
<td>56</td>
<td>72</td>
<td>2.0</td>
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<td>100</td>
<td>54</td>
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<td>3.2</td>
<td>395</td>
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<td>52</td>
<td>112</td>
<td>92</td>
<td>76</td>
<td>70</td>
<td>1.0</td>
<td>1.6</td>
<td>448</td>
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<tr>
<td>12</td>
<td>100</td>
<td>96</td>
<td>108</td>
<td>44</td>
<td>36</td>
<td>3.0</td>
<td>0.6</td>
<td>479</td>
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<tr>
<td>Mean</td>
<td>103</td>
<td>95.0</td>
<td>92.8</td>
<td>61.8</td>
<td>65.8</td>
<td>1.7</td>
<td>2.4</td>
<td>488</td>
</tr>
<tr>
<td>SD</td>
<td>30</td>
<td>13.4</td>
<td>10.8</td>
<td>10.3</td>
<td>14.3</td>
<td>0.8</td>
<td>1.0</td>
<td>86</td>
</tr>
</tbody>
</table>

Contents

- Background of His bundle pacing

- How to implant a His bundle lead & EGM/ECG

- Ideal candidate for His bundle pacing based on clinical data
Criteria of RAE

Preparation – implanting tools and system

SelectSecure® 3830 lead (4.1 Fr exposed helix screw)

EP recording system

Interrogator

C315HIS sheath (non-deflectable)

C304 deflectable sheath
Anatomy types of His bundle

Type I (47%)

Type II (32%)

Type III (21%)
Venous access
7Fr sheath insertion
C315 advanced to RA/RV over wire
3830 lead advanced to tip of sheath
Unipolar mapping connections

Map for His
Can’t find His
His signal recorded

Use C304 sheath to direct lead to His location
Reshape the C315
Use combination with pace mapping
Fix lead and assess response/parameters

Courtesy of Dr. Sharma
Mapping the His bundle with imaging

Criteria of RAE

Atrial enlargement

Mapping the His bundle with imaging

Mapping the His bundle with imaging

Using right atrial septogram

His bundle mapping with EP catheter

Criteria of RAE
- Atrial enlargement

Using right atrial septogram

Courtesy of Dr. Acosta

His bundle mapping with EP catheter

Courtesy of Dr. Susan Kim
<table>
<thead>
<tr>
<th></th>
<th>Normal His-Purkinje system</th>
<th>Diseased His-Purkinje system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>with BBB correction</td>
<td>without BBB correction</td>
</tr>
<tr>
<td><strong>Selective HBP</strong></td>
<td>S-QRS = H-QRS with isoelectric interval</td>
<td>S-QRS ≤ H-QRS with isoelectric interval</td>
</tr>
<tr>
<td></td>
<td>Discrete local ventricular EGM</td>
<td>Discrete V EGM</td>
</tr>
<tr>
<td></td>
<td>Paced = native QRS</td>
<td>Paced ≤ native QRS</td>
</tr>
<tr>
<td></td>
<td>Single capture threshold (HB)</td>
<td>2 distinct capture threshold (HB with or without BBB correction)</td>
</tr>
<tr>
<td><strong>Non-selective HBP</strong></td>
<td>S-QRS &lt; H-QRS</td>
<td>S-QRS &lt; H-QRS</td>
</tr>
<tr>
<td></td>
<td>Pseudodelta wave +/-</td>
<td>Pseudodelta wave +/-</td>
</tr>
<tr>
<td></td>
<td>Direct captured local ventricular EGM</td>
<td>Direct captured local ventricular EGM</td>
</tr>
<tr>
<td></td>
<td>Paced &gt; native QRS</td>
<td>Paced ≤ native QRS</td>
</tr>
<tr>
<td></td>
<td>2 distinct capture thresholds (HB, RV)</td>
<td>3 distinct capture thresholds (HB with BBB, HB without BBB, RV)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 distinct capture thresholds (HB with BBB, RV capture)</td>
</tr>
</tbody>
</table>
Selective His bundle pacing

- Pure His bundle area capture
- S-QRS = H-QRS
- Paced QRS = native QRS
- Isoelectric interval & discrete local V EGM (activation of tissue by intrinsic wave front)
- Single capture threshold (HB)

Non-selective His bundle pacing

- Simultaneous His + RV capture
- Local V myocardial capture on His lead
- S-QRS (0ms) < H-QRS
- Paced QRS > native QRS
- Two capture thresholds (HB : increased S-A, RV)

Non-selective (HB+RV) to selective (HB) HBP
Electrical synchrony of HBP
Selectie vs. non-selective HBP

- No differences in hemodynamic improvements
  - Inter- or intraventricular dyssynchrony, myocardiac performance index,..
## Selective vs. non-selective HBP

### Table: Direct His-bundle Pacing (N = 63) vs. Para-Hisian Pacing (N = 150)

<table>
<thead>
<tr>
<th>Visit</th>
<th>Selective HBP</th>
<th>Non-selective HBP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pacing Threshold, V</td>
<td>Sensing Wave, mV</td>
</tr>
<tr>
<td></td>
<td>2.5 ± 2.3</td>
<td>3.4 ± 1.0</td>
</tr>
<tr>
<td>Implant</td>
<td>2.8 ± 2.8</td>
<td>4.8 ± 3.6</td>
</tr>
<tr>
<td>6 months</td>
<td>2.7 ± 2.8</td>
<td>4.6 ± 3.0</td>
</tr>
<tr>
<td>12 months</td>
<td>3.2 ± 2.9</td>
<td>5.8 ± 3.0</td>
</tr>
<tr>
<td>24 months</td>
<td>1.3 ± 1.1†</td>
<td>11.3 ± 5.2†</td>
</tr>
<tr>
<td></td>
<td>1.8 ± 1.6*†</td>
<td>9.6 ± 6.0†</td>
</tr>
<tr>
<td></td>
<td>1.6 ± 1.2†</td>
<td>9.5 ± 6.6†</td>
</tr>
<tr>
<td></td>
<td>1.6 ± 1.5†</td>
<td>11.1 ± 5.8†</td>
</tr>
</tbody>
</table>

*Statistically significant difference between groups.
†Significantly different from baseline.
Selective vs. non-selective HBP

Advancing LV activation time

Selective vs. non-selective HBP

• **Selective (n=118) vs. Non-selective (n=232)**
• Clinical outcome – all cause mortality or HF hospitalization (3mon f/u)

• **Results**
  • Selective – 35%
  • Non-selective – 19%
  • HR 1.38 (p=0.17)  *SAME*

ECG after His bundle pacing

85-yr patient with CAVB after TAVI, underlying RBBB

A: Before TAVI
   - ECG with normal sinus rhythm

B: Temporary pacing
   - ECG with atrial pacing

C: During HBP
   - ECG with His bundle pacing

D: Radiographic image of His bundle lead placement

E: Radiographic image with His bundle lead in place

Criteria of RAE

BBB correction by HBP

Courtesy of Dr. Vijayaraman
Suggested mechanisms of BBB correction

*The exact mechanism – still uncertain*

- **Longitudinal dissociation in the His bundle**
  - Pre-destination of fibers
  - Localized intra/inter-Hisian disease

- **Left bundle conduction delay**
  - Reset/accelerate with pacing impulse
  - Source-sink relationships during pacing vs. intrinsic impulse propagation

- **Left bundle block – proximal / high**
  - Virtual electrode polarization effect

Suggested mechanisms of BBB correction

*The exact mechanism – still uncertain*

- Longitudinal dissociation in the His bundle
  - Pre-destination of fibers
  - Localized intra/inter-Hisian disease

Pacing distal to block/delay site can recruit fibers predestined to be the BB

AVN → His → RBB, LBB

Longitudinal dissociation in the His bundle

Criteria of RAE

Atrial enlargement

Longitudinal dissociation in the His bundle

NS-HBP (RB+LB+RV)

S-HBP (RB+LB)

S-HBP (RB only)

2.0V

1.5V

1.0V

Heterogeneous septal conduction in LBBB pattern

- Sites of conduction block and QRS correction rate in LBBB pattern on surface ECG

Circulation 2019;139:1876-88.
Programming considerations for HBP

• **Pacing threshold**
  • Much higher than RV → battery issue
  • Higher capture threshold → offset by pulse width at 1ms
  • No absolute threshold cutoff, but > 3V/1ms or significant differences between uni- and bipolar should be avoided.
  • Do not use automatic threshold testing algorithms.
  • Always utilize 12-lead ECG

• **Sensing**
  • Lead location at TA adjacent to the fibrous membranous septum → the amplitude is low
  • Be careful of atrial or ventricular over- or undersensing

Lead Fixation

Turn clockwise to drive fixed screw tip into tissue

Withdraw and slit sheath allowing adequate slack

Courtesy of Dr. S. Kim, HRS 2018
Too much slack of HB lead

Successful implantation of HBP

Outcomes

• Changes of electrical parameters

<table>
<thead>
<tr>
<th>Visit</th>
<th>RVP</th>
<th>Threshold (V)</th>
<th>R wave (mV)</th>
<th>Impedance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant</td>
<td>98</td>
<td>0.62 ± 0.5</td>
<td>13.7 ± 5.7</td>
<td>754 ± 167</td>
</tr>
<tr>
<td>1 year</td>
<td>88</td>
<td>0.80 ± 0.3</td>
<td>12.7 ± 5.6</td>
<td>585 ± 128†</td>
</tr>
<tr>
<td>2 years</td>
<td>77</td>
<td>0.80 ± 0.4</td>
<td>15.2 ± 6.6</td>
<td>515 ± 136</td>
</tr>
<tr>
<td>5 years</td>
<td>58</td>
<td>0.84 ± 0.4†</td>
<td>13.3 ± 5.7</td>
<td>468 ± 117</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>HBP</th>
<th>n</th>
<th>Threshold (V)</th>
<th>R wave (mV)</th>
<th>Impedance (Ω)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>75</td>
<td>1.35 ± 0.9*</td>
<td>6.8 ± 5.3*</td>
<td>639 ± 159</td>
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<tr>
<td></td>
<td>66</td>
<td>1.60 ± 0.9*</td>
<td>6.7 ± 5.7*</td>
<td>476 ± 121†</td>
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<tr>
<td></td>
<td>61</td>
<td>1.50 ± 0.8*†</td>
<td>7.0 ± 6.0*</td>
<td>465 ± 75</td>
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<tr>
<td></td>
<td>51</td>
<td>1.62 ± 1.0*†</td>
<td>7.2 ± 5.2*</td>
<td>463 ± 78</td>
</tr>
</tbody>
</table>

Pacing threshold tested at 0.5-ms pulse duration.

• Overall successful implant rate : 84.8%
• Learning curve : 10 cases ...?
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Patient selection

• Patients at **high risk for pacing-induced cardiomyopathy**

  4. In patients with atrioventricular block who have an indication for permanent pacing with a LVEF between 36% and 50% and are expected to require ventricular pacing more than 40% of the time, it is reasonable to choose pacing methods that maintain **physiologic ventricular activation** (e.g., cardiac resynchronization therapy [CRT] or His bundle pacing) over right ventricular pacing (S6.4.4.1-7, S6.4.4.1-11–S6.4.4.1-19).

• Patients with **BBB** and resulting **ventricular dyssynchrony**

• Patients with a narrow QRS undergoing **AVN ablation**

• **BiV-CRT nonresponders** or patients with **failed LV lead** (rescue)

• **NOT** helpful in patients with intact purkinje activation, distal conduction disease, or extensive LV scar

Patient selection

- Patients at high risk for pacing-induced cardiomyopathy
- Patients with BBB and resulting ventricular dyssynchrony
- Patients with a narrow QRS undergoing AVN ablation
- BiV-CRT nonresponders or patients with failed LV lead (rescue)

- NOT helpful in patients with intact Purkinje activation, distal conduction disease, or extensive LV scar

How good is HBP than other pacing technique?
Clinical Outcomes of His Bundle Pacing Compared to Right Ventricular Pacing

Mohamed Abdelrahman, MD, Faiz A. Subzposh, MD, Dominik Beer, DO, Brendan Durr, DO, Angela Naperkowskis, RN, CEPS, CCDS, Haiyan Sun, MS, Jess W. Oren, MD, Gopi Dandamudi, MD, Pugazhendhi Vijayaraman, MD

Primary Outcome (Death, Heart Failure Hospitalization, or Upgrade to Biventricular Pacing)

P = 0.02
HR = 0.65

### HBP studies in CRT eligible patients

#### Table 1

<table>
<thead>
<tr>
<th>Study Name</th>
<th>Design</th>
<th>Study Population</th>
<th>Total Attempted Procedures</th>
<th>Success Rate (Recruitment of BBB) Using PHBP</th>
<th>Outcomes</th>
</tr>
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<tbody>
<tr>
<td>Barba-Pichardo et al, 16 2013</td>
<td>Prospective</td>
<td>PHBP attempted in pts with failed LV lead placement</td>
<td>16</td>
<td>9</td>
<td>Improvement in NYHA class; improvement in LVEF and LV dimensions</td>
</tr>
<tr>
<td>Lustgarten et al, 17 2015</td>
<td>Crossover</td>
<td>PHBP and LV leads in all patients undergoing CRT</td>
<td>29</td>
<td>21</td>
<td>Significant improvements in ejection fraction, functional status, 6-min walk distance with both PHBP and BVP in 12 pts who completed the crossover</td>
</tr>
<tr>
<td>Su et al, 18 2015</td>
<td>Prospective</td>
<td>PHBP in pts with indication for CRT</td>
<td>16</td>
<td>29</td>
<td>Tested various pacing configurations and showed lower pacing thresholds using a bipolar HB lead and RV lead configuration</td>
</tr>
<tr>
<td>Ajijola et al, 19 2017</td>
<td>Prospective</td>
<td>PHBP attempted in pts with failed LV lead placement</td>
<td>21</td>
<td>16 (76%)</td>
<td>Improvement in LVEF and dimensions</td>
</tr>
<tr>
<td>Sharma et al, 20 2018</td>
<td>Prospective, multicenter</td>
<td>Failed LV lead placement (rescue CRT); primary HBP in pts with all indications for CRT</td>
<td>106</td>
<td>95 (90%)</td>
<td>Improvement in NYHA functional class; improvement in LVEF</td>
</tr>
<tr>
<td>Sharma et al, 21 2018</td>
<td>Prospective, multicenter</td>
<td>PHBP in pts with RBBB and indication for CRT as a primary or rescue strategy</td>
<td>39</td>
<td>37 (95%)</td>
<td>Improvement in NYHA functional class; improvement in LVEF</td>
</tr>
<tr>
<td>Shan et al, 27 2018</td>
<td>Prospective</td>
<td>PHBP for CRT in patients with chronic RV pacing</td>
<td>18</td>
<td>16 (89%)</td>
<td>Improvement in ORSd, LV dimensions, and LVEF</td>
</tr>
</tbody>
</table>

*Mostly, small and non-randomized case series*
His Corrective Pacing or Biventricular Pacing for Cardiac Resynchronization in Heart Failure

Gaurav A. Upadhyay MD, Pugazhendi Vijayaraman MD, Hemal M. Nayak MD, Nishant Verma MD, Gopi Dandamudi MD, Parikshit S. Sharma MD, Moeen Saleem MD, John Mandrola MD, Davide Genovese MD, Roderick Tung MD on behalf of the His-SYNC Investigators

aThe University of Chicago Medicine, Center for Arrhythmia Care, Pritzker School of Medicine, Department of Medicine, Section of Cardiology, Chicago, IL (Study Coordinating Site)
bGeisinger Heart Institute, Wilkes Barre, PA
cNorthwestern University, Feinberg School of Medicine, Department of Medicine, Section of Cardiology, Chicago, IL
dIndiana University School of Medicine, Department of Medicine, Section of Cardiology, Indianapolis, IN
eRush University Medical Center, Department of Medicine, Section of Cardiology, Chicago, IL
fAdvocate Heart Institute, Chicago, IL
gBaptist Health Louisville, Louisville, KY

JACC April 2019 accepted
HBP vs. BiV-CRT – the 1st head-to-head RCT

The HIS-SYNC PILOT

- QRS does not ↓20% or <130
- His lead cannot be placed

Credit of RAE

PRIMARY ENDPOINT:
- Change in ejection fraction
- Change in QRS width
- CV hospitalization/death

CRT Indication

His-Bundle Lead

3 months
- ECG
- Device check
- TTE
- HF survey

6 months
- ECG
- Device check
- HF survey
- Registry

12 months

CROSSOVER Permitted

CS Lead

3 months
- CS cannulation difficult
- Phrenic capture at LV site

JACC April 2019 accepted / presented at HRS 2019
HBP vs. BiV-CRT – the 1\textsuperscript{st} head-to-head RCT

- **Conclusion**: His-CRT was not superior to BiV-CRT, therefore it was not suitable as a first-line strategy in an unselected CRT population.

*JACC April 2019 accepted / presented at HRS 2019*
HBP vs. CRT – the 1st head-to-head RCT

The HIS-SYNC PILOT

- QRS does not ↓20% or <130
- His lead cannot be placed

N=41

CRT Indication

N=21

His-Bundle Lead

3 months
- ECG
- Device check
- TTE
- HF survey

6 months
- ECG
- Device check
- HF survey
- Registry

12 months

N=20

CS Lead

3 months

48%

26%

Primary Endpoint:
- Change in ejection fraction
- Change in QRS width
- CV hospitalization/death

JACC April 2019 accepted / presented at HRS 2019
# Ongoing study

<table>
<thead>
<tr>
<th>Row</th>
<th>Status</th>
<th>Study Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Not yet recruiting</td>
<td>Electrical Resynchronization on Pacing</td>
</tr>
<tr>
<td>2</td>
<td>Active, not recruiting</td>
<td>Imaging Study of Lead Implant</td>
</tr>
<tr>
<td>3</td>
<td>Recruiting</td>
<td>His Bundle Pacing Registry</td>
</tr>
<tr>
<td>4</td>
<td>Recruiting</td>
<td>Effect of His Bundle Pacing in Brugada</td>
</tr>
<tr>
<td>5</td>
<td>Recruiting</td>
<td>Effect of His Bundle Pacing in Brugada</td>
</tr>
<tr>
<td>6</td>
<td>Recruiting</td>
<td>His Bundle Pacing in Brugada</td>
</tr>
<tr>
<td>7</td>
<td>Active, not recruiting</td>
<td>His Bundle Pacing Versus Cor</td>
</tr>
<tr>
<td>8</td>
<td>Unknown</td>
<td>Comparison of His Bundle Pac</td>
</tr>
<tr>
<td>9</td>
<td>Recruiting</td>
<td>HBP Device SGM Data Collect</td>
</tr>
<tr>
<td>10</td>
<td>Not yet recruiting</td>
<td>Fluoroscopic vs Conventional HBP</td>
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<tr>
<td>11</td>
<td>Active, not recruiting</td>
<td>The His Optimized Pacing Evaluated for Heart Failure Trial (HOPE-HF)</td>
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<tr>
<td>12</td>
<td>Recruiting</td>
<td>Left Bundle Branch Area Pacing in AVB Patients</td>
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<tr>
<td>13</td>
<td>Terminated</td>
<td>Pacing Affects Cardiovascular Endpoints in Patients With Right Bundle Branch Block (The PACE-RBBB Trial)</td>
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<tr>
<td>14</td>
<td>Recruiting</td>
<td>Direct HIS pacing as an Alternative to BIV pacing in Sympathetic HIBP Patients With True LBBB</td>
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<tr>
<td>15</td>
<td>Not yet recruiting</td>
<td>Mapping and Pacing of the His Bundle for Heart Failure Patients With Left Bundle Branch Block</td>
</tr>
<tr>
<td>16</td>
<td>Recruiting</td>
<td>Right Ventricular Pacing in Patients With Right Bundle Branch Block and Heart Failure (The SPARK Trial)</td>
</tr>
<tr>
<td>17</td>
<td>Recruiting</td>
<td>Bilateral Right Ventricular Pacing in Right Bundle Branch Block and Heart Failure With Reduced Ejection Fraction. The Study Tests the Superiority of Bilateral Right Ventricular Pacing Over With Implantable Defibrillator in Right Bundle Branch Block and Heart Failure</td>
</tr>
<tr>
<td>18</td>
<td>Not yet recruiting</td>
<td>Optimised MultiSite Pacing Vector Study</td>
</tr>
<tr>
<td>19</td>
<td>Terminated</td>
<td>High Septal Pacing for Cardiac Resynchronization Therapy</td>
</tr>
</tbody>
</table>
• Distal conduction disease or extensive LV scar

• In case of H-P disease progression

• High threshold and generator longevity

• Lead failure → necessity of backup lead? Non-selective?
Conclusions

• **Permanent HBP is unique** compared to other more common forms of pacing despite current limitations.

• It provides **physiological resynchronization** by normalization of His-Purkinje activation.

• Understanding of both **anatomy and physiology is critical** to have successful & reliable long-term outcomes.

• HBP-specific **tools or devices**, and further outcomes study in **RCTs** are needed.
Thank you for your attention!