His Bundle Pacing

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M/72, dyspnea and pitting edema

• 2014 Pacemaker implantation for complete AV block (VDD)

• 2016 TTE: Global hypokinesia, LVEF = 45%
  ➔ ACE inhibitor, Diuretics

• 2017 Dyspnea (NYHA 3) and pitting edema after f/up loss
  TTE: Global hypokinesia, LVEF = 17%
Dyspnea (NYHA 3), LVEF 17%
CRT?
 우선은, 심부전약제로 치료!!
3개월간, ACE inhibitor /diuretics
Which do you choose?

1. Increase the dose of medication
2. Heart transplantation
3. CRT-D implantation
4. Permanent His-Bundle Pacing
ICD 만 하고 나온다

환자는 숨이 너무 차고, 장이 부어서 몇 달째 밥을 못 먹어서 10kg 이상이 빠졌다.

What is next step?
Which do you choose?

1. Increase the dose of medication
2. Heart transplantation
3. CRT-D implantation
4. Permanent His-Bundle Pacing
CRT-Implantation in this patient

1) RA lead
2) RV lead
3) LV lead ➔ Epicardial lead after thoracotomy
Which do you choose?

1. Increase the dose of medication
2. Heart transplantation
3. CRT-D implantation
4. Permanent His-Bundle Pacing
Anatomical Background of His Bundle Pacing

Normalization of Bundle Branch Block Patterns by Distal His Bundle Pacing

Clinical and Experimental Evidence of Longitudinal Dissociation in the Pathologic His Bundle

Nabil El-Sherif, M.D., Fernando Amat-Y-Leon, M.D., Clyde Schonfield, M.D.,
Benjamin J. Scherlag, Ph.D., Kenneth Rosen, M.D., Ralph Lazzara, M.D.,
and Christopher Wyndham, M.D.

Circulation. 1978:57:473-483

Longitudinal Dissociation
27 pts. With LBBB
(24 pts with prolonged HV conduction)
Normalization of Bundle Branch Block Patterns by Distal His Bundle Pacing

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Circulation. 1978:57:473-483

Longitudinal Dissociation
Permanent His-Bundle Pacing

First Clinical Description

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 Romanynshyn, CRNP; Kathleen Anderson, BSN
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 Romanysyn, CRNP; Kathleen Anderson, BSN

- 18 patients
- 69 ±10 years
- Patients with
  - Chronic AF
  - Dilated cardiomyopathy
  - Normal activation (QRS120 ms)
- Among 18 patients
- 14 patients: Success of His bundle pacing
- 12 patients: Success of fixed screw of lead
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 Romanyshyn, CRNP; Kathleen Anderson, BSN

- Among 18 patients
- 14 patients: Success of His bundle pacing
- 12 patients: Success of fixed screw of lead

Mismatch between His catheter position and active fixation site !!!
Implant Technique

3830 Select Secure Lead
Delivery System

C315 His Sheath
7F Short Sheath

C304 Deflectable Sheath
9F Short Sheath
• Non-Selective His-Bundle Pacing
  • Parahisian capture (His+RV) at all outputs or high outputs
  • RV septal capture at low output
Follow up From HRS Live Case
His Bundle Lead Placement 5/11/17
Verma N, Chicos A, Dandamudi S, Ringwala S, Kim S.

Selective His-Bundle Pacing

[A diagram showing an ECG with annotations: A, H, V, 3.5V, 2.0V]
• Non-Selective His-Bundle Pacing
  • Parahisian capture (His+RV) at all outputs or high outputs
  • RV septal capture at Low output
Biventricular Pacing

• Rationale
  • Clearly BiV pacing is superior to RV pacing in HF patients with EF < 35% and wide QRS (LBBB > 150ms)
  • It has to be better in patients with reduced EF (as well as normal EF) and requiring ventricular pacing (pacing induced BBB)

• Two large trials
  • BLOCK-HF
  • BIOPACE
BLOCK-HF (primary endpoint driven by LVSVI change)

*AB Curtis et al., N Engl J Med 2013;368;1585-1593*

- **Background**
  - RV pacing restores an adequate heart rate
  - RV pacing increases LV systolic dysfunction

- **Study population**
  - Atrioventricular block
  - New York Heart Association (NYHA) class I, II or III
  - Left ventricular ejection fraction < 50%
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Pacemaker (N=484)</th>
<th>ICD (N=207)</th>
<th>All Patients (N=691)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biventricular</td>
<td>Right</td>
<td>Biventricular</td>
</tr>
<tr>
<td>Male sex — no. (%)</td>
<td>181 (74.5)</td>
<td>168 (69.7)</td>
<td>87 (82.1)</td>
</tr>
<tr>
<td>Age — yr</td>
<td>74.4±10.2</td>
<td>73.8±10.8</td>
<td>72.0±9.3</td>
</tr>
<tr>
<td>Left ventricular ejection fraction — %</td>
<td>43.4±6.5</td>
<td>42.5±6.6</td>
<td>33.0±7.8</td>
</tr>
<tr>
<td>Left ventricular ejection fraction &gt;35% — no. (%)</td>
<td>213 (87.7)</td>
<td>215 (89.2)</td>
<td>30 (28.3)</td>
</tr>
<tr>
<td>Heart rate — beats/min</td>
<td>68.7±23.4</td>
<td>68.7±23.9</td>
<td>68.2±16.9</td>
</tr>
<tr>
<td>QRS duration — msec</td>
<td>125.4±32.8</td>
<td>124.5±31.1</td>
<td>122.5±30.1</td>
</tr>
<tr>
<td>NYHA class — no. (%)†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>35 (14.4)</td>
<td>47 (19.5)</td>
<td>11 (10.4)</td>
</tr>
<tr>
<td>II</td>
<td>141 (58.0)</td>
<td>126 (52.3)</td>
<td>67 (63.2)</td>
</tr>
<tr>
<td>III</td>
<td>66 (27.2)</td>
<td>68 (28.2)</td>
<td>28 (26.4)</td>
</tr>
<tr>
<td>Cardiomyopathy — no. (%)‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic</td>
<td>94 (38.7)</td>
<td>91 (37.8)</td>
<td>67 (63.2)</td>
</tr>
<tr>
<td>Nonischemic</td>
<td>47 (19.3)</td>
<td>65 (27.0)</td>
<td>26 (24.5)</td>
</tr>
<tr>
<td>Unknown</td>
<td>2 (0.8)</td>
<td>6 (2.5)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Other</td>
<td>9 (3.7)</td>
<td>6 (2.5)</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>CAD — no. (%)</td>
<td>151 (62.1)</td>
<td>147 (61.0)</td>
<td>82 (77.4)</td>
</tr>
<tr>
<td>Myocardial infarction — no. (%)</td>
<td>93 (38.3)</td>
<td>77 (32.0)</td>
<td>56 (52.8)</td>
</tr>
<tr>
<td>Hypertension — no. (%)</td>
<td>200 (82.3)</td>
<td>200 (83.0)</td>
<td>84 (79.2)</td>
</tr>
<tr>
<td>Atrial fibrillation — no. (%)</td>
<td>136 (56.0)</td>
<td>133 (55.2)</td>
<td>44 (41.5)</td>
</tr>
<tr>
<td>Diabetes — no. (%)</td>
<td>90 (37.0)</td>
<td>87 (36.1)</td>
<td>47 (44.3)</td>
</tr>
<tr>
<td>Atrioventricular block — no. (%)¶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st degree</td>
<td>39 (16.0)</td>
<td>35 (14.5)</td>
<td>29 (27.4)</td>
</tr>
<tr>
<td>2nd degree</td>
<td>84 (34.6)</td>
<td>70 (29.0)</td>
<td>35 (33.0)</td>
</tr>
<tr>
<td>3rd degree</td>
<td>120 (49.4)</td>
<td>135 (56.0)</td>
<td>42 (39.6)</td>
</tr>
<tr>
<td>Bundle-branch block — no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>86 (35.4)</td>
<td>75 (31.1)</td>
<td>37 (34.9)</td>
</tr>
<tr>
<td>Right</td>
<td>52 (21.4)</td>
<td>55 (22.8)</td>
<td>21 (19.8)</td>
</tr>
</tbody>
</table>
918 Patients were assessed for eligibility

227 Were excluded
  95 Did not meet inclusion criteria before implantation (most commonly owing to atrioventricular-node conduction results)
  14 Withdrew before implantation
  51 Had unsuccessful implantations
  67 Underwent implantation but did not undergo randomization
  16 Died
  21 Withdrew
  10 Had a device programmed for biventricular pacing
  10 Missed visits
  10 Had other reasons

691 Underwent randomization

349 Were assigned to biventricular pacing
  346 Received assigned intervention
  3 Did not receive assigned intervention

342 Were assigned to right ventricular pacing
  342 Received assigned intervention

52 Withdrew or were lost to follow-up
  75 Died
13 Crossed over to right ventricular pacing
  3 Met primary end point before crossover

50 Withdrew or were lost to follow-up
  90 Died
84 Crossed over to biventricular pacing
  50 Met primary end point before crossover

349 Were included in the analysis
  83 Had data censored for primary end point owing to missing LVESVI data

342 Were included in the analysis
  71 Had data censored for primary end point owing to missing LVESVI data
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pacemaker (N = 484)</th>
<th>ICD (N = 207)</th>
<th>Hazard Ratio (95% CI)*</th>
<th>Posterior Probability of Hazard Ratio &lt;1†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event related to left ventricular end-systolic volume index</td>
<td>56</td>
<td>79</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>Urgent care visit for heart failure</td>
<td>40</td>
<td>38</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Death</td>
<td>12</td>
<td>10</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>Secondary outcomes‡</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death or urgent care visit for heart failure</td>
<td>78</td>
<td>95</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>Death or hospitalization for heart failure</td>
<td>76</td>
<td>89</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Death</td>
<td>52</td>
<td>64</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Hospitalization for heart failure</td>
<td>49</td>
<td>63</td>
<td>27</td>
<td>27</td>
</tr>
</tbody>
</table>
BLOCK-HF (primary endpoint driven by LVSVI change)

AB Curtis et al., N Engl J Med 2013;368;1585-1593

• 이 연구의 결과를 다른 말로 옮겨 보자면,

• Atrioventricular block 과 함께 LVEF 가 감소 (50% 이하) 한 환자에서 RV apical pacing 보다는 BiV pacing 이 장기 예후를 좋게 한다.
• 그렇다면,

• Atrioventricular block 과 함께 LVEF 가 감소 (50% 이하)

BiV pacing ≅ His bundle pacing > RV apical pacing ???
BiV pacing $\cong$ His bundle pacing
His-bundle pacing versus biventricular pacing in cardiac resynchronization therapy patients: A crossover design comparison


RA lead, RV lead, LV lead, HBP lead

CRT – D + HBP !!!
Summary of QRS duration at implant

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Nonselective HBP</th>
<th>Selective HBP</th>
<th>His to LV</th>
<th>BiVP</th>
</tr>
</thead>
<tbody>
<tr>
<td>QRS duration (ms)</td>
<td>169 ± 16</td>
<td>160 ± 25</td>
<td>131 ± 35</td>
<td>145 ± 24</td>
<td>165 ± 17</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value compared to baseline QRS</td>
<td>.23</td>
<td>.014</td>
<td>.002</td>
<td>.007</td>
<td>.52</td>
</tr>
<tr>
<td>P value compared to BiVP QRS</td>
<td>.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6 months outcomes

Panel A: Ejection Fraction
- Baseline: 30%
- His: 35%
- BIV: 33%

Panel B: NYHA Class
- Baseline: 3
- His: 2
- BIV: 2

Panel C: Quality of Life
- Baseline: 80
- His: 50
- BIV: 55

Panel D: Six Minute Hallwalk
- Baseline: 500 meters
- His: 400 meters
- BIV: 450 meters
BiV pacing ≅ His bundle pacing > RV apical pacing ???

아직은 추가적인 연구가 더 필요하다!!

2018 Heart Rhythm

Permanent His-bundle pacing as an alternative to biventricular pacing for cardiac resynchronization therapy: A multicenter experience

Parikshit S. Sharma, MD, MPH, FACC, * Gopi Dandamudi, MD, FHRS, † Bengt Herweg, MD, ‡ David Wilson, MD, ‡ Rajeev Singh, MD, † Angela Naperkowsk, RN, FHR, CCDS, CEPS, § Jayanthi N. Koneru, MBBS, ‡ Kenneth A. Ellenbogen, MD, FACC, FHRS, ‡ Pugazhendhi Vijayaraman, MD, FACC, FHR, §
현재 보고되고 있는 새로운 결과들

• 정상 심기능을 가진 환자에서 His bundle pacing 은 RV pacing 보다 효과적인가?

• 정상 심기능을 가진 환자에서 LBBB 와 같은 conduction 장애를 동반한 AV conduction problem 해결을 위해서 His bundle pacing 이 유용한가?
Conclusion

• 최근 His bundle pacing을 가능하게 하는 lead 및 delivery system이 개발되어 His bundle pacing이 보다 용이하게 되었다.

• His bundle pacing은 정상 전도 체계에서 conduction 되기 때문에 기존의 RV pacing의 여러 문제 (pacemaker syndrome)를 극복할 수 있는 수단을 제공할 수 있다.

• His bundle pacing의 적용대상은 보다 확대될 것으로 기대된다.
경청하여 주셔서 감사합니다.