DDD is Superior to VVI?

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What is your answer?

My answer is “no”, based on the several randomized clinical trials.

The era of evidence-based medicine has come since 1992. Our medical practice should be based on the evidence confirmed by randomized clinical trial.
# Pacemaker Implantation: CNUH

<table>
<thead>
<tr>
<th>Indication</th>
<th>n</th>
<th>VVI(R)</th>
<th>D(V)DD(R)</th>
<th>AAI(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSS</td>
<td>347</td>
<td>204(58.8)</td>
<td>115(33.1)</td>
<td>28(8.1)</td>
</tr>
<tr>
<td>AVB-2\textsuperscript{nd} D</td>
<td>81</td>
<td>37(45.7)</td>
<td>44(54.3)</td>
<td>0</td>
</tr>
<tr>
<td>AVB-3\textsuperscript{rd} D</td>
<td>530</td>
<td>274(51.7)</td>
<td>256(48.3)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>958</td>
<td>515(53.8)</td>
<td>415(43.3)</td>
<td>28(2.9)</td>
</tr>
</tbody>
</table>
What is DDD Pacing?

Dual chamber pacing
AV sequential pacemaker
‘so-called’ physiologic (??) pacemaker
‘so-called’ universal pacemaker
Most expensive and complex pacemaker
What is VVI Pacing?
Single chamber pacing
Atrial-asynchronous ventricular pacing
‘so-called’ non-physiologic pacemaker
Most cheap and simple pacemaker
What is the Difference between DDD and VVI?

DDD: RV pacing + AV synchrony
VVI: RV pacing – AV synchrony

DDD pacing preserves AV synchrony, but disturbs ventricular synchrony resulting from RV pacing like VVI. However, AAI pacing preserves AV synchrony and ventricular synchrony.
Determinants of Cardiac Function

Heart rate: **chronotropy**
Afterload
Preload: **AV synchrony**
Contractility: **ventricular synchrony**
Role of each PM Function in Hemodynamic Benefits

Total potential hemodynamic benefits from a physiologic pacemaker
## Clinical Trials Comparing DDD with VVI Pacing

<table>
<thead>
<tr>
<th>Clinical Trial</th>
<th>Pacing Indication</th>
<th>No. of Patients</th>
<th>Modes</th>
<th>Selected Endpoints</th>
<th>Summary of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersen 1997</td>
<td>SND</td>
<td>225</td>
<td>AAI vs VVI</td>
<td>Mortality: AAI relative risk, 0.66 (0.44–0.99); ( P=0.045 )</td>
<td>Long-term follow up favored atrial pacing in all clinical endpoints</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thromboembolism: AAI relative risk, 0.47 (0.24–0.92); ( P=0.023 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atrial fibrillation: AAI relative risk, 0.54 (0.33–0.89); ( P=0.012 )</td>
<td></td>
</tr>
<tr>
<td>PASE 1998</td>
<td>SND + AVB</td>
<td>407</td>
<td>DDDR vs VVI</td>
<td>Mortality: DDDR 18%; VVIR 17%; ( P=0.95 )</td>
<td>Quality of life was the primary endpoint and was similar between pacing modes in the overall group; subgroup analysis of SND patients suggested benefit for DDDR pacing in quality of life and atrial fibrillation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stroke or death: DDDR 17%; VVIR 19%; ( P=0.75 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atrial fibrillation: DDDR 17%; VVIR 19%; ( P=0.80 )</td>
<td></td>
</tr>
<tr>
<td>Mattioli 1998</td>
<td>SND + AVB</td>
<td>210</td>
<td>VVI(R) vs AAI, DDDR(R) or VDD</td>
<td>Stroke: VVI(R) 19 patients; atrial-based 10 patients; ( P&lt;0.05 ).</td>
<td>Physiological pacing associated with less stroke and atrial fibrillation</td>
</tr>
<tr>
<td>PAC-A-TACH 1998</td>
<td>SND</td>
<td>200</td>
<td>DDDR vs VVIR</td>
<td>Death: DDDR 3.2%; VVIR 6.8%; ( P=0.007 )</td>
<td>Mortality benefit for atrial-based pacing; no difference in recurrence of AF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atrial tachycardia: DDDR 48%; VVIR 43%; ( P=0.09 )</td>
<td>No difference in stroke or death between pacing modalities; AF less frequent in atrial-based pacing</td>
</tr>
<tr>
<td>CTOPP 2000</td>
<td>SND + AVB</td>
<td>2568</td>
<td>DDDR(R) or AAI(R) vs VVI(R)</td>
<td>Stroke and cardiovascular mortality: reduction in relative risk, 9.4% (−10.5 to 25.7%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atrial fibrillation: reduction in relative risk, 18% (3 to 32.6%)</td>
<td></td>
</tr>
</tbody>
</table>
## Clinical Trials Comparing DDD with VVI Pacing

<table>
<thead>
<tr>
<th>Trial</th>
<th>Pacing Scheme</th>
<th>Year</th>
<th>Comparison</th>
<th>Primary Endpoint</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOST 2002</td>
<td>SND</td>
<td>2010</td>
<td>DDDR vs VVI or VVI</td>
<td>Mortality and stroke: DDDR hazard ratio, 0.91 (0.75–1.10); ( P=0.32 ) Atrial fibrillation: DDDR hazard ratio, 0.77 (0.64–0.92); ( P=0.004 ) Heart failure hospitalization: DDDR hazard ratio, 0.73 (0.56–0.95); ( P=0.021 )</td>
<td>No difference in death or stroke between pacing modalities; atrial fibrillation and heart failure less in DDDR-paced patients</td>
</tr>
<tr>
<td>UKPACE 2002</td>
<td>AVB</td>
<td>2000</td>
<td>DDDR vs VVI or VVI</td>
<td>Mortality primary endpoint</td>
<td>No difference between groups (ACC 2003 late-breaking trials presentation only)</td>
</tr>
<tr>
<td>STOP-AF</td>
<td>SND</td>
<td>350</td>
<td>WI vs AAI or DDD</td>
<td>Atrial fibrillation primary endpoint</td>
<td>Results not reported</td>
</tr>
<tr>
<td>RAMP 1999</td>
<td>SND+AVB</td>
<td>400</td>
<td>DDDR vs DDDR</td>
<td>Quality of life primary endpoint</td>
<td>No difference between groups (NASPE abstract presentation only)</td>
</tr>
<tr>
<td>ADEPT 2003</td>
<td>SND+AVB+chronotropic incompetence</td>
<td>870</td>
<td>Factorial trial: DDD vs DDDR mode switch-on vs off</td>
<td>Quality of life primary endpoint</td>
<td>No difference between groups (NASPE 2003 late-breaking trials presentation only)</td>
</tr>
<tr>
<td>DANPACE</td>
<td>SND</td>
<td>2000</td>
<td>AAI vs DDD with ventricular capture</td>
<td>Mortality primary endpoint</td>
<td>Currently enrolling; results in 2004</td>
</tr>
<tr>
<td>SAVE-PACE</td>
<td>SND</td>
<td>1800</td>
<td>DDD+search AV vs DDD</td>
<td>Endpoints: reduction in ventricular pace; atrial fibrillation; LV remodeling</td>
<td>Currently enrolling; results on ventricular pace in 5/04; clinical results in 2005</td>
</tr>
</tbody>
</table>
1\textsuperscript{st} Randomised Trial of AAI vs. VVI Pacing for SSS

225 patients with \textbf{SSS} randomised to either single-chamber atrial pacing (n=110) or single-chamber ventricular pacing (n=115)
Follow-up: up to 8 years
Endpoints were mortality, CV death, AF, TE events, heart failure, and AV block.
1\textsuperscript{st} Randomised Trial of AAI vs. VVI Pacing for SSS

<table>
<thead>
<tr>
<th></th>
<th>Total death</th>
<th>CV death</th>
<th>AF</th>
<th>TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAI</td>
<td>39</td>
<td>19</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>VVI</td>
<td>57</td>
<td>39</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>RR</td>
<td>0.66</td>
<td>0.47</td>
<td>0.54</td>
<td>0.47</td>
</tr>
<tr>
<td>P</td>
<td>0.045</td>
<td>0.0065</td>
<td>0.012</td>
<td>0.023</td>
</tr>
</tbody>
</table>
Clinical Outcome: Total Death

Cumulative survival

Years

Atrial pacing

Ventricular pacing

P=0.045
### 1st Randomised Trial of AAI vs. VVI Pacing for SSS


<table>
<thead>
<tr>
<th></th>
<th>Total death</th>
<th>CV death</th>
<th>AF</th>
<th>TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAI</td>
<td>39</td>
<td>19</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>VVI</td>
<td>57</td>
<td>39</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>RR</td>
<td>0.66</td>
<td>0.47</td>
<td>0.54</td>
<td>0.47</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>0.045</strong></td>
<td><strong>0.0065</strong></td>
<td><strong>0.012</strong></td>
<td><strong>0.023</strong></td>
</tr>
</tbody>
</table>

**Multivariate analysis**

<table>
<thead>
<tr>
<th></th>
<th>Total death</th>
<th>CV death</th>
<th>AF</th>
<th>TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td>0.71</td>
<td>0.52</td>
<td>0.45</td>
<td>0.47</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>0.11</strong></td>
<td><strong>0.022</strong></td>
<td><strong>0.063</strong></td>
<td><strong>0.028</strong></td>
</tr>
</tbody>
</table>
1\textsuperscript{st} Randomised Trial of AAI vs. VVI Pacing for SSS

Conclusions:
Compared to VVI pacing, atrial pacing is only associated with a significantly lower CV death and fewer TE events.

\textbf{AAI appears superior to VVI.}
This can not be extrapolated to comparison of DDD vs VVI.
Pacemaker Selection in the Elderly (PASE)

PASE: 30-month, single-blind, randomized, controlled comparison of DDD and VVI pacing in 407 pts ≥65 years of age in 29 centers

**Background:** Ventricular pacemakers are less expensive, but dual-chamber pacemakers are believed to be more physiologic. However, it is not known whether either type of pacemaker results in superior clinical outcomes.
Pacemaker Selection in the Elderly (PASE)

Primary End-Point
QOL by the 36-item Medical Outcomes Study Short-Form General Health Survey (SF-36)

Subjects
◆ The average age was 76 years (65 to 96), and 60 percent were men.
◆ SVT including AF, 29%; HF (NYHA FC ≥III), 27%; CV disease 13%; low EF, 44%
◆ AVB, 49% (CHB: 59%); SSS, 43%; VAC, 29%
## PASE Study: Quality of Life

<table>
<thead>
<tr>
<th>Subscale</th>
<th>base</th>
<th>3</th>
<th>9</th>
<th>18 mos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>0.55</td>
<td>0.23</td>
<td>0.22</td>
<td>0.99</td>
</tr>
<tr>
<td>Social function</td>
<td>0.45</td>
<td>0.37</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>Physical role</td>
<td>0.54</td>
<td>0.051</td>
<td>0.36</td>
<td>0.78</td>
</tr>
<tr>
<td>Emotional role</td>
<td>0.41</td>
<td>0.052</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.72</td>
<td>0</td>
<td>0.91</td>
<td>0.78</td>
</tr>
<tr>
<td>Energy</td>
<td>0.67</td>
<td>0.91</td>
<td>0.64</td>
<td>0.42</td>
</tr>
<tr>
<td>Pain</td>
<td>0.97</td>
<td>0.99</td>
<td>0.95</td>
<td>0.33</td>
</tr>
<tr>
<td>Health perception</td>
<td>0.97</td>
<td>0.99</td>
<td>0.95</td>
<td>0.33</td>
</tr>
</tbody>
</table>
## PASE Study: Clinical Outcomes

<table>
<thead>
<tr>
<th>End-points</th>
<th>Total</th>
<th>SND</th>
<th>AVB</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-cause death</td>
<td>0.95</td>
<td>0.09</td>
<td>0.41</td>
</tr>
<tr>
<td>Stroke or all-cause death</td>
<td>0.75</td>
<td>0.11</td>
<td>0.68</td>
</tr>
<tr>
<td>Stroke or HF admission</td>
<td>0.18</td>
<td>0.07</td>
<td>0.49</td>
</tr>
<tr>
<td>or all-cause death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>0.80</td>
<td>0.06</td>
<td>0.26</td>
</tr>
</tbody>
</table>

**no significance!**
Pacemaker Selection in the Elderly (PASE)

Results:
◆ QOL improved significantly (p<0.001).
◆ There were no differences between VVI and DDD in either the QOL or clinical outcomes including cardiovascular events or death.
Canadian Trial of Physiologic Pacing (C-TOPP)

Large, randomized, controlled, 32 center-trial to evaluate the effects of physiologic (DDD or AAI) pacing versus ventricular pacing on the risk of stroke and CV death

**Subjects:** Patients without chronic AF who were scheduled for a first implantation of a PM to treat symptomatic bradycardia.
Follow-up for an average of 3 years

**Results:** 1474 pts were randomly assigned To VVI and 1094 to DDD or AAI pacemaker. Annual CV events (VVI vs DDD or AAI):

- All-cause mortality: 6.6% vs 6.3% (p=ns)
- Stroke, CV death: 5.5% vs 4.9% (p=ns)
- Hospitalized HF: 3.5% vs 3.1% (p=ns)
- AF: 6.6 vs 5.3 (p<0.05)
- Peri-Op Cx: 3.8% vs 9.0% (p<0.001)
CTOPP: Stroke & CV Death

Cumulative Risk vs. Year after Randomization

- Ventricular pacing
- Physiologic pacing

P=0.33
C-TOPP: Atrial Fibrillation

![Graph showing cumulative risk over years after randomization for ventricular pacing and physiologic pacing. The graph indicates that ventricular pacing has a higher cumulative risk compared to physiologic pacing, with a significance level of P=0.05.]
## CTOPP: Peri-Op Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Ventricular Pacing (%)</th>
<th>Physiologic Pacing (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>3.8</td>
<td>9.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>1.4</td>
<td>1.8</td>
<td>0.42</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>0.4</td>
<td>0.2</td>
<td>0.32</td>
</tr>
<tr>
<td>Inadequate pacing</td>
<td>0.3</td>
<td>1.3</td>
<td>0.002</td>
</tr>
<tr>
<td>Inadequate sensing</td>
<td>0.5</td>
<td>2.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Device malfunction</td>
<td>0.1</td>
<td>0.2</td>
<td>0.40</td>
</tr>
<tr>
<td>Lead dislodgement</td>
<td>1.4</td>
<td>4.2</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Mode Selection Trial in Sinus Node Dysfunction (MOST)

Background: DDD and VVI pacing are alternative treatment approaches for SND. However, it is unknown which type of pacing results in the better outcome.

Subjects: 2010 pts with SND received DDD in 1014 pts and VVI in 996 pts, followed for a median of 33.1 months.
Mode Selection Trial in Sinus Node Dysfunction (MOST)

The primary end point was death from any cause or nonfatal stroke. Secondary end points were the composite of death, stroke, or hospitalization for HF; AF; heart-failure score; the PM syndrome; and the quality of life.
Mode Selection Trial in Sinus Node Dysfunction (MOST)

Results (VVI vs DDD)
◆ PEP: 23.0% vs 21.5% (p=0.48)
  Death: 20.5% vs 19.7% (p=0.78)
  Stroke: 4.9% vs 4.0% (p=0.36)
◆ CV Death: 9.2% vs 8.5% (p=0.61)
◆ AF: 27.1% vs 21.4% (p=0.008)
◆ HF scores: 1.75 vs 1.49 (p<0.001)
◆ HF admission: 12.3% vs 10.3% (p=0.13)
MOST: Primary End-Point

Event rate vs Months

Ventricular pacing
Dual chamber pacing

P=0.48
MOST: Admission for HF

Event rate

Ventricular pacing

Dual chamber pacing

P = 0.13

Months

0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00

0 6 12 18 24 30 36 42 48 54 60
MOST: AF

Event rate vs Months

- Ventricular pacing
- Dual chamber pacing

P = 0.008
UK Pacing & Cardiovascular Events (UKPACE) Trial

Dual-chamber cardiac pacing is thought to confer a clinical benefit as compared with ventricular pacing, but the supporting evidence is mainly from retrospective study. **UKPACE** is a prospective multicenter, randomized, parallel-group trial comparing the clinical benefits of ventricular pacing and dual-chamber pacing in elderly patients with AV block.
UK Pacing and Cardiovascular Events (UKPACE) Trial

2021 patients $\geq$70 years of age who were undergoing their first pacemaker implant for high-grade AV block were randomly assigned to receive a ventricular PM (1009 pts; 504: VVI; 505: VVIR) or a dual-chamber PM (1012 pts) and followed for 4.6 yrs for mortality and 3 yrs for other CV events. AV block was second degree in 26.1% and complete in 73.3%.
UK Pacing and Cardiovascular Events (UKPACE) Trial

Mean annual total and CV mortality rate were 7.2% and 3.9% in the ventricular pacing group and 7.4% and 4.5% in the dual-chamber group (P=0.56, 0.07, respectively).
UK Pacing and Cardiovascular Events (UKPACE) Trial

There were no significant differences between the group with ventricular pacing and that with dual-chamber pacing in the rates of AF (3.0% vs 2.8%; P=0.74), HF (3.2% vs 3.3%; P=0.80), or a composite of stroke, TIA, or other TE (2.1% vs 1.7%; P=0.20).
Procedural Cx’s were more common in the dual-chamber group than in the ventricular group (7.8% vs 3.5%, P<0.001). Therapeutic intervention was more frequent in the dual-chamber group (8.8% vs 5.6%, P=0.005), as were Cx’s requiring repeated Op before discharge (4.2% vs 2.5%, P=0.04), usually due to problems with the placement or stability of atrial leads.
UK Pacing and Cardiovascular Events (UKPACE) Trial

Conclusions:
In elderly patients with high-grade AV block, the pacing mode does not influence the rate of death from all causes during the first 5 years or the incidence of CV events during the first 3 years after implantation of a PM.
So, DDD is not superior to VVI.

The several randomized clinical trials such as Andersen’s first randomized clinical trials, PASE, CTOPP, MOST, and UKPACE demonstrated that DDD pacing is not superior to VVI pacing in the prevention of death and stroke.
What’s the Problem with DDD?

DDD pacing forces the pacemaker to stimulate the ventricle to tract atrial activity and to maintain AV synchrony. This causes excessive RV pacing, resulting in inter-ventricular (V-V) and intra-ventricular asynchronous contraction (ventricular dyssynchrony).
Problems of RV Pacing


영구형 심박조율기 이식 환자에서 심근 관류와 국소벽운동의 변화

Kwang Soo Cha, MD², Jung Jun Min, MD³, Ju Han Kim, MD¹, Jun Woo Kim, MD¹,
Sung Hee Kim, MD¹, Youl Bae, MD¹, Young Keun Ahn, MD¹, Jong Cheol Park, MD¹,
Jeong Pyeong Seo, MD¹, Joo Hyung Park, MD¹, Myung Ho Jeong, MD¹, Hee Seung Bom, MD³,
Jeong Gwan Cho, MD¹, Jong Chun Park, MD¹ and Jung Chaee Kang, MD¹

¹Department of Cardiology, Chonnam University Hospital, ²Dong-A University Hospital, Pusan,
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Problems of RV Pacing

ABSTRACT

Background: The effect of right ventricular pacing on myocardial perfusion and regional wall motion is not well known, although some studies have suggested that it may be adverse. We investigated the effects of right ventricular pacing on myocardial perfusion and regional wall motion in patients with permanent pacemakers.

Method: Thirty patients receiving permanent pacemakers for complete heart block or sick sinus syndrome were included in this study. All the patients showed normal coronary angiograms. Myocardial scintigraphy and two-dimensional echocardiography were performed to assess myocardial perfusion and to evaluate regional wall motion and global function of the left ventricle (LV).

Results: 1) Mean age was 66.7 ± 8.2 (41–84) years, and the males were more frequent than females. 2) Of the 30 patients, 18 (60%) were on dual-chamber pacing modes with a pacing lead positioned in the apex of the right ventricle. 2) Patients were divided into two groups, 1) patients who developed myocardial perfusion defects, and 2) patients who did not. A total of 27 patients met the criteria of myocardial perfusion defects, and 3 patients did not. 3) Regional wall motion abnormalities were noted mainly over the apical region of the LV in 26 (93%) of 28 patients with ventricular pacing. However, LV ejection fraction did not differ significantly before and early after implantation of the pacemaker (62.7 ± 5.8% vs. 61.0 ± 5.8%, p = 0.313). Conclusions: Right ventricular apical pacing frequently caused myocardial perfusion defects and regional wall motion abnormalities.
Problems of RV Pacing

장기적인 우심실 첨부 조율 시 좌심실 기능부전의 발생에 관련하는 인자

한국내과학회지 : 제63권 제2호 2002

Abstract

Factors for development of left ventricular dysfunction during long-term right ventricular apical pacing

Jay Young Rhew, M.D., Jeom Seok Koh, M.D., Sang Hyun Lee, M.D.,
Bo Ra Yang, M.D., Sang Yup Lim, M.D., Young Joon Hong, M.D.,
Seung Hyun Lee, M.D., Ok Young Park, M.D., Weon Kim, M.D.,
Ju Han Kim, M.D., Ju Hyup Yum, M.D., Hyung Wook Park, M.D.,
Young Keun Ahn, M.D., Myung Ho Jeong, M.D.*, Jeong Gwan Cho, M.D.*,
Jong Chun Park, M.D.* and Jung Chae Kang, M.D.*

Division of Cardiology, The Heart Center, Chonnam National University Hospital,
Chonnam National University Research Institute of Medical Sciences*, Gwangju, Korea
Problems of RV Pacing

dysfunction with the paced QRSd (cut-off value: 180 ms), sensitivity, specificity, positive and negative predictive values were 60.0%, 88.7%, 50.0% and 99.2%, respectively. The paced QRSd at the last follow-up was significantly correlated with paced QRSd immediately after implantation (r=0.542, p<0.01).

Conclusion LV systolic dysfunction after long-term right ventricular apical pacing may develop. Prolongation of paced QRSd ≥180 ms during follow-up may suggest development of LV systolic dysfunction. New technologies to minimize prolongation of paced QRSd should be investigated to prevent LV systolic dysfunction after permanent ventricular pacing.(Korean J Med 63:169–176, 2002)

Key Words : Cardiac pacing, Artificial, Ventricular function

LV systolic dysfunction may develop after long-term RV apical pacing.
Prolongation of paced QRSd ≥180 ms suggests development of systolic LVD.
Problems of RV Pacing

- Correlation coefficient: $r = -0.451$
- Statistical significance: $P < 0.01$
Percent RV Pacing Predicts Outcomes in the DAVID trial

The relationship of % RV pacing to the composite endpoint of death or admission for CHF was evaluated in VVI group (n=195) and DDDR group (n=185).

Results: Percent RV pacing was correlated with the primary endpoint. As a dichotomous variable, the best separation for predicting endpoints occurred with DDDR RV pacing >40% vs DDDR RV pacing ≤ 40% (P=0.025).
% RV Pacing and Outcomes

- DDDR > 40% vs DDDR < 40%  p = 0.03
- DDDR > 40% vs VVI unpaced  p = 0.07

Graph showing:
- DDDR > 40%
- VVI unpaced
- DDDR ≤ 40%

3 month FU to primary end-point
Relative Importance of AV and V-V Synchrony

Heart rate: chronotropism
Afterload
Preload: AV synchrony
Contractility: ventricular synchrony
New Algorithm for PM Selection

Symptomatic Bradycardias

<table>
<thead>
<tr>
<th>IV Conduction</th>
<th>Normal</th>
<th>Abnormal</th>
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<tbody>
<tr>
<td>AV Conduction</td>
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<tr>
<td></td>
<td>Normal</td>
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<tr>
<td>LV-EF ≥0.35</td>
<td>AAI</td>
<td>VVI or</td>
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<td></td>
<td>AAI</td>
<td>DDD-MVP</td>
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<td>LV-EF &lt;0.35</td>
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<td>DDD-MVP at</td>
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<td>RVS or LV</td>
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<tr>
<td></td>
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<td>or BiV</td>
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</tbody>
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LV-EF: Left Ventricular Ejection Fraction