Site of Latest Mechanical Activation, LV Lead Position and Response to Cardiac Resynchronization Therapy

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Disclosure

Mark J. Boogers is supported by the Dutch Heart Foundation, grant number 2006T102
Outline

- Background and Study Rationale
- Methodology
- Study Results
- Conclusion and Clinical Implications
Resynchronization therapy is a well-established therapeutic option in patients with heart failure. Individual response to CRT varies with up to one-third of patients who show no response.
Background

Response to CRT is related to mechanical dyssynchrony, infarcted myocardium and LV lead position

Importance of LV lead position and site of latest mechanical activation
Background

Concordant LV lead position is associated with superior CRT response

Ypenburg et al. JACC 2008
Background

Phase analysis on GSPECT allows assessment of mechanical dyssynchrony, regional activation and perfusion defects.
Study Purpose

The current study evaluated the relation between the site of latest mechanical activation, LV lead position and CRT response in patients with heart failure.
## Methods - Population

Patient inclusion based on current CRT guidelines

- Advanced HF (NYHA III or IV)
- Depressed LV systolic function (LVEF ≤35%)
- Prolonged QRS duration (QRS ≥120 ms)
- Sinus rhythm
Methods - Design

Baseline
- Resting SPECT with phase analysis
- Transthoracic 2D echocardiography
- Evaluation of clinical status

6 Months follow-up
- Transthoracic 2D echocardiography
- Evaluation of clinical status
Response Definition

Response to CRT
Patients with a decrease of $>15\%$ in LVESV were classified as responders to CRT

Non-response to CRT
Patients without $<15\%$ decrease in LVESV
Phase Analysis

The site of latest mechanical activation assessed with 6-segment model

- Septal
- Anteroseptal
- Anterior
- Lateral
- Posterior
- Inferior
LV Lead Position

The LV lead position was assessed on biplane fluoroscopy using RAO and LAO views.

The LV lead position was considered *concordant* or *discordant*.
CONCORDANT LV LEAD POSITION

BASELINE

LVESV 139 mL
LVEDV 203 mL
LVEF 32%

FOLLOW-UP

LVESV 86 mL
LVEDV 153 mL
LVEF 44%
DISCORDANT LV LEAD POSITION

**BASELINE**
- LVESV: 124 mL
- LVEDV: 171 mL
- LVEF: 27%

**FOLLOW-UP**
- LVESV: 153 mL
- LVEDV: 196 mL
- LVEF: 22%
The Site of Latest Mechanical Activation

Discordant LV lead

Concordant LV lead
Results

The study was based on 90 patients with advanced heart failure.

Fifty-two (58%) patients showed a concordant LV lead, whereas 38 (42%) patients showed a discordant LV lead position.

Responder to CRT was observed in 51 (57%) patients.
## Patient Characteristics

**Baseline Characteristics (N=90)**

<table>
<thead>
<tr>
<th></th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td>65 (72)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>67 ± 10</td>
</tr>
<tr>
<td><strong>Ischemic heart failure</strong></td>
<td>62 (69)</td>
</tr>
<tr>
<td><strong>NYHA functional class</strong></td>
<td>3.0 ± 0.4</td>
</tr>
<tr>
<td><strong>QRS duration (ms)</strong></td>
<td>161 ± 36</td>
</tr>
</tbody>
</table>

**Echocardiographic parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEDV (mL)</td>
<td>214 ± 64</td>
</tr>
<tr>
<td>LVESV (mL)</td>
<td>160 ± 57</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>26 ± 8</td>
</tr>
</tbody>
</table>

**Medication**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diuretics</td>
<td>81 (90)</td>
</tr>
<tr>
<td>ACE inhibitors / AT II antagonists</td>
<td>79 (88)</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>62 (69)</td>
</tr>
</tbody>
</table>
## Concordant and Discordant LV Lead Position

<table>
<thead>
<tr>
<th>Baseline Characteristics</th>
<th>Concordant LV Lead position (N = 52)</th>
<th>Disconcordant LV Lead position (N = 38)</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>37 (71)</td>
<td>28 (74)</td>
<td>0.8</td>
</tr>
<tr>
<td>Age</td>
<td>68 ± 10</td>
<td>66 ± 11</td>
<td>0.5</td>
</tr>
<tr>
<td>Ischemic heart failure</td>
<td>38 (73)</td>
<td>24 (63)</td>
<td>0.4</td>
</tr>
<tr>
<td>NYHA functional class</td>
<td>3.0 ± 0.4</td>
<td>3.0 ± 0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>QRS duration (ms)</td>
<td>168 ± 35</td>
<td>153 ± 33</td>
<td>0.1</td>
</tr>
<tr>
<td>LVEDV (mL)</td>
<td>214 ± 67</td>
<td>213 ± 62</td>
<td>1.0</td>
</tr>
<tr>
<td>LVESV (mL)</td>
<td>160 ± 57</td>
<td>161 ± 57</td>
<td>0.9</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>27 ± 8</td>
<td>26 ± 8</td>
<td>0.7</td>
</tr>
<tr>
<td>Histogram bandwidth (°)</td>
<td>126 ± 67</td>
<td>157 ± 86</td>
<td>0.1</td>
</tr>
<tr>
<td>Phase SD (°)</td>
<td>38 ± 20</td>
<td>45 ± 21</td>
<td>0.1</td>
</tr>
<tr>
<td>Extent of perfusion defect (%)</td>
<td>23 ± 14</td>
<td>29 ± 18</td>
<td>0.1</td>
</tr>
<tr>
<td>Perfusion defect pacing region</td>
<td>7 (13)</td>
<td>10 (26)</td>
<td>0.2</td>
</tr>
<tr>
<td>CRT response</td>
<td>41 (79)</td>
<td>10 (26)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Site of Latest Activation and LV Lead Position

### Site of Latest Activation

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>42</td>
</tr>
<tr>
<td>L</td>
<td>16</td>
</tr>
<tr>
<td>I</td>
<td>13</td>
</tr>
<tr>
<td>A</td>
<td>23</td>
</tr>
<tr>
<td>AS</td>
<td>3</td>
</tr>
<tr>
<td>S</td>
<td>2</td>
</tr>
</tbody>
</table>

### LV pacing Lead Position

- **Lateral**
  - 23%
- **Posterior**
  - 50%
- **Anterior**
  - 6%
Response to CRT

LVEF

LVESV

* p<0.05

* p<0.05
Reproducibility

Randomly selected subset of 30 patients

LV lead position
Intraobserver (k = 0.82, total agreement of 90%)
Interobserver (k = 0.76, total agreement of 87%)

Site of latest mechanical activation on GSPECT
Intraobserver (k = 0.96, agreement of 93%)
Interobserver (k = 0.92, agreement of 87%)
Conclusion

Concordant LV lead position was related to significant LV reverse remodeling and improvement in LV systolic function.

GSPECT with phase analysis can be used for assessment of optimal LV lead position in heart failure patients.
Clinical Implications

GSPECT with phase analysis can be clinically performed to evaluate:

- Presence of LV systolic dyssynchrony
- The site of latest mechanical activation
- Perfusion defects (at LV pacing region)

--> These parameters may be used for guidance of CRT implantation
Acknowledgements

Department of Cardiology, LUMC
Jeroen J. Bax
Martin J. Schalij
Ernst E. van der Wall
Victoria Delgado
Mark J. Boogers
Rutger J. van Bommel
C. Jan Willem Borleffs

Department of Nuclear Medicine, LUMC
Bernies van der Hiel
Imad Al Younis
Petra Dibbets-Schneider

Department of Radiology, Emory University
Ernest V. Garcia
Ji Chen
## Total Population

### Baseline vs. Follow-up data

<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline</th>
<th>Follow-up</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYHA</td>
<td>$3.0 \pm 0.4$</td>
<td>$2.5 \pm 0.7$</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>LVESV (mL)</td>
<td>$160 \pm 57$</td>
<td>$137 \pm 55$</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>LVEDV (mL)</td>
<td>$214 \pm 64$</td>
<td>$197 \pm 64$</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>$26 \pm 8$</td>
<td>$32 \pm 11$</td>
<td>p&lt;0.05</td>
</tr>
</tbody>
</table>
Validation of Site of Latest Mechanical Activation

A total of 50 randomly selected patients underwent 2D speckle tracking radial strain analysis.

**Good agreement** was observed between GMPS and 2D echocardiography with speckle tracking radial strain analysis (agreement 86%, $K = 0.79$)
LV Lead Position

RAO 30° was used to assess the apico-basal position of the LV lead; Apical, Mid or Basal

LAO 60° was used to define whether the LV lead was positioned anterior, lateral, posterior or inferior
DISCORDANT LV LEAD POSITION

Delayed site of mechanical activation: Anterior
Phase angle: 82.3
HBW: 175.0, Phase SD: 45.8
CONCORDANT LV LEAD POSITION

DELAYED SITE OF MECHANICAL ACTIVATION: LATERAL
Phase angle: 112.7
HBW: 130, Phase SD: 37.8