New Advances & Technologies of CRT

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Topics:
1. Quadripolar LV lead
2. Autovect select
3. MPP
4. SyncAV CRT
5. LV lead design
CRT Therapy for Heart Failure Patients

CRT devices offer proven treatment for heart failure patients:

- Over 200,000 patients worldwide receive CRT devices each year\(^1\)
- Many heart failure patients greatly benefit from CRT as it:
  - Electrically restore mechanical AV and ventricular synchrony
  - Reorganize the ventricular activation sequence
  - Coordinate septal and freewall contractions
  - Improve symptoms and enhance quality of life
  - Reverse Remoduling
  - Decrease the likelihood of disease progression & reduce the risk of death

\[1. \text{ Heart Rhythm Society Press Release, “CRT Consensus Set to Standardize and Improve Care for Patients Worldwide,” Aug 27, 2012.} \]

The Varying Degrees of CRT Response

In a study (n=302), 43% of CRT patients could be classified as non-responders or negative-responders by LVESV after 6 months\(^1\)

Potential Reasons for Suboptimal Response in CRT

About 30% of patients fail to respond to CRT


Optimal LV lead position

- Studies suggest that the optimal LV lead position should be at the latest activation site, to optimize CRT response.
- Lateral or posterolateral LV base, & Avoid Apical position.
- Target location: lateral or posterolateral CS vein.
1. **Causes of suboptimal lead position:**

1. **Lead stability Vs pacing site:**

   from MADIT-CRT: LV leads positioned in the apical region were associated with an unfavorable outcome, suggesting that this lead location should be avoided in CRT

2. **High pacing thresholds:** incidence rate is between 10-20% at implantation,

   - Narrow the safety margin of pacing stimulation.
   - Negatively impact on device longevity.

3. **PNS** incidence rate are at 37% of CRT patients at implant or follow-up,

   - intolerable for patients

   **At Implantation:** Repositioning increase procedure & fluoroscopy time

   **At follow-up:** Surgical revision increasing risk of infection
Quadripolar LV lead

Quadripolar Pacing Technology

- 10 possible pacing configurations.
- Offers noninvasive lead repositioning options that may reduce the need for surgical revisions

<table>
<thead>
<tr>
<th>Vector</th>
<th>Mid 1 to Mid 2</th>
<th>Mid 1</th>
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<tbody>
<tr>
<td>Vector 1</td>
<td>Distal 1 to Mid 2</td>
<td>Distal 1</td>
<td>Mid 2</td>
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<tr>
<td>Vector 2</td>
<td>Distal 1 to Proximal 4</td>
<td>Distal 1</td>
<td>Proximal 4</td>
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<td>Vector 3</td>
<td>Distal 1 to RV Coil</td>
<td>Distal 1</td>
<td>RV Coil</td>
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<td>Vector 4</td>
<td>Mid 2 to Proximal 4</td>
<td>Mid 2</td>
<td>Proximal 4</td>
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<td>Vector 5</td>
<td>Mid 2 to RV Coil</td>
<td>Mid 2</td>
<td>RV Coil</td>
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<td>Vector 6</td>
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<td>Vector 7</td>
<td>Mid 3 to Proximal 4</td>
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<td>Vector 8</td>
<td>Mid 3 to RV Coil</td>
<td>Mid 3</td>
<td>RV Coil</td>
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<td>Vector 9</td>
<td>Proximal 4 to Mid 2</td>
<td>Proximal 4</td>
<td>Mid 2</td>
</tr>
<tr>
<td>Vector 10</td>
<td>Proximal 4 to RV Coil</td>
<td>Proximal 4</td>
<td>RV Coil</td>
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</table>
The Use of a New Quadripolar Left Ventricular Pacing Lead Improves the Hemodynamic Response to Cardiac Resynchronization Therapy.


- This study compared the effects of pacing from traditional vectors to vectors unique to the Quartet LV lead related to stroke volume (n=15).

- In 53% of all patients, the best stroke volume was obtained from pacing from one of the two proximal electrodes only available on the quadripolar lead.

- All of these patients were responders as they had a 10% increase in cardiac output.

HRS 2014 abstract

- Patients with quadripolar LV leads may receive more effective CRT than those with bipolar LV leads.

- 18% Relative reduction in all cause mortality: (n = 23,178) at 8 months Follow up when compared to bipolar CRT systems1

- Quartet™ LV lead enable LV pacing at the preferred site without compromising lead stability for better management of heart failure patients.
- No re-interventions duo to PNS
- No re-interventions for high threshold or loss of capture
- 98.8% success rate in implantation
- Decreased implant times and fluoroscopic exposure\textsuperscript{3,4}
- More basal pacing opportunities with increase in acute haemodynamics & response rate.

Access from CRT Toolkit: AutoVect Select

“Perform Auto VectSelect”
RV-LV Conduction Test

**Step 2:** Press “Perform Measurements”

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**Potential Reasons for Suboptimal Response in CRT**

About 30% of patients fail to respond to CRT\(^1\)

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Goals of MultiPoint™ Pacing Technology

Pacing from TWO LV sites is designed to capture more tissue to improve:

- Capture a larger area of the myocardium
- Improve transventricular activation time
- Improve hemodynamics
- Offer resynchronization throughout the LV

resulting in a more uniform ventricular contraction, which may enhance the response of both CRT responders and non-responders.


* Animated activation pattern

Possible Patterns of Wavefront Propagation* with conventional LV Pacing vs. MPP in HF, Scarred Heart

* Animated activation pattern
MultiPoint™ Pacing Technology
Programming Options

Pacing Sequences and Delay
- Allows LV first or RV first
- Delays between pulses are programmable

MultiPoint™ Pacing Technology
Programming Options

Improved Hemodynamics:
- MultiPoint™ pacing improved acute systolic function over single-site pacing in 80% of patients in a study assessing acute hemodynamics with dP/dtmax\(^1\)
- MultiPoint™ pacing reduced mechanical dyssynchrony on echo tissue Doppler imaging in more patients than single-site pacing alone\(^2\)

Improved CRT Response:
After 3 months, 73% of traditional CRT patients and 89% of patients treated with MultiPoint™ pacing were classified as responders\(^3\)

Clinical Evidence of improved outcomes with MultiPoint™ Pacing

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Study Details</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Pappone, et al.</td>
<td>(n = 44) MPP™ technology improved acute LV hemodynamic parameters and mid- and long-term LV reverse remodelling compared to conventional CRT</td>
<td>Improved acute LV hemodynamic parameters and mid- and long-term LV reverse remodelling.</td>
</tr>
<tr>
<td>Rinaldi, et al.</td>
<td>(n = 52) MPP technology was acutely safe, and a proportion of MPP technology pacing configurations resulted in a significant reduction in echocardiographic dyssynchrony.</td>
<td>Acutely safe and reduced echocardiographic dyssynchrony.</td>
</tr>
<tr>
<td>Zanon, et al.</td>
<td>(n = 29) MPP technology increased hemodynamic response compared with BiV pacing at any LV site and improved 1-yr CRT response.</td>
<td>Increased hemodynamic response.</td>
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<tr>
<td>Pappone, et al.</td>
<td>(n = 8) Multipoint LV pacing may provide additional improvement to LV function in patients receiving conventional CRT.</td>
<td>Additional improvement to LV function.</td>
</tr>
<tr>
<td>Park, et al.</td>
<td>(n = 8) MPP technology resulted in better electrical and structural reverse remodeling after 6 months compared to using conventional bipolar lead.</td>
<td>Improved electrical and structural reverse remodeling.</td>
</tr>
<tr>
<td>Menardi, et al.</td>
<td>(n = 10) CRT with MPP technology improved both endocardial and surface electrical parameters and hemodynamics in comparison with conventional CRT.</td>
<td>Improved endocardial and surface electrical parameters.</td>
</tr>
<tr>
<td>Forlì, et al.</td>
<td>(n = 436) MPP technology was programmable in 97% of patients; at follow-up QRS was reduced and EF improved with MPP technology relative to conventional BiV.</td>
<td>Programmable in 97% of patients with improved QRS and EF.</td>
</tr>
<tr>
<td>Shetty, et al.</td>
<td>(n = 15) MPP technology may give some degree of hemodynamic benefit, and delivery via a single lead may be as efficacious as pacing with multiple LV leads.</td>
<td>Some degree of hemodynamic benefit with a single lead.</td>
</tr>
<tr>
<td>Forlì, et al.</td>
<td>(n = 25) In comparison to conventional CRT, MPP technology decreased further LV dyssynchrony indexes and resulted in an additional improvement in EF and in CO.</td>
<td>Decreased LV dyssynchrony and additional improvement in EF and CO.</td>
</tr>
<tr>
<td>Tomassoni, et al.</td>
<td>(n = 502) Wider cathode spacing and near-simultaneous intraventricular timing delays provide best MPP technology response at 87% and 'superresponse' at 54% (52 patients).</td>
<td>Wider cathode spacing and best response at 87% and superresponse at 54%.</td>
</tr>
<tr>
<td>Thibault, et al.</td>
<td>(n = 19) MPP technology improved acute LV dP/dtmax compared with BiV pacing using a pacing protocol designed to isolate changes due to cardiac effects.</td>
<td>Improved acute LV dP/dtmax compared with BiV pacing.</td>
</tr>
</tbody>
</table>

**Syncav™ CRT**

[Logo of St. Jude Medical]
SyncAV™ CRT Dynamically Tailored to the patient’s beat¹

- New dynamic timing feature for quadripolar CRT devices
- Individualize and dynamically adjust timing (AV Delays) based on intrinsic patient rhythm
- Drive fusion with intrinsic rhythm for improved electrical synchrony and narrower QRS¹
- Can complement Multipoint™ Pacing

QRS Reduction with SyncAV™ CRT technology

- Study Detail:
  - Methods:
    - Compared QRS reduction in N = 23 patients utilizing Neg-Hys (predicate version of SyncAV™ CRT feature)
  - Results:
    - Using a delta value of -50ms, fusion pacing was achieved and provided a 20% improvement in QRS width
    - Methodology improved QRS duration over traditional fixed AV delays and LV only pacing
    - Incremental QRS narrowing can be achieved by fine-tuning delta value, programmable only in SJM™ SyncAV feature
Multiple quadripolar lead options to the right target vein to deliver MultiPoint™ Pacing
RV only Pacing
Conventional BiV pacing

MPP on
Thank you for your attention