Multisite and Multipoint Pacing to Optimize Cardiac Resynchronization Therapy

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Cardiac Resynchronization Therapy

Widely accepted for treatment

- Pts with systolic heart failure,
- Impaired LVEF
- Electrical asynchrony.

It improves

- Systolic LV function
- Peak oxygen uptake
- Exercise tolerance
- New York Heart Association (NYHA) Class
- Reverses the remodeling
- Neurohormonal changes accompanying HF.

Large randomized trials also showed improved survival with CRT.
The puzzle for CRT success

Left ventricular (LV) reverse remodelling is achieved in only 60–70% of patients.

% Improved Clinical Composite Score

- MIRACLE
- MIRACLE ICD
- MIRACLE II ICD
- iSync III Marquis
- PROSPECT
- FREEDOM

* AV optimised only

Maximising the response to CRT requires a multidisciplinary approach.

**CRT non Responder**

- Failure of biventricular (BIV) pacing to restore *intra-LV synchrony* is likely a major cause of patients failing to respond to CRT.

- In some patients, the paced activation front arising from a single LV electrode is unfavourable.

- To restoring intra-LV synchrony is need a rapid and uniform electrical activation of the left ventricle.

- It also is important that the LV stimulation site be in an optimal location to ensure rapid and uniform spread of electrical current throughout the left ventricle.
The Best Place to Pace

• Some acute hemodynamic studies suggest that the mid-lateral wall of the left ventricle is the optimal pacing site, but other studies indicate that the optimal site may vary and be patient specific.

• Various methodologies to determine the optimal pacing site are
  • invasive measurement (dP/dt)
  • Expansive (MRI)
  • Time consuming (TDI)

• All remain unproven or too difficult for routine clinical use.

Avoid apical lead placement

Singh et al – Circulation 2011;123:1159-1166
Why to propose alternatives pacing modes?

• LV dyssynchrony is a **complex process** involving not only one LV spot but usually a **large area**

• **Pacing in one spot** at the epicardium level may **not** totally **correct** LV dyssynchrony and so may provide a **sub-optimal** resynchronization.

• With **non optimal** resynchronization the response to CRT may be **sub-optimal** or **absent**.

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Biventricular pacing

• In **non responder** PTS, any technique which could increase the response rate of resynchronization would be **crucial** for CRT candidates.

• Has been recently proposed as a safe and efficient method of resynchronization:
  – Dual site
  – Multi site stimulation
Rationale and potential benefits of Multi Point Pacing

- Capture a larger area
- Engage areas around scar tissue
- Improve pattern of depolarization/repolarization
- Improve acute/chronic hemodynamics
- Improve resynchronization

→ Improve CRT response

Hemodynamic Superiority of Dual-Site Left Ventricular Stimulation over Conventional Biventricular Stimulation in Heart Failure Patients

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Table 1: Patient demographics (N = 14)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Measurement</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean ± SD</td>
<td>72.0 ± 8.4</td>
</tr>
<tr>
<td>Gender</td>
<td>Male/Female</td>
<td>10/4</td>
</tr>
<tr>
<td>NYHA Class</td>
<td>IV/V</td>
<td>12/1</td>
</tr>
<tr>
<td>Ejection Fraction</td>
<td>Mean ± SD</td>
<td>25.6 ± 3.3</td>
</tr>
<tr>
<td>EF (%)</td>
<td>Mean ± SD</td>
<td>52.0 ± 15</td>
</tr>
<tr>
<td>PR interval (ms)</td>
<td>Mean ± SD</td>
<td>160 ± 28</td>
</tr>
</tbody>
</table>

CRT with simultaneous dual LV free-wall sites produced a significantly greater increase in dP/dt compared to CRT with a single LV site.
A Randomized Comparison of Triple-Site Versus Dual-Site Ventricular Stimulation in Patients With Congestive Heart Failure

multicenter single-blind, crossover study.


Mid-term outcomes of triple-site vs. conventional cardiac resynchronization therapy: A preliminary study

Radosław Lenarczyk *, Oskar Kowalski, Tomasz Kukulski, Patrycja Pruszowska-Skrzep, Adam Sokal, Mariola Szulik, Teresa Ziębiańska, Jacek Kowalczyk, Sławomir Pluta, Beata Średniawa, Agata Musialik-Lydka, Zbigniew Kalanus

After 3 months of CRT - TRIV VS conv.CRT.
(27/27 Pts):
- NYHA class reduction
- increase in VO2 max
- increase 6MWD
- increase EF
- improved intraventricular synchrony

The response rate in the TRIV group was 96.3% vs. 62.9% in the conventional group (P=0.002).

• TRIV-CRT : appears to be MORE BENEFICIAL than conventional CRT.
  • Upgrade to triple-site CRT may be considered in non-responders to standard resynchronization.

International J of Cardiology 2009: 133:87-94
Implantation Feasibility, Procedure-Related Adverse Events and Lead Performance During 1-Year Follow-Up in Patients Undergoing Triple-Site Cardiac Resynchronization Therapy: A Substudy of TRUST CRT Randomized Trial

- 100 PTS randomized in a 1:1 to conventional or triple-site CRT-D
- Fluoroscopic TIME TRIV system longer VS conventional
- Implantation success-rate similar
- Adverse events at 1 year FU were similar

12 months FU NYHA CLASS III/IV:
30% pz with conv CRT
12.5% TRIV CRT

Radoslaw L. et Coll. J. C. Electrophysiol 2012;23:1228-1236

Quad-Site Pacing Using a Quadripolar Left Ventricular Pacing Lead

ANOOP K. SHETTY, M.B.CH.B.,*,† PARESH MEHTA, M.B.CH.B.,*
JULIAN BOSTOCK, M.SC.,* C. ALDO RINALDI, M.B.B.S.,*

Pacing four ventricular sites simultaneously using:
- Two vectors of a Quartet lead
- A right ventricular apical lead
- An additional LV lead temporarily placed in an anterior branch of the coronary sinus

Multisite pacing using the Quartet lead alone did not improve the hemodynamic response (AHR) but “quad-site” pacing using an additional temporary LV lead did increase dP/dt max

PACE 2011
Specifically designed LV lead multipoints pacing

Quadripolar Lead

- A quadripolar LV lead (Quartet model 1458Q, St Jude Medical, Inc.- Attain Performa LV, Medtronic) has recently been developed with three ring electrodes located 20, 30, and 47 mm from the tip electrode.
- With compatible pacing system, it is possible to deliver independent pacing pulses to multiple electrodes of the lead, potentially capturing a larger area and engaging multiple zones in the long axis of the LV.
In 21 pts with CRT:
- quadripolar LV lead
- conventional RV and RA leads
- guidewire pressure sensor was placed in the LV for continuous dP/dt measurement
- BiV pacing (using the distal LV electrode) vs multisite pacing

Conclusion
• In the majority of patients, multisite pacing improved acute systolic function further compared with BiV pacing.
• Pacing with the most distal and proximal electrodes of the quadripolar LV lead most commonly yielded greatest LV dP/dt max.

MultiPoint™ Pacing Improves Hemodynamics

Improved Acute Hemodynamics and Contractility
At implant, 88% of patients had at least one MultiPoint™ pacing configuration that produced an increase in LV dP/dt max when compared to pacing from a single BiV vector.

Reduced LV Dyssynchrony
In 67% of patients, at least one MultiPoint™ pacing intervention exhibited a significant improvement in acute mechanical dyssynchrony compared to standard BiV pacing.

Objectives
- To characterize acute hemodynamics with MultiPoint™ pacing vs. single-site LV BiV pacing
- To assess echocardiographic outcome of MultiPoint™ pacing compared to single-site LV BiV pacing after 3 mo and 12 mo

Design
n=44, single center, 12-mo f/u, single-center feasibility, randomized

Evaluation
LV hemodynamic assessment: CD Leycom INCA PV loop system
Echo outcome assessment (baseline vs. 3- and 12-mo f/u)

Key Finding
MultiPoint™ pacing in a single CS branch significantly improves LV hemodynamics relative to single site LV pacing

MultiPoint™ Pacing Improves Response Rates

After 3 months, 8/11 (73%) single-site patients vs. 8/9 (89%) MultiPoint™ pacing patients were classified as responders (n=20)

Multisite LV pacing can improve LV reverse remodeling and cardiac function as characterized by echocardiography, and may result in a higher rate of response to CRT than with single site pacing.

 Designed to Provide Greater CRT Response

The dual pulses from MultiPoint™ pacing
- Capture a larger area of the myocardium
- Improve transventricular activation time
- Improve hemodynamics
- Offer resynchronization throughout the LV

Clinical studies demonstrate the benefits of these clinical improvements

1. Theis C. et al. The relationship of bipolar left ventricular pacing stimulus intensity to cardiac depolarization and repolarization in humans with cardiac resynchronization devices. Journal of Cardiovascular Electrophysiology Vol. 20, No. 6, June 2009
2. Thibault et al. Multisite Pacing with a Quadripolar Left Ventricular Lead Improves Acute Hemodynamics. Abstract HRS 2011
3. Thibault et al. Multisite left ventricular pacing improves acute mechanical dyssynchrony in heart failure patients. Abstract ACC 2012
Conclusion

A new approach to CRT pacing

- Useful for reduction the percentage of CRT recipients do not respond to therapy
- A data of a few clinical studies demonstrate that:
  - Is safe and simple implant technique.
  - Improves acute hemodynamics
  - Improves CRT response rate at 3 months

Conclusions

- Upgrade to triple-site CRT may be considered in non-responders to standard resynchronization.
- Additional studies to further evaluate the impact of MultiPoint or multisite pacing in heart failure patients are necessary.