Αυτόματη βελτιστοποίηση της θεραπείας καρδιακού επανασυγχρονισμού με βάση τις συσκευές

Device-based automatic optimization of CRT

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Evolution of implantable devices
Evolution of implantable devices
The Birth of Cardiac Resynchronization Therapy

Cardiac resynchronization therapy implantation: a blend of skill and technology
Philipp Ritter, Serge Cazeau, Daniel Grai, Jean-Claude Daubert

Introduction
Cardiac resynchronization therapy (CRT) was conceived in the mid-1990s. It offered new, very small, intracardial biventricular pacemakers that allowed asynchronous pacing but also synchronization of the two ventricles. By pacing the right and left ventricle simultaneously, it was possible to augment heart function and improve heart failure.

As the result of CRT, more pacing problems that already been overcome. For example, data indicated that the absence of ventricular asynchrony behavior, muscle stretching from CRT to CRT or CRT to atrial-synchronous rhythm, and algorithms to avoid asynchrony-mimetic behavior were all standard and well understood in CRT.

Some important work anticipated the introduction of CRT. Dr. Lown showed that CRT is a part of the ablation group in attempting to synchronize the atrioventricular conduction block in his work. The synchronization of the 20th by right ventricular (RV) atrial pacing was established to reduce atrial activation and block fibrous portion accessory pathway..

1994: the first four - chamber cardiac resynchronization therapy implantation

The first published patient [1] was Agnes and Jack Beals of New York. He was the first to receive CRT. The patient was asymptomatic before the procedure and remained asymptomatic after the procedure.

The patient was followed for 5 years. During this time, he did not have any recurrence of heart failure.

Figure 1. Lateral X-ray view of the first fully transcatheter cardiac resynchronization therapy system (courtesy of D.G. and J.C.D., University Hospital of Rennes, August 1994).

Figure 2. Intraoperative view (frontal) showing two leads introduced through the CS to pace the left ventricle. (1) A bipolar CS lead (Medtronic 2188) positioned in the proximal part of the great cardiac vein to pace the LV anterior base (2) A unipolar conventional ventricular lead inserted in an anterolateral vein over the LV free wall (3) The right ventricular lead is placed at the RV apex.
Ventricular Dyssynchrony defined

**Ventricular Dyssynchrony**

**Electrical**: Intraventricular conduction delays usually manifested as left bundle branch block

**Structural**: disruption of myocardial collagen matrix impairing electrical conduction and mechanical efficiency

**Mechanical**: Regional wall motion abnormalities with increased workload and stress, compromising ventricular Mechanics

Tavazzi L. Eur Heart J 2000;21:1211-1214
Cardiac Resynchronization Therapy defined

Cardiac Resynchronization Therapy

Therapeutic intent of Atrial synchronized Biventricular Pacing through the modification of interventricular, intraventricular and atrioventricular activation sequence
Cardiac Resynchronization Therapy is beneficial

Smyseth et al. Eur Heart Jour Cardiovasc Imaging 2011
Cardiac Resynchronization Therapy is beneficial

<table>
<thead>
<tr>
<th>Study</th>
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<th>HF or CV Hospitalisations</th>
<th>Cardiac Function/Structure</th>
<th>QoL or NYHA</th>
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NA = Not powered, not collected, or not blinded for specific end point. * Post-hoc analysis.

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Cardiac Resynchronization Therapy response rates

Despite decades of successful CRT therapy, there is still a recognized non-responder rate of 30-45%.¹

¹ Daubert JC et al. Heart Rhythm 2012. 2012 EHRA/HRS expert consensus statement on cardiac resynchronization therapy in heart failure: implant and follow-up recommendations and management
Identify the responder – CRT response definitions

Clinical Measures Assessment
NYHA class & Quality of Life
6 min walk test, exercise duration, & metabolic exercise tests (CPX)

LV Reverse Remodeling Assessment
**Acute:** Hemodynamic parameters (C.O., LV $dP/dt_{max}$)
**Chronic:** Increase in LVEF, reduction in LV end systolic/diastolic volumes & MR

Outcome Measures Assessment
Reductions in HF hospitalizations, morbidity, & all cause mortality
Potential reasons for suboptimal response in CRT therapy

Mullens et al. JACC Vol. 53, No. 9, 2009:765–73
Potential reasons for suboptimal response in CRT therapy

Mullens et al. JACC Vol. 53, No. 9, 2009:765–73
Optimization of CRT in real world

Gras et al. PACE, Vol. 32 March 2009, Supplement 1 S237
Conclusions: In real-world practice, AV and VV optimization was not performed in a high proportion of patients. A less time-consuming and easier optimization method might enable a more systematic optimization of the AV and VV delays at routine follow-up visits in all recipients of CRT systems. (PACE 2009; 32:S236–S239)

Gras et al. PACE, Vol. 32 March 2009, Supplement 1 S236 –S239
Why CRT optimization generates reticence?

Although Echo is so far the “golden standard” for CRT optimization, there are limitations

- Lack of clear guidelines and real proof of efficacy of acute optimization at long term
- Typically reserved for CRT non-responders
- Requirement of a skilled echo sonographer
- Coordination of clinical services
- Resource constraints (cost, time)
- Lack of standard protocol
- Only perform at rest and inability to continually re-optimize
A-V delay optimization in CRT

- AV optimization is the coordination of Atria and Ventricle to maximize LV filling and increase Cardiac Output.
- Cardiac Output is maximized in CRT when LV contraction occurs at the completion of LA contraction.
V-V delay optimization in CRT

- VV optimization is resynchronization of systolic movement
- Shorter Isovolumetric Contraction Time (IVCT) results in longer LV filling time
What the guidelines suggest

2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy

The Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA).

Patient selection, procedural timings and methodology employed (device algorithms, ECG or echocardiography) were not homogeneous across the studies, thus preventing firm conclusions from being obtained. Therefore, current evidence does not support AV and VV optimization routinely in all patients receiving CRT.

However, in non-responders to CRT, in patients with ischaemic heart disease or in need of atrial pacing, evaluation of AV and VV delay may be recommended in order to correct suboptimal device settings.
What the guidelines suggest

2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

The reader is directed to guidelines on pacing and CRT for recommendations on device implantation procedures. The value of trying to optimize AV or VV intervals after implantation using echo- or electrocardiographic criteria or blood pressure response is uncertain, but may be considered for patients who have had a disappointing response to CRT.
December 2016 ESC webinar on CRT optimization

Survey from the audience during the webinar revealed the following:

The evidences of additional clinical benefits of CRT optimization (AV and VV delays) were considered:

- 14% Strong
- 29% Moderate
- 38% Uncertain or mild
- 19% Inconclusive

How do you program AV and VV timings?

- 14% Fixed AV delay and no VV delay
- 30% Echo-based AV and VV delays
- 46% ECG based AV and VV timings
- 11% Nominal settings of the device
- 0% I don’t think these timings are important

Optimization of AV and VV timings is recommended:

- 48% At discharge and at each follow-up
- 5% Only at discharge
- 28% Only in non-responders
- 20% There are not sufficient evidence to recommend routinely AV and VV optimization
Device based optimization – Abbott/SJM

**QuickOpt™**

**Systolic Filling**

**Diastolic Contraction**

- Optimize preload and ejection fraction via AV and VV delays without echo
- Over 96% correlation with echo-based methods

**Device based optimization – Abbott/SJM**

### QuickOpt™ Timing Cycle Optimization

#### AV Delay Optimization
- **A Sense:** 57 ms (55, 62, 55, 55, 62, 62, 55, 55 ms)
- **Paced AV Delay:** 170 ms, 170 ms
- **Sensed AV Delay:** 150 ms, 120 ms

#### Interventricular Delay Optimization
- **V Sense:** 69 ms (RV First) (78, 78, 78, 62, 62, 78, 55, 62 ms)
- **Interventricular Pace Delay:** Simultaneous, 15 ms (LV First)
- **RV Pace:** 94 ms (86, 102, 109.86, 86, 102, 86, 102 ms)
- **LV Pace:** 51 ms (47, 47, 55, 55, 47, 55, 55, 47 ms)
Device based optimization – Abbott/SJM

SyncAV™ CRT

1. Automatic Measurement of intrinsic AV conduction intervals
   - Automatically measured when 3 consecutive V-sense events occur

2. Paced and Sensed AV Delays Automatically determined
   - Calculated based on measured intrinsic AV conduction interval

3. Review & Program SyncAV™ CRT settings
Device based optimization – Biotronik

AV Hysteresis
Device based optimization – Boston Scientific

Smart Delay®

Sensed AV offset

$PAV = (SAV) + (Sensed\ AV\ Offset)$

Review Suggested Settings

- Paced AV Delay: 180 ms
- Sensed AV Delay: 140 ms
Device based optimization – LivaNova/Sorin

SonR

SonR – Correlated to LV contractility

SonR amplitude is an index of contractility and correlates with LVdP/dt max:

- SonR = 0.60 g
- Sequential BIV
- 29 ms L/R ECG
- LV PRESSURE

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70 YEARS OF CARDIOLOGY (HSC)
ΠΑΝΕΛΛΗΝΙΟ ΚΑΡΔΙΟΛΟΓΙΚΟ ΣΥΝΕΔΡΙΟ
PANHELLENIC CONGRESS OF CARDIOLOGY

WWW.HCS.GR
Device based optimization – Medtronic

AdaptivCRT®

Every Patient Optimised.

- Normal AV Conduction: Adaptive LV pacing
- Prolonged AV Conduction: Adaptive BiV pacing

Assesses Intrinsic Conduction

Adaptive BiV and LV
Dynamic pacing algorithm which switches between Adaptive BiV and Adaptive LV operation.

Adaptive BiV
Biventricular pacing with automatic optimisation of AV/VV delays and the ventricular pacing configuration.

Nonadaptive CRT
Traditional BiV pacing with no automatic timing adjustments

Every Minute.
Device based optimization – Medtronic

AdaptivCRT®
Empiric programming algorithm of AV and VV delay

Pre-discharge
AV and VV interval optimization

3 months follow-up
Lack of improvement in NYHA functional class

YES
Repeat AV and VV interval optimization

NO

6 months follow-up
Reduction of LVESV ≤ 15%

YES
Repeat AV and VV interval optimization

NO

12 months follow-up
Clinical responder + LV reverse remodeling

NO

YES
Non-responder: consider status of heart failure and potential alternative therapies
Re-evaluation every 3-6 months: if clinical or echocardiographic parameters worsen, consider repetition of AV and VV interval optimization

Conclusions

• Many options are available to assist in optimizing the device so patients may gain the full benefit of CRT

• Device-based automatic CRT Optimization is non-inferior to echo-optimization and is more time-efficient. No long term data in CHF/ Mortality endpoint

• We should use all options available to help us determine if programming changes can and should be made

• LV-based pacing algorithm improves inter/intra-ventricular hemodynamic/synchrony/reduces CHF in patients with preserved AV conduction

• There will still be a population of patients who will require physician intervention in the form of heart failure management and rate control medications