Abstract

Introduction: Left ventricular (LV) lead placement in the latest activated region is an important determinant of response to cardiac resynchronization therapy (CRT).

Purpose: Aim of this study was to evaluated the latest activated region in coronary sinus (CS) in patients underwent CRT devices implant.

Methods and results: 46 consecutive CRT patients (38 males, age 72.9±7.3 years), underwent intra-procedural coronary venous EAM using EnSite NavX. A guidewire was used to map the coronary veins during intrinsic activation. The latest activated region were reported in Table 1.

Conclusions: Coronary venous EAM can be used intraprocedurally to guide LV lead placement to the latest activated region. This approach especially contributes to optimization of LV lead electrical delay in patients with multiple target veins. Conventional anatomical LV lead placement strategy does not target the vein with maximal electrical delay in many of these patients.

<table>
<thead>
<tr>
<th>Delay in LAO</th>
<th>Latest activation during sinus rhythm – Number of patients</th>
<th>Latest activation during RV pacing - Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>anterior</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Antero-lateral</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Lateral</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Postero-lateral</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Posterior</td>
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<td>0</td>
</tr>
<tr>
<td>Delay in RAO</td>
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</tbody>
</table>
**Quadrifocal Pacing In A Congestive Heart Failure Patient: 1 Year Follow-Up**

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## Abstract

**Introduction:** Up to 30% of CHF patients can be non responder to CRT. Multipoint Left Ventricular (LV) pacing (MPP) could help reducing the percentage of non responders relying upon usage of a quadripolar LV lead to deliver ventricular stimulation sequentially over three sites, LV distal (d), LV proximal (p), and right ventricle (RV). We present a case of quadrifocal pacing.

**Methods:** An 81 years old pt with ischemic cardiomyopathy (LVEDV 201 ml, LVESV 150 ml, LVEF 25%), permanent AF, previously implanted with a VVIR pacemaker with a lead in the RV apex (RVA), LBBB, NYHA class III, was upgraded to MPP CRT-Defibrillator (Quadra Assura MP™, St. Jude Medical, Sylmar, CA). A dual coil lead was screwed in the basal septum (IVS) and a quadripolar LV lead (Quartet™, St. Jude Medical, Sylmar, CA) was positioned in a postero-lateral coronary sinus branch. The old RV apical lead was connected to the atrial port of the CRT-D. Before discharge, QRS width and aortic VTI were evaluated pacing from one to four sites (table 1).

**Results:** At discharge, aortic VTI in quadrifocal pacing increased by 22% as compared to RVA pacing. At 1 year follow-up NYHA class improved to II and LVEF to 42% (LVEDV 144 ml, LVESV 84 ml). QRS width decreased from 148 to 113 ms with quadrifocal pacing.

**Conclusions:** Quadrifocal pacing improves aortic VTI more than biventricular pacing in acute setting. At 1 year follow-up a 28% LVEDV and 44% LVESV decrease and a QRS width shortening were demonstrated.

<table>
<thead>
<tr>
<th>Implant</th>
<th>ONE SITE</th>
<th>TWO SITES</th>
<th>THREE SITES</th>
<th>FOUR SITES</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>RVA</td>
<td>IVS</td>
<td>LVd</td>
<td>LVp</td>
</tr>
<tr>
<td>QRS</td>
<td>197</td>
<td>175</td>
<td>207</td>
<td>212</td>
</tr>
<tr>
<td>VTI</td>
<td>13.9</td>
<td>13.5</td>
<td>13.1</td>
<td>13.9</td>
</tr>
<tr>
<td>1 year F-up</td>
<td>QRS</td>
<td>185</td>
<td>165</td>
<td>227</td>
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<tr>
<td></td>
<td>VTI</td>
<td>16.6</td>
<td>16.1</td>
<td>17.7</td>
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</table>
Cardiac Resynchronization Therapy By Multipoint Pacing Improves The Acute Response Of Left Ventricular Mechanics And Fluid Dynamics: A Three-Dimensional And Particle Image Velocimetry Echocardiographic Study

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Abstract

Introduction: Multipoint pacing (MPP) is supposed to provide a more effective CRT than conventional biventricular pacing (BiV-CONV). We compared the acute effects of MPP versus BiV-CONV and CRT-OFF on LV function in CRT responders.

Methods: In 9 consecutive CRT patients (65±11) receiving a quadripolar LV lead (Quartet™, St. Jude Medical) and positive clinical response at 6 months, 3D echocardiography (3DE) and Echo-PIV were performed for MPP, BiV-CONV and CRT-OFF during the same session. LV acquisitions were randomly analysed in a blinded fashion.

Results: MPP resulted in shorter QRS duration and significant reduction in end diastolic volume, end systolic volume compared with CRT-OFF and BiV-CONV (p<0.05); moreover, MPP resulted in better 3D LV ejection fraction, strain (longitudinal and circumferential), more synchronous LV contraction than CRT-OFF (p<0.05). Flow force angle by Echo-PIV was significantly lower for BiV-CONV vs CRT-OFF (p=0.002), and for MPP vs BiV-CONV (p=0.002).

Conclusions: 3DE and Echo-PIV enabled to identify improvement in LV systolic function and fluid dynamics during MPP. This pilot study suggests that Echo-PIV could be a more sensitive echocardiographic index for evaluating the subtle effects of various CRT modalities.
Non Invasive Hemodynamic Optimization Of Cardiac Resynchronization Therapy With Multipoint Left Ventricular Pacing. A Multi-Center Pilot Experience


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Abstract

Introduction: multipoint left ventricular pacing (MPP) using a quadripolar catheter in a single coronary vein allows delivery of two sequential stimuli from different dipoles. This new technology has shown to improve cardiac contractility in the acute setting and increase the response if compared with conventional cardiac resynchronization therapy (CRT). The varied number of configurations of MPP can lead to doubts in choosing the best sequence and intervals between stimuli according to different patient’s characteristics. The QRS width and morphology are the most used parameters for CRT optimization. QRS reduction is correlated with CRT clinical outcome, but is not proved to be a good tool to optimize the different MPP configurations. This study evaluates the optimization of MPP inter and intra ventricular (RV-LV and LV1-LV2) delays using a non-invasive measure of hemodynamic parameters (Indexed Stroke Volume - SVI, Cardiac Output - CO and Cardiac Index - CI) and compare it with the ECG.

Methods: 48 patients were included. If multisite pacing was feasible, measurement of CO, CI and SVI were performed at first follow-up in different configurations: spontaneous rhythm, conventional biventricular pacing (BiV) and 12 different MSP configuration using both the most and the least delayed LV dipole automatically calculated (varying intervals and sequence of stimulation, RV-LV1-LV2 and vice versa). A 12-lead ECG for QRS width analysis was collected for any configuration.

Results: Among 48 patients (pts) implanted with MPP, 44 were eligible for the study (age 71.1 ± 8.5 years, 72.9% male, EF 28.4 ± 7.1%, QRS 163 ± 23 ms). Three were not eligible because of no MPP configuration available (high LV thresholds or phrenic nerve stimulation) and one not analyzed for incomplete data. In the study group LBBB was present in 34/44 pts. Hemodynamic parameters in spontaneous rhythm were: CI 2.6 ± 0.6 L/min/Kg/m2; CO 4.7 ± 1.3 L/min and SVI 40.4 ± 22.0 ml/Kg/m2. The best MPP configuration was chosen according to CI values. The best MPP, the mean of 12 configuration MPP (Mean MPP), biventricular pacing (BiV) and the configuration with shortest QRS (Best QRS) all determined a significant increase of CI with respect to spontaneous rhythm (p<0.0001; p=0.004; p=0.004; p=0.021 respectively). No differences between BiV and Best QRS were found (p=0.53). In 18/44 patients (40.1%) all the 12 MPP configurations were superior to BiV in terms of CI. In only one patient (2.2%) Best MPP was also Best QRS. There were neither differences in terms of CI, CO and SVI between patients with ischemic vs non ischemic cardiomyopathy (CI p=0.337; CO p=0.410; SVI p=0.475), nor between patients with LBBB vs non-LBBB (CI p=0.249; CO p=0.387; SVI p=0.695). Best configuration in terms of CI by pacing first from right ventricle or from one of the LV was not associated with presence of LBBB or non-LBBB (p=0.472).

Conclusions: Different MPP configurations carry variations in non-invasive hemodynamic parameters, seemingly not correlated with QRS reduction. Measurement of hemodynamic with a non-invasive tool is a valuable method to optimize MPP devices. Larger randomized trials and long-term follow-up will help to clarify the clinical impact of hemodynamic guided MPP optimization.
Cardiovascular Rehabilitation In Patients With Cardiac Resynchronization Therapy Devices

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Abstract

Introduction & Background: Patients with cardiac resynchronization therapy (CRT) devices, according the current guidelines, must be referred to a cardiovascular rehabilitation (CR) program. The aim of the study was to evaluate the need for an optimization of device programming, in order to obtain the maximal increase in heart rate and to maintain resynchronization therapy during exercise.

Methods: Thirteen consecutive CHF patients, recently implanted with a CRT-D devices for primary prevention underwent cardiopulmonary exercise testing, during which device programming were evaluated.

Results: The patients’ baseline characteristics were the following: male sex 77%; age 71±9 years; non-ischaemic cardiomyopathy 85%; ejection fraction 37±6%; sinus rhythm 85%; peak oxygen uptake 14±8 ml/kg/min. Device “brady” functions reprogramming was necessary in 6 patients (46%): optimization of rate-responsive function in 2 cases; optimization of inter-ventricular delay in 1 case; optimization of atrio-ventricular delay in 1 case; increase of upper rate in 2 cases. No modifications of device “tachy” functions were considered necessary.

Conclusions: Individualized device programming during exercise may be warranted in selected patients with CRT-D device referred to a CR program.
Abstract

Background: In cardiac resynchronization therapy (CRT) targeting the optimal LV pacing site is decisive for therapy effectiveness. The aim of the study is to compare the clinical response of CRT in a group of pts whose LV lead was optimized vs a group of pts with a conventional procedure. Optimization consists in the selection of the best position through systematic screening of all the available pacing sites pursuing both the maximum electrical delay (Q-LV) and the highest response in LV dP/dtmax.

Methods: A group of 56 pts (OPT group) was optimized at implant, by means of a systematical screening of LV electrical delay and LV dP/dtmax in all available tributary veins of the coronary sinus and was compared with a group of 54 pts implanted with the conventional standard CRT procedure in the previous years and used as control group (CONV group).

Results: The response to CRT was evaluated as remodeling (variations in LVESVi) and clinical status (NYHA class and Packer HF clinical composite score). At 12 months follow up (mean FU 305±98 days), 44 pts (79%) vs 30 (56%) had a ΔLVESVi≥15% (p=0.014), 45 (80%) vs 33 (61%) improved NYHA≥1 class (p=0.036), 41 (73%) vs 29 (54%) responded as Packer HF index (p=0.047), in OPT group vs CONV group respectively.

In OPT group, pts with longer Q-LVmax (higher than median value of 133 ms) responded to CRT in 86% (ΔLVESVi≥15%), 87% (ΔNYHA≥1 class), and 83% (HF Packer index) of cases.

Conclusions: The acute optimization of LV pacing site, by means of a systematical screening of LV electrical delay and LV dP/dtmax, resulted in a significant higher rate of responder to CRT compared to the conventional non-optimized group. In our experience, longer Q-LVmax may predict a further benefit.
Identification Of Systolic Time Intervals Using Peak Endocardial Acceleration Sonr Sensor Signal


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Abstract

Purpose: Systolic Time Interval measurement (STI) is an established non invasive method to test ventricular performance by using a function of time instead of force and distance. STI provides a quantitative estimate of cardiovascular disease effects in left ventricle. Especially the pre-ejection period (PEP), the electro mechanical activation time (EMAT, QS1), the left ventricular ejection time (LVET) and the total mechanical systole (QS2) is of interest.

Methods: In our pilot study we investigated if the STI measurements can be done by using an integrated sensor (SonRTip, Sorin Group) that is able to measure beside intracardial electrograms the peak endocardial acceleration signals (S1, S2) in order to optimize the AV and VV timing intervals in cardiac resynchronization patients. Therefore the EMAT and the QS2 timing intervals where measured using the gold standard ECHO and were compared with the obtained SonR measurements.

Results: In seven patients STI measurements were done and the signals of all intervals were derived and compared to the ECHO measurements. After removing outliers we obtained a good correlation with r=0.58 for EMAT and r=0.64 for QS2.

Conclusions: In this study we were able to show that STI can be permanently measured using SonR signal. More patient data are needed to overcome the limitations of this pilot and to enable diagnostic and/or therapeutic benefit.

Figure 1A: Depicts the intracardial electrogram in the first and the peak endocardial acceleration signal in the second line that were used for STI extraction

Figure 1B: Depicts the measured ECHO superimposed by the peak endocardial acceleration signal