The role of echo to guide LV lead placement

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Defining Left Bundle Branch Block in the era of Cardiac Resynchronization Therapy

Strauss et al. Am J Cardiol 2011
“True” LBBB: relationship between electrical activation and mechanical contraction

Risum et al. Am Heart J 2013
Three-Dimensional Mapping of Optimal Left Ventricular Pacing Site for Cardiac Resynchronization

CURE: circumferential uniformity ratio estimate

Helm et al. Circulation 2007
Three-Dimensional Mapping of Optimal Left Ventricular Pacing Site for Cardiac Resynchronization
Three-Dimensional Mapping of Optimal Left Ventricular Pacing Site for Cardiac Resynchronization

RV pacing

LBB ablation + 3-week tachypacing

Helm et al. Circulation 2007
Three-Dimensional Mapping of Optimal Left Ventricular Pacing Site for Cardiac Resynchronization

Optimal Function Map (Stroke Work) + Optimal Mechanical Synchrony Map (CURE) = Optimal Function and Mechanical Synchrony Map (Overlay)

Helm et al. Circulation 2007
**CONCLUSION:** “CRT with LV free wall stimulation produced significantly better LV systolic performance compared with anterior stimulation.”

*Butter et al. Circulation 2001*
Is the Left Ventricular Lateral Wall the Best lead implantation Site for Cardiac Resynchronization Therapy?

A significant improvement in cardiac function and increase in exercise capacity were observed over time regardless of the LV stimulation sites, either considered singly or grouped as lateral versus septal sites.

Gasparini et al PACE 2003
Fluoroscopic Left Ventricular Lead Position and the Long-Term Clinical Outcome of Cardiac Resynchronization Therapy

Cardiovascular death or hospitalization for heart failure

- Middle (30/95 [31.6%])
- Anterolateral (71/191 [37.2%])
- Posterolateral (89/267 [33.3%])

$ p = 0.6206 $
Left Ventricular Lead Position and Clinical Outcome in the Multicenter Automatic Defibrillator Implantation Trial–Cardiac Resynchronization Therapy (MADIT-CRT) Trial

Sing et al. Circulation 2011
IMAGING

SCAR DETECTION

VIABILITY ASSESSMENT

ACTIVATION DELAY ASSESSMENT
**Conclusions:** Regional TDI (Tissue Doppler Imaging) quantitative analysis is an effective non-invasive technique that can assess the severity of the regional delay in activation at each LV wall in LBBB and HF patients who are candidates for BIV treatment. Even if LV performance improved significantly in all patients after BIV, the greatest improvement was found in patients paced at the most delayed site.
Heart Failure/ LV Pacing Site in CRT

Tissue synchronization imaging

Murphy et al. Am J Cardiol 2006
Heart Failure/ LV Pacing Site in CRT

Group 1 (n°22 pts) had lead placement corresponding to the segment of maximal delay

Group 2 (n°13 pts) had lead placement 1 segment adjacent

Group 3 (n°19 pts) had lead placement remote from the site

Murphy et al. Am J Cardiol 2006
Heart Failure/ LV Pacing Site in CRT

Speckle-tracking echocardiography

47 wide QRS patients, 21 (44.7%) highest delay lateral wall
82% second most delayed segments next to the first
28 concordant LV lead position (59.5%)
LV Lead Position and Response to CRT

257pts (70% LBBB)

62.7% concordant LV lead positioning

Ypenburg et al J Am Coll Cardiol 2008
LV Lead Position and Response to CRT

LV EF  concordant: from 23±7% to 33±9% (p<0.001)
LV EF  discordant: from 24±7% to 27±8% (N.S.)

Ypenburg et al J Am Coll Cardiol  2008
LV Lead Position and Response to CRT

32 ± 16 months follow-up
55 HF hospitalizations in 25 pts (10%) (20 vs 35, p 0.04)
56 deaths (23%) + 1 heart transplantation (24-month survival 85% vs 79%)

Ypenburg et al J Am Coll Cardiol 2008
Dependency of CRT on Myocardial Viability at the LV Lead Position

LS: Lead Segment
SS: Surrounding Segments

Becker J Am Coll Cardiol Img 2011
Dependency of CRT on Myocardial Viability at the LV Lead Position

CS: Circumferential Strain
Cut-off: -11.1%

Becker J Am Coll Cardiol Img 2011
Survival in Ischemic Heart Failure After CRT

Delgado Circulation 2011
Survival in Ischemic Heart Failure After CRT

**Model 1**, clinical variable (age, plasma levels of creatinine).

**Model 2**, model 1 plus dyssynchrony.

**Model 3**, model 2 plus discordant LV lead position

**Model 4**, model 3 plus myocardial Scar in the targeted segment

Delgado  Circulation 2011
Analysis of LV Lead Position in Cardiac Resynchronization Therapy Using Different Imaging Modalities

Becker et al. J Am Coll Card Img 2010
A total of 220 patients scheduled for CRT underwent baseline echocardiographic speckle-tracking 2-dimensional radial strain imaging and were randomized 1:1 into 2 groups:

**GROUP 1** (TARGET [ Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy]). LV lead was positioned at the latest site of peak contraction with an amplitude of >10% to signify freedom from scar.

**GROUP 2** (control) patients underwent standard unguided CRT.

Khan et al. J Am Coll Cardiol 2012
Speckle-Tracking Echocardiography to Determine Optimal Sites

Khan et al. J Am Coll Cardiol 2012
Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy

The TARGET Study: A Randomized, Controlled Trial

Table 2

<table>
<thead>
<tr>
<th>Latest site of activation, % (% basal/mid)</th>
<th>Target Group (n = 103)</th>
<th>Control Group (n = 104)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior</td>
<td>13 (13) [4/9]</td>
<td>14 (15) [6/9]</td>
<td>0.962</td>
</tr>
<tr>
<td>Posterior</td>
<td>38 (39) [14/24]</td>
<td>41 (43) [15/26]</td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>32 (33) [13/19]</td>
<td>31 (32) [11/20]</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>9 (9) [3/6]</td>
<td>7 (7) [3/4]</td>
<td></td>
</tr>
<tr>
<td>Anteroseptal</td>
<td>4 (4) [1/3]</td>
<td>4 (4) [1/3]</td>
<td></td>
</tr>
<tr>
<td>Interoseptal</td>
<td>4 (4) [1/3]</td>
<td>3 (3) [0/3]</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of changes in left ventricular (LV) volumes and LV function between both study groups at baseline and at 6-month follow-up showing greater improvement in LV reverse remodeling and improvements in ejection fraction in the TARGET population.

Khan et al. J Am Coll Cardiol 2012
Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy

The TARGET Study: A Randomized, Controlled Trial

Khan et al. J Am Coll Cardiol 2012
Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy

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Khan et al. J Am Coll Cardiol 2012
Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy

The TARGET Study: A Randomized, Controlled Trial
A: Short-axis echocardiography speckle tracking images (RADIAL STRAIN) at basal and mid-left ventricular (LV) levels. Site of latest mechanical activation (arrows right top) was determined to be basal lateral (left top).

CONCORDANT LV SITE:
• echo-guided group 85%
• control group (by chance) 66% (P 0.01)

Saba et al Circ Heart Fail 2013
THE STARTER TRIAL

Saba et al. Circ Heart Fail 2013
THE STARTER TRIAL

Saba et al Circ Heart Fail 2013
THE STARTER TRIAL

**Patient A** had a significant septal to posterior wall strain delay by speckle tracking echocardiography that resynchronized after CRT with a concordant left ventricular (LV) lead position.

**Patient B** had significant dyssynchrony that failed to resynchronize after CRT with a remote LV lead position.

Saba et al Circ Heart Fail 2013
The STARTER TRIAL

Resynchronization was defined as having dyssynchrony at baseline (> 95 ms anterior to septal radial strain delay) and a > 50% reduction in dyssynchrony after CRT.

Saba et al Circ Heart Fail 2013
Limitations of speckle tracking echocardiography

✓ Need of optimal short axis alignment
✓ Need of good acoustic window, high frame-rate images and high quality ECG trace
✓ Requirement of a dedicated software
✓ Requirement of off-line imaging processing
✓ Lack of absolute consensus on best parameter (radial vs longitudinal vs circumferential strain) and cut-offs
✓ LV lead implantation at the most delayed site is not always possible because of technical issues (not suitable anathomy, high threshold, high likelihood of dislodgment, phrenic nerve stimulation, etc...)
Conclusions

✓ Tailored LV-lead position impacts patients response to CRT.
✓ Although significant LV reverse remodeling and favourable clinical outcome was demonstrated after CRT regardless of LV lead site, the preponderance of available data support the hypothesis of the importance of proper LV lead position to optimize clinical outcomes.
✓ Speckle tracking echocardiography allows detection of myocardial viability as well as assessment of the site of latest mechanical activation.
✓ In 2 RCTs the strategy of echocardiographic guidance to LV lead placement was proved superior to a routine approach in CRT device implantation in terms of major clinical outcomes as well as degree of LV reverse remodeling.
Thank you for your attention