

**De Meerwaarde van Cardio Resynchronisatie Therapie bij Hartfalen**

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Continuing Nursing Education  
 Hartfalen  
 29 oktober 2013, Utrecht

**Devices & Heart Failure**

2001, 2007, 10/2010, 11/2011

Center

**ICD's**

University Medical Center  
 Utrecht

**ICD lead fractures: a common problem**

Sprint Fidelis  
 Riata  
 Endotak

**Lead Body Competitive Comparison**

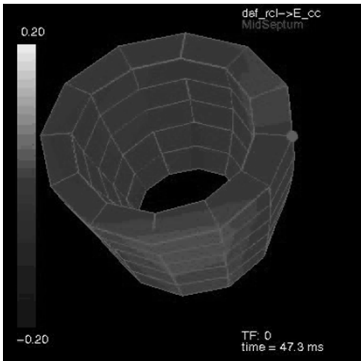
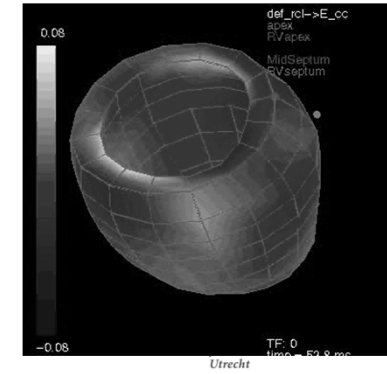
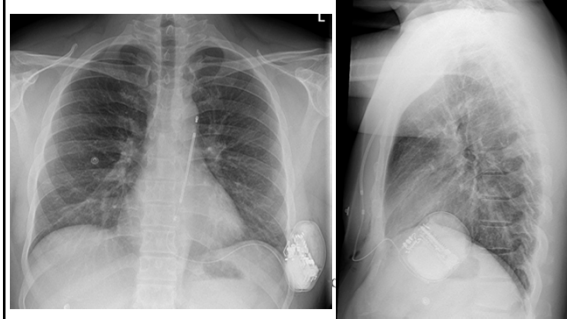
STJ Durata™	RELIANCE 4-FRONT™	MDT Sprint Quattro™
6.8 F (2.3mm)	7.3F (2.4mm)	8.4F (2.8mm)

~~ICD "zonder" draad~~  
**ICD zonder draad in het hart**

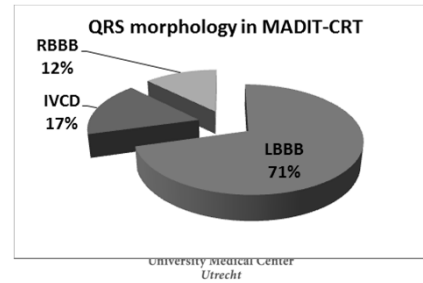
**S-ICD implantatie**



**S-ICD**



**Substudy “QRS morphology” in MADIT-CRT**

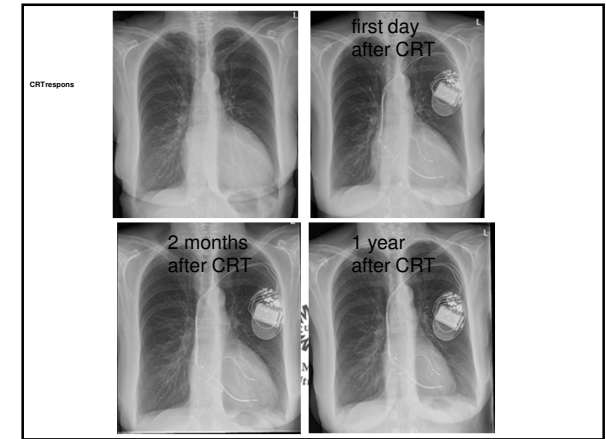
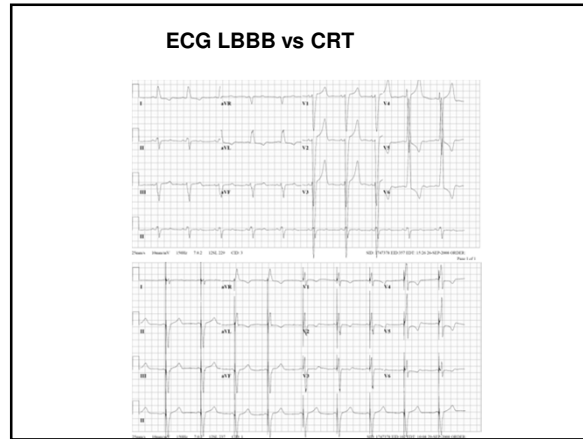
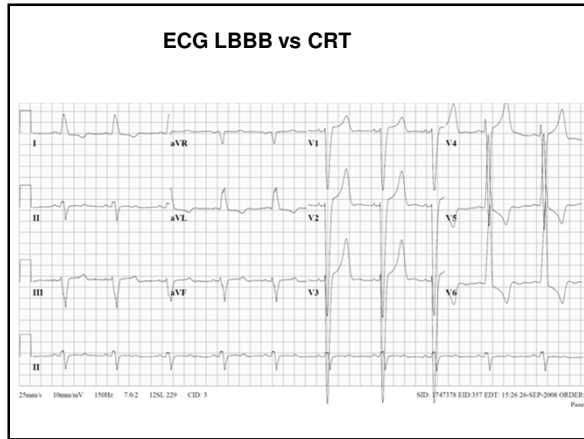


MADIT-CRT, HRS 2010

**Devices in heart failure patients**

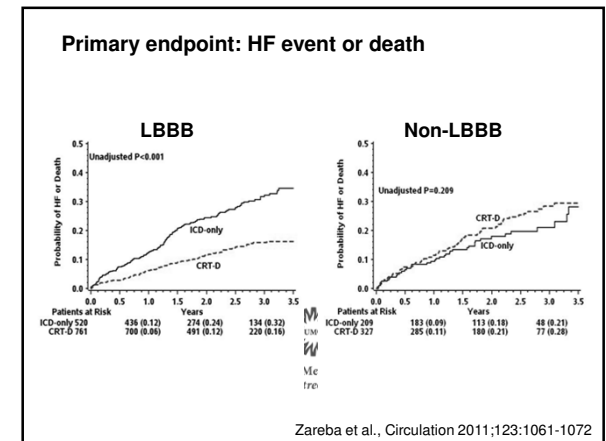
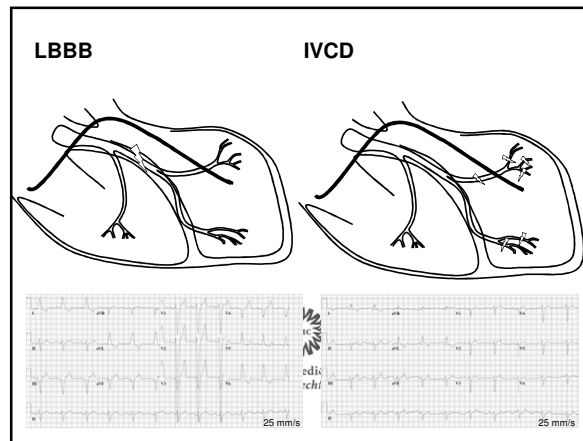
- Improvement of LV function
  - CRT
    - Indication
    - Implantation
    - Optimization

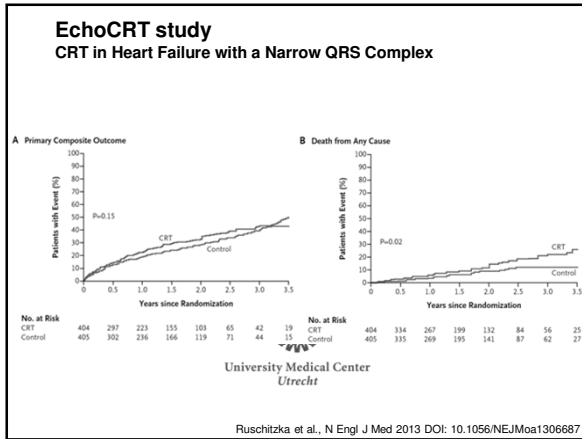




### QRS-duration in 'milestone trials'

study	QRS-duration cut-off	RBBB	echo	QRS-duration inclusion
PATH-CHF	≥ 120 ms	y	no	71% > 150 ms
MIRACLE	≥ 130 ms	y	no	mean 166 ms
CARE-HF	≥ 120 ms	y	y (120-149 ms)	71% ≥ 150 ms
COMPANION	≥ 120 ms	y	no	68% ≥ 150 ms
REVERSE	≥ 120 ms	y	no	mean 153 ms
MADIT-CRT	≥ 130 ms	y	no	65% ≥ 150 ms
RAFT	≥ 120 ms	y	no	mean 158 ms
RethinQ	≤ 130 ms	y	y	mean 107 ms
EchoCRT	< 130 ms	y	y	mean 105 ms





### Indications for cardiac resynchronization therapy in patients with ...

... sinus rhythm permanent atrial fibrillation ... conventional pacemaker indications and heart failure

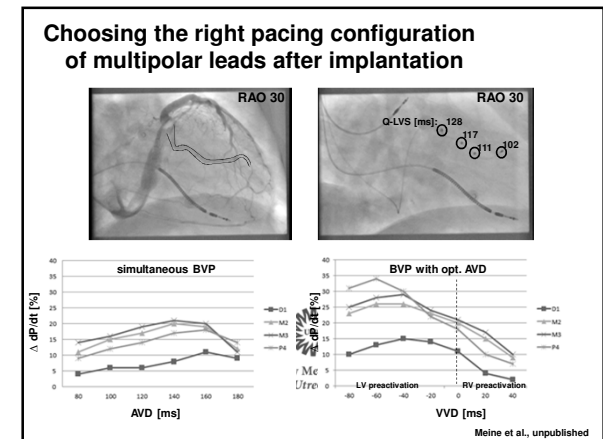
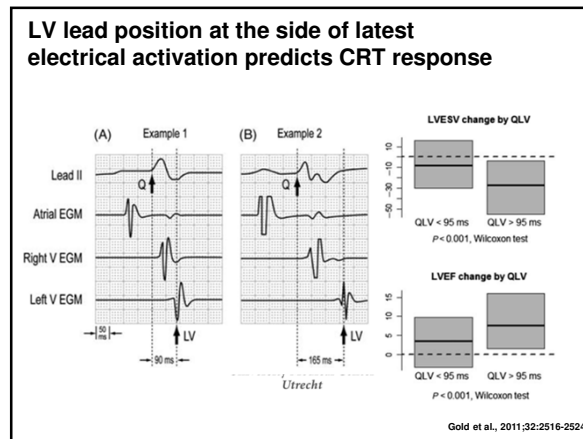
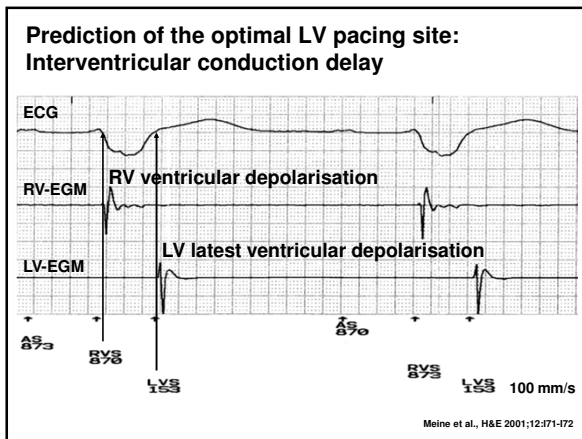
Recommendations	Class*	Level†
1) LBBB with QRS duration >150 ms. CRT is recommended in chronic HF patients and LVEF <35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment.*	I	A
2) LBBB with QRS duration 120-150 ms. CRT is recommended in chronic HF patients and LVEF <35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment.*	I	B
3) Non-LBBB with QRS duration >150 ms. CRT should be considered in chronic HF patients and LVEF <35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment.*	IIa	B
4) Non-LBBB with QRS duration 120-150 ms. CRT may be considered in chronic HF patients and LVEF <35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment.*	IIb	B
5) CRT in patients with chronic HF with QRS duration <120 ms is not recommended.	III	B

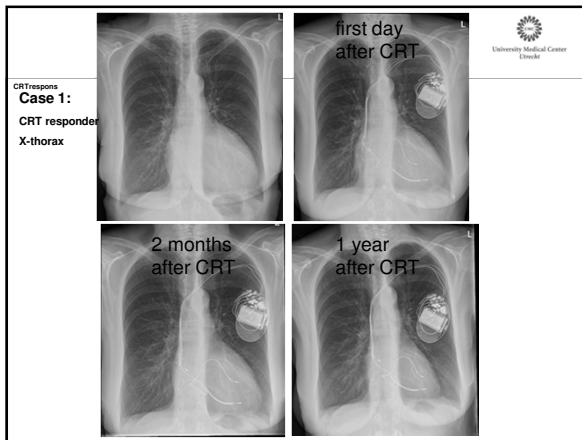
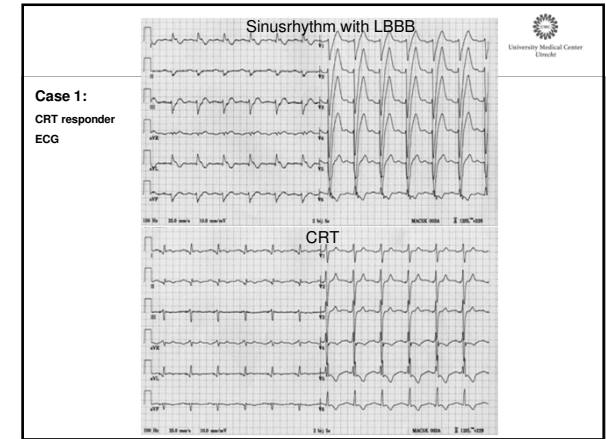
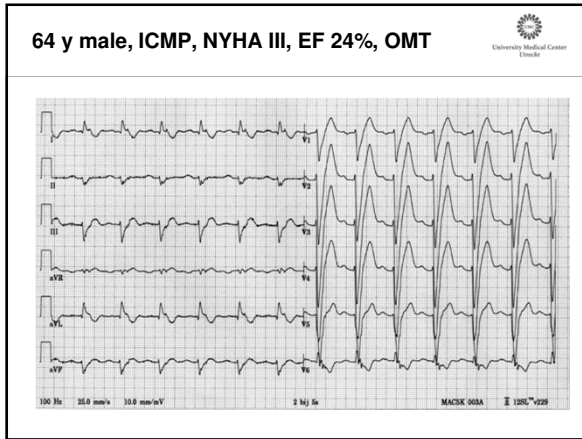
Eur Heart J (2013) 34 (29): 2281-2329  
doi: 10.1093/eurheartj/eh1150

### Table of content

- Optimizing CRT:
  - LV lead implantation
  - AV and VV delay

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**ESC Guidelines CRT**

Recommendation in patients with heart failure in New York Heart Association function class III/IV

Recommendation	Patient population	Class <sup>a</sup>	Level <sup>b</sup>	Ref. <sup>c</sup>
CRT-ICRT-D is recommended to reduce morbidity and mortality <sup>d</sup>	NYHA function class III/IV LVEF < 35%, QRS > 120 ms, SR Optimal medical therapy Class IV patients should be ambulatory <sup>e</sup>	I	A	5-19

<sup>a</sup>Class of recommendation.  
<sup>b</sup>Level of evidence.  
<sup>c</sup>References.  
<sup>d</sup>Reasonable expectation of survival with good functional status for >1 year for CRT-D. Patients with a secondary prevention indication for an ICD should receive a CRT-D.  
<sup>e</sup>No admissions for HF during the last month and a reasonable expectation of survival >6 months.  
CRT = cardiac resynchronization therapy; CRT-P = CRT with pacemaker function; CRT-D = CRT with defibrillator function; ICD = implantable cardioverter defibrillator; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; SR = sinus rhythm.

Dickstein et al., EHJ 2010

- Patient selection  
QRS duration**
- Guidelines  $\geq 120$  ms ?
    - PATH-CHF**  $\geq 120$  ms (71 %  $\geq 150$  ms)
    - MIRACLE**<sup>§</sup>  $\geq 130$  ms (mean QRS width 166 ms)
    - CARE-HF**<sup>¶</sup>  $\geq 120$  ms (88 %  $\geq 150$  ms, mean QRS width 160 ms)
    - COMPANION**<sup>1</sup>  $\geq 120$  ms (68 %  $\geq 150$  ms, mean QRS width 160 ms)
    - PROSPECT**  $\geq 130$  ms (mean QRS 163 ms)
    - REVERSE**  $\geq 120$  ms (mean QRS 153 ms)
    - MADIT-CRT**<sup>2</sup>  $\geq 130$  ms (65 %  $\geq 150$  ms)
    - RAFT**<sup>3</sup>  $\geq 120$  ms (mean QRS 158 ms)
    - RethinQ**  $\leq 130$  ms (no benefit of CRT)
- <sup>§</sup> MIRACLE and CONTAK CD meta-analysis: no benefit of pts with RBBB  
<sup>¶</sup> CARE-HF: QRS 120-150 ms required echo asynchrony  
<sup>1, 2, 3</sup> CRT benefit only in pts with LBBB

**MADIT-CRT (III)**

The **NEW ENGLAND**  
JOURNAL of **MEDICINE**

Cardiac-Resynchronization Therapy for the Prevention  
of Heart-Failure Events

Arthur J. Moss, M.D., W. Jackson Hall, Ph.D., David S. Cannom, M.D., Helmut Klein, M.D., Mary W. Brown, M.S.,  
James P. DiMarco, M.D., N.A. Mark Estes III, M.D., Elvira Frustaci, M.D., Henry Greenberg, M.D.,  
Steven L. Higgins, M.D., Marc A. Pfeffer, M.D., Ph.D., Scott D. Solomon, M.D., David Wilber, M.D.,  
and Wojciech Zareba, M.D., Ph.D., for the MADIT-CRT Trial Investigators\*

N Engl J Med 2009;361

**Methods – MADIT-CRT**

- enrollment: N = 1820, 12/2004 – 04/2008
- inclusion:
  - ICMP NYHA I,II (N = 265, 734)
  - NICMP NYHA II (N = 821)
  - EF ≤ 30% (mean EF = 24 %)
  - QRS ≥ 130 ms (65 % had QRS ≥ 150 ms, 70 % LBBB)
  - stable CHF, optimal medication, SR at least 1 m before enrollment
- randomization CRT-D (3) : ICD (2)

Moss et al., N Engl J Med 2009;361

**Result: death or heart failure event  
MADIT-CRT**

No. at Risk (Probability of Survival)

ICD only	731	621 (0.89)	379 (0.78)	173 (0.71)	43 (0.63)
CRT-ICD	1089	985 (0.92)	651 (0.86)	279 (0.80)	58 (0.73)

Moss et al., N Engl J Med 2009;361

**Result – primary endpoint in detail  
MADIT-CRT**

Table 2. Risk of Death or Heart Failure.\*

Variable	ICD-Only Group	CRT-ICD Group	Hazard Ratio (95% CI)†	P Value
	no. (%)			
All patients	731	1089		
Death or heart failure‡	185 (25.3)	187 (17.2)	0.66 (0.52–0.84)§	0.001§
Heart failure only	167 (22.8)	151 (13.9)	0.59 (0.47–0.74)	<0.001
Death at any time¶	53 (7.3)	74 (6.8)	1.00 (0.69–1.44)	0.99

Moss et al., N Engl J Med 2009;361

**Sub-analysis  
MADIT-CRT**

Variable	No. of Events/No. of Patients	Hazard Ratio
Age		
<65 yr	142/852	
≥65 yr	230/968	
Sex		
Male	294/1807	
Female	78/453	
NYHA class		
Ischemic I	53/265	
Ischemic II	186/734	
Nonischemic II	133/821	
QRS duration		
<150 msec	147/645	
≥150 msec	235/1175	
LVEF		
≥25%	101/646	
<25%	271/1174	
LVEDV		
≤240 ml	184/828	
>240 ml	184/969	
LVEFV		
≤170 ml	190/835	
>170 ml	178/962	
All patients	372/1820	

Moss et al., N Engl J Med 2009;361

**Primary endpoint: HF event or death**

Patients at Risk

ICD-only 528	436 (0.12)	274 (0.24)	134 (0.32)
CRT-D 761	700 (0.06)	491 (0.12)	220 (0.16)

ICD-only 309	183 (0.09)	113 (0.18)	48 (0.21)
CRT-D 327	285 (0.11)	180 (0.21)	77 (0.28)

MADIT-CRT, HRS 2010

### Probleem nonresponders

- Geen LBTB
- Niet optimale lokalisatie
- Hoge drempel
- Phrenicus stimulatie
- Geen goede timing

### Case 2: CHF NYHA III, QRS ≥ 120 ms

CRT non-responder

QRS 132 ms, PQ 178 ms

- Non LBBB
- ICMP, ASI
- EF 25 %

### CRT non-responder despite optimal LV lead placement

Case 2: CRT non-responder X-thorax

### ESC Guidelines CRT: NYHA class II

Recommendation in patients with heart failure in New York Heart Association function class II

Recommendation	Patient population	Class <sup>a</sup>	Level <sup>b</sup>	Ref. <sup>c</sup>
CRT preferentially by CRT-D is recommended to reduce morbidity or to prevent disease progression <sup>d</sup>	NYHA function class II LVEF ≤ 35% QRS ≥ 150 ms SR	I	A	9, 20-22
	Optimal medical therapy			

<sup>a</sup>Class of recommendation.  
<sup>b</sup>Level of evidence.  
<sup>c</sup>References.  
<sup>d</sup>The guideline indication has been restricted to patients with HF in NYHA function class II with a QRS width ≥ 150 ms, a population with a high likelihood of a favourable response.  
 CRT = cardiac resynchronization therapy; CRT-D = CRT with defibrillator function; HF = heart failure; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; SR = sinus rhythm.

Dickstein et al, EHJ 2010

### Venogram of the the coronary sinus

LAO 40°      RAO 30°

- Anatomie
- Drempelwaarde
- Phrenicus stimulatie

### Methods: LV "mapping"

LAO 40°

RAO 30°

LV  $dP/dt_{max}$  at each pacing site:  
 AVD: 200 ms – 80 ms (BiV pacing)  
 VVD: 80 ms (LV first) – 80 ms (RV first)

### Case report 3 dP/dt (LV pacingsite, AVD, VVD)

#### Simultaneous BVP (AVD)

#### VV sequential BVP (VVD)

### A non-optimal pacing site can not be compensated by optimization of the VV delay

Bogaard et al., Europace 2010;12:1262-69

### Quadripolar LV lead

### Optimal programming of the AV and VV delay?

- **Doppler echocardiography**  
[Jansen et al., Am J Cardiol 2006]
- **TDI**  
[Sogaard et al., Circulation 2002]
- **Intracardiac EGM**  
[Meine et al., Europace 2004]
- **LV dP/dt**  
[van Gelder et al., Am J Cardiol 2004]

### AV timing

Obtain Pulsed Wave Transmittal Doppler View

Apical 4 chamber View

Observe E-wave, A-wave, and ECG



### AV optimalisatie

University Medical Center Utrecht

Medtronic academia Optimizing the AV Interval Using Doppler Echocardiography

Short AV      Long AV      Optimized AV

### VV timing

University Medical Center Utrecht

V-V 4 MSEC

### CRT ECG

Interpretation of the ECG during CRT

University Medical Center Utrecht

### LV pacing, posterolateral

University Medical Center Utrecht

lead I: negative      aVL: negative  
lead II: positive/negative      aVF: positive  
lead III: positive

V1: positive  
V6: positive/negative

### SR, LBBB

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### LV pacing VVI

### BV pacing

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lead I: negative      aVL: positive  
lead II: negative      aVF: negative  
lead III: negative/positive

V1: positive  
V6: negative

