

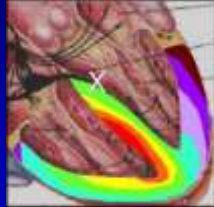
EAE Teaching Course  
Sofia, 2012



# Assessing LV Dyssynchrony

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Belgium

## Left Bundle Branch Block



JU Voigt, University Leuven, Belgium Prinzen et al., 2000

## Left Bundle Branch Block

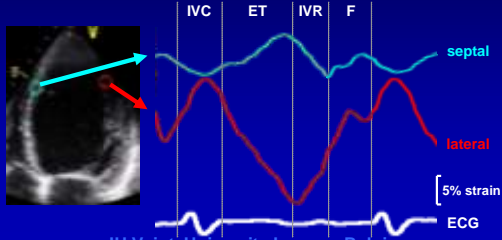
intra-ventricular asynchrony



JU Voigt, University Leuven, Belgium

## Left Bundle Branch Block

intra-ventricular asynchrony



IVC ET IVR F septal lateral  
5% strain  
ECG

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## Left Bundle Branch Block

mechanical consequences

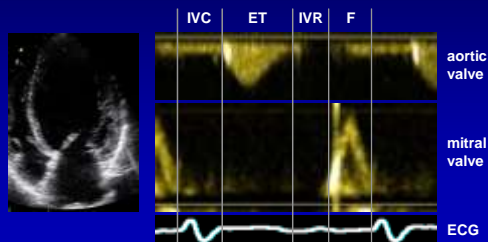
- septal contraction without load ejection due to lateral contraction
- asymmetric hypertrophy
- LV dilatation

↪ LV – „remodelling“

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## Left Bundle Branch Block

haemodynamic consequences



IVC ET IVR F aortic valve mitral valve  
ECG

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### Left Bundle Branch Block

#### haemodynamic consequences

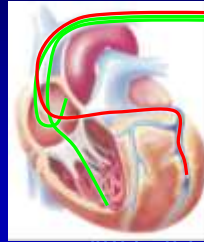
septal contraction stops filling  
 slow pressure rise  
 long IVCT, short ejection,  
 asynchronous relaxation  
 long IVRT



**impaired LV function  
 even without cardiomyopathy !**  
 JU Voigt, University Leuven, Belgium

### CRT Principle

#### bi-ventricular stimulation



„Left ventricular pre-excitation to restore physiologic AV timing and contraction synchrony.“

Leglerc & Kass, JACC 2002

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### CRT Patient Selection

## Patient Selection According to Guidelines

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### CRT Patient Selection

**clinical criteria:**  
 symptomatic congestion NYHA III-IV\*  
 ischaemic oder non-ischaemic cardiomyopathy\*

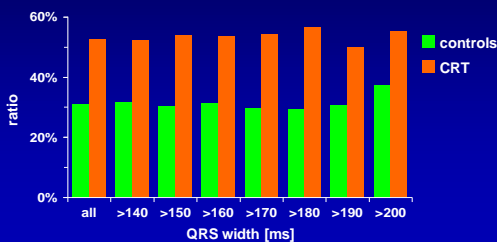
**ECG criteria:**  
 QRS  $\geq 130\text{ms}^*$   
 sinus rhythm  
 LBBB

**echo criteria:**  
 LV end-diastolic diameter  $\geq 55\text{mm}$   
 LV EF  $\leq 35\%$   
 mechanical criteria of LV asynchrony

JU Voigt, University Leuven, Belgium FAHA/ACC/NASPE guidelines 2002, 2007

### Selection by QRS Width ?

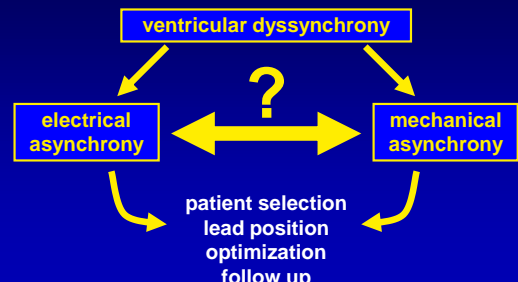
#### MIRACLE - study: CRT response vs. QRS width



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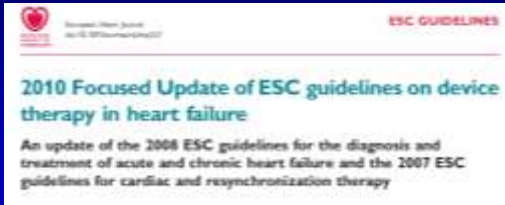
nach Sogaard 2002

### CRT Patient Selection



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## The New Guidelines



JU Voigt, University Leuven, Belgium; Dickstein et al., Eur Heart J 2010

## The New Guidelines

### new selection criteria

ESC Guidelines  
 Considering limited resources, it would be prudent to target the population most likely to respond favourably. In patients with mild symptoms and a QRS width of 120–150 ms, clinicians may wish to assess other criteria associated with a favourable outcome such as dyssynchrony by echocardiography, LV dilatation, LBBB, non-ischaemic cardiomyopathy, or recent NYHA class III symptoms.

JU Voigt, University Leuven, Belgium; Dickstein et al., Eur Heart J 2010

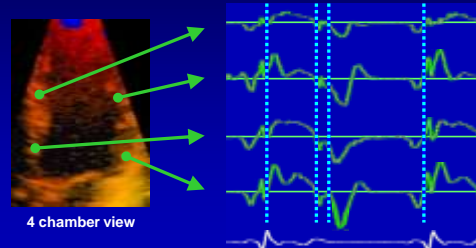
## CRT Patient Selection

# Assessing Mechanical Asynchrony Tissue Velocity

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## Tissue Velocity Imaging

### synchronous velocity patterns

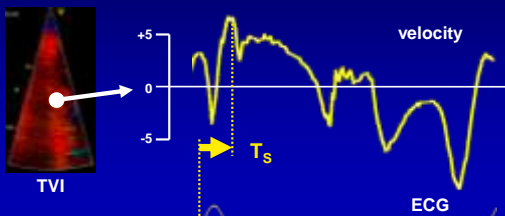


4 chamber view

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## Asynchrony by TVI

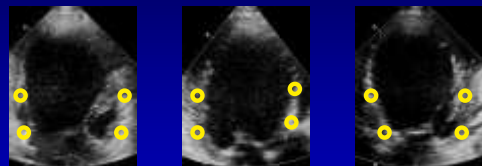
### onset QRS – peak velocity



JU Voigt, University Leuven, Belgium

## Asynchrony by TVI

### timing of max. syst. velocity



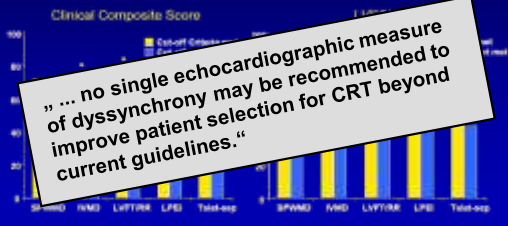
$T_s$ -SD (12 segments)  
 cut-off 34.4 ms  
 sens. 87%, spec. 81%

Bax/Gorscan (2 segments) ...  
 cut-off 65 ms ...  
 sens. 87%, spec. 100% ...

JU Voigt, University Leuven, Belgium; CC 05; Gorscan, AJC 04

### PROSPECT Study

added predictive value of echo parameters



\*Sign. higher level of response among those meeting the cut-off (p < 0.05)  
 JU Voigt, University Leuven, Belgium. Circulation 2008; 117: 2608-2616

### Assessing Asynchrony

Does peak systolic velocity tell us about contraction ?

When does the wall move fastest?



When does the wall contract?

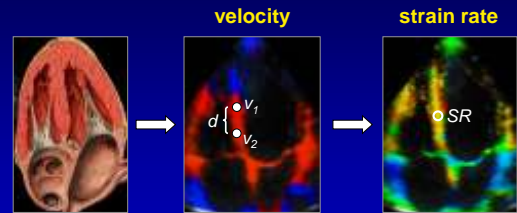
JU Voigt, University Leuven, Belgium

### CRT Patient Selection

Assessing Mechanical Asynchrony  
 Deformation Imaging

JU Voigt, University Leuven, Belgium

### Strain Rate Imaging



$$v = \frac{\Delta f}{f_0} \cdot \frac{1}{2} c$$

$$\text{Strain Rate} = \frac{v_1 - v_2}{d}$$

JU Voigt, University Leuven, Belg.....

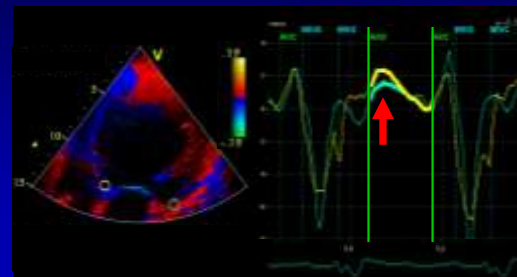
JU Voigt 1998

### Typical LBBB



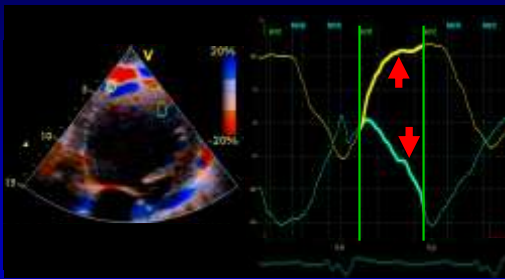
JU Voigt, University Leuven, Belgium

### Synchronous Velocity Peaks



JU Voigt, University Leuven, Belgium

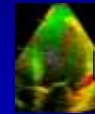
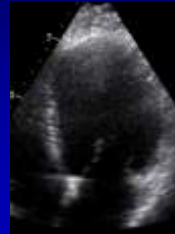
### Asynchronous Deformation !



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### High Scar Burden

velocity based parameters



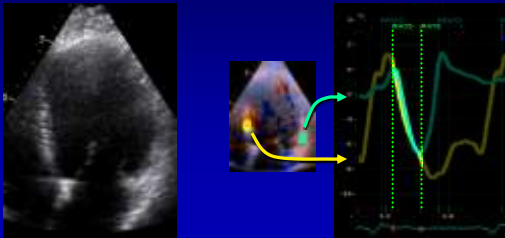
velocity based parameters:

Septal Lat delay	56 ms
Septal Post delay	143 ms
Basal max delay	166 ms
Basal stdev	76 ms
All seg. max delay	201 ms
All segments stdev	64 ms

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### High Scar Burden

deformation measurement

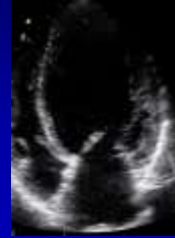


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### Selection by QRS Width ?

LSB, QRS 154ms

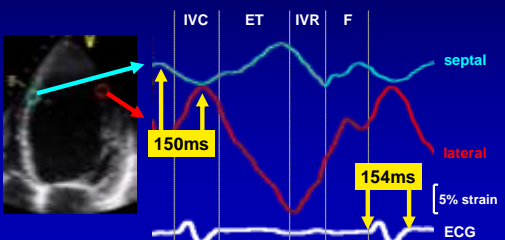
LSB, QRS 162ms



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### Selection by QRS Width ?

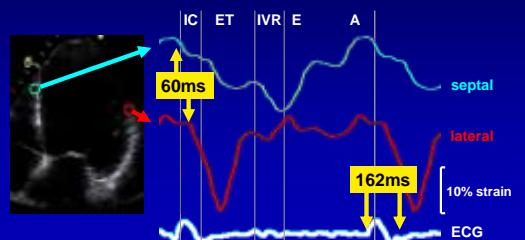
Pat.1: H<sub>x</sub> myocarditis, no CAD



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### Selection by QRS Width ?

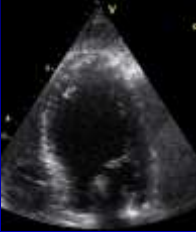
Pat.2: CAD, H<sub>x</sub> anterior infarction




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### Deformation Imaging in CRT

CRT off



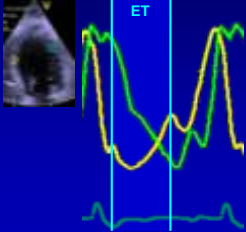
CRT on



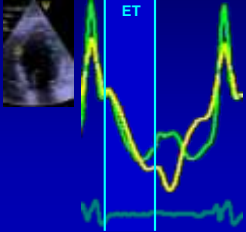
JU Voigt, University Leuven, Belgium

### Deformation Analysis for CRT

CRT on



CRT off



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### CRT Patient Selection


## Assessing Mechanical Asynchrony

### Other Approaches

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### Septal Flash

short septal bounce in early systole



**Study:**

52 patients

septal flash at rest

sensitivity 82%

specificity 88%

septal flash LD Dobu

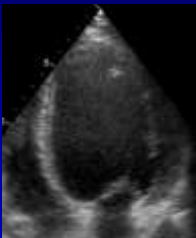
sensitivity 97%

specificity 88%

JU Voigt, University Leuven, Parsa / Sutherland et al., Eur Heart J 2009

### Apical Rocking

characteristic motion pattern in LBBB



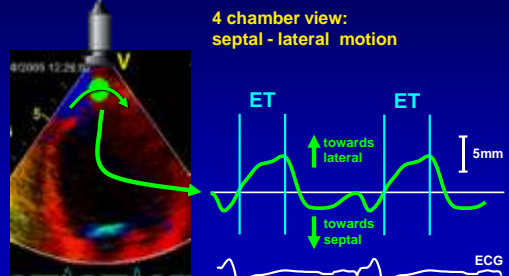
**typical features:**

- reduced LV function
- early short septal motion
- lateral motion during ejection

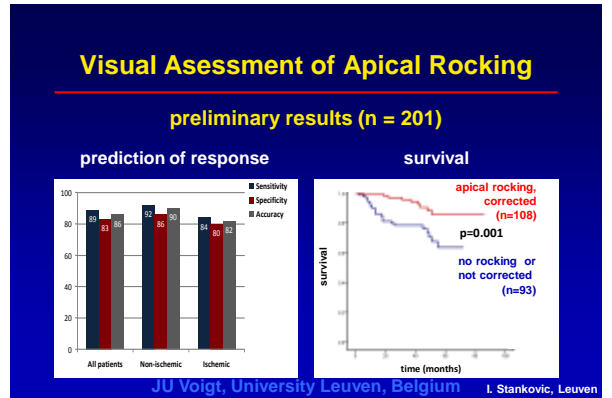
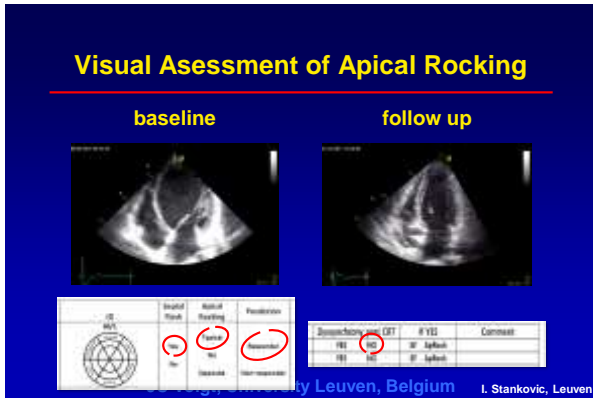
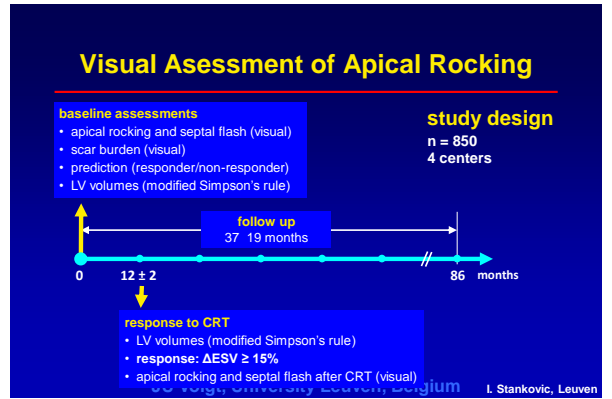
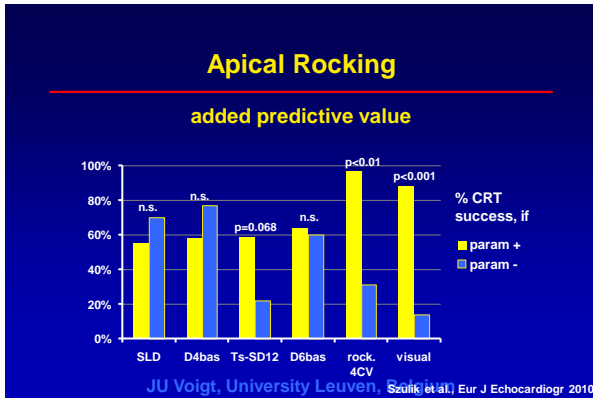
JU Voigt, University Leuven, Belgium

### Apical Rocking

4 chamber view: septal - lateral motion



JU Voigt, University Leuven, Belgium Voigt et al., Eur Heart J 2009



## Summary

Echocardiography can analyze regional myocardial function in patients eligible for CRT.

Optimal parameters for patient selection are still subject to debate.

Dyssynchrony may be measured by tissue velocity based parameters which do not always mirror the true contraction sequence.

Preliminary study results indicate, that septal flash, apical rocking or deformation based parameters may be helpful alternative approaches.

JU Voigt, University Leuven, Belgium