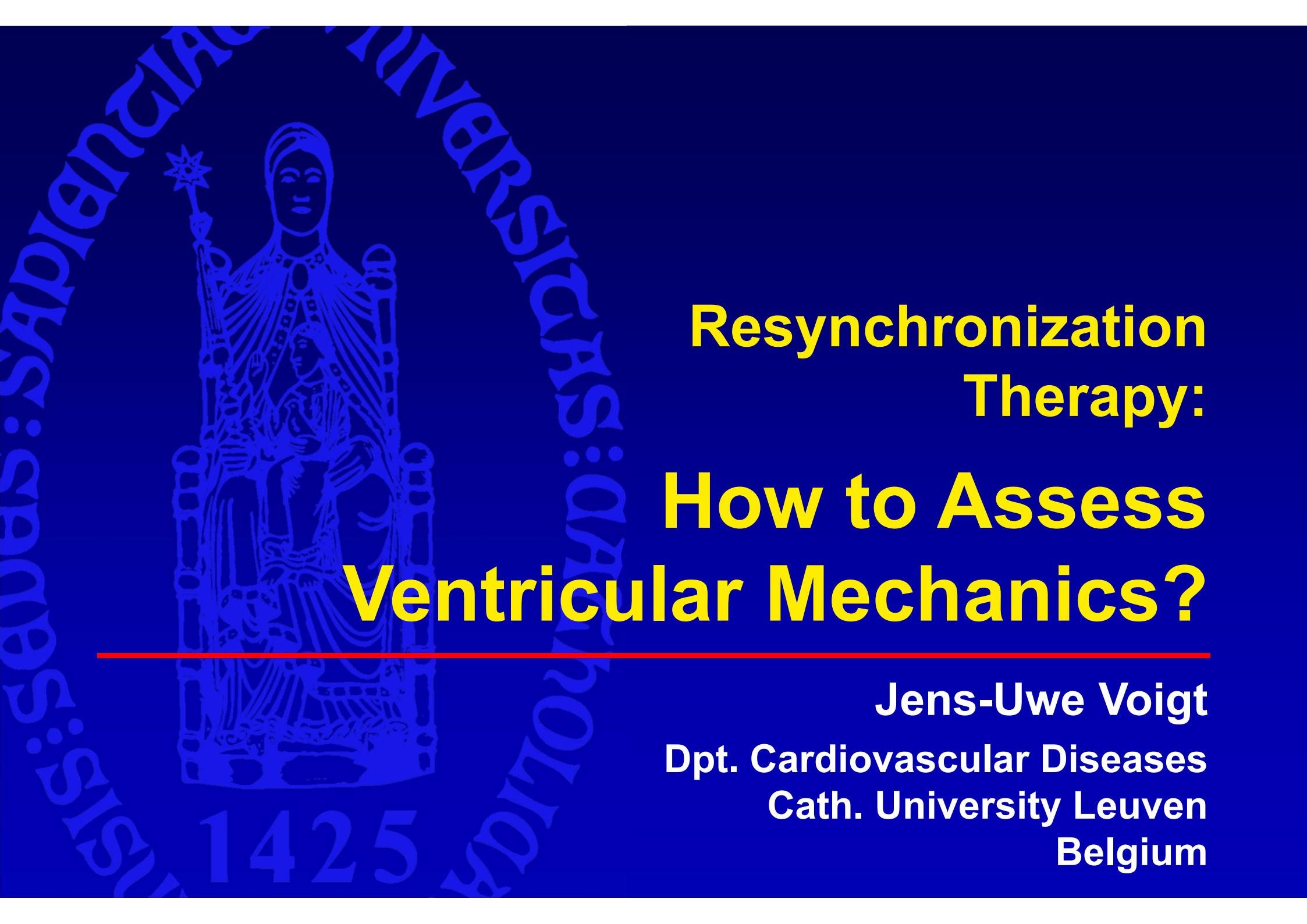




Resynchronization Therapy: How to Assess Ventricular Mechanics?

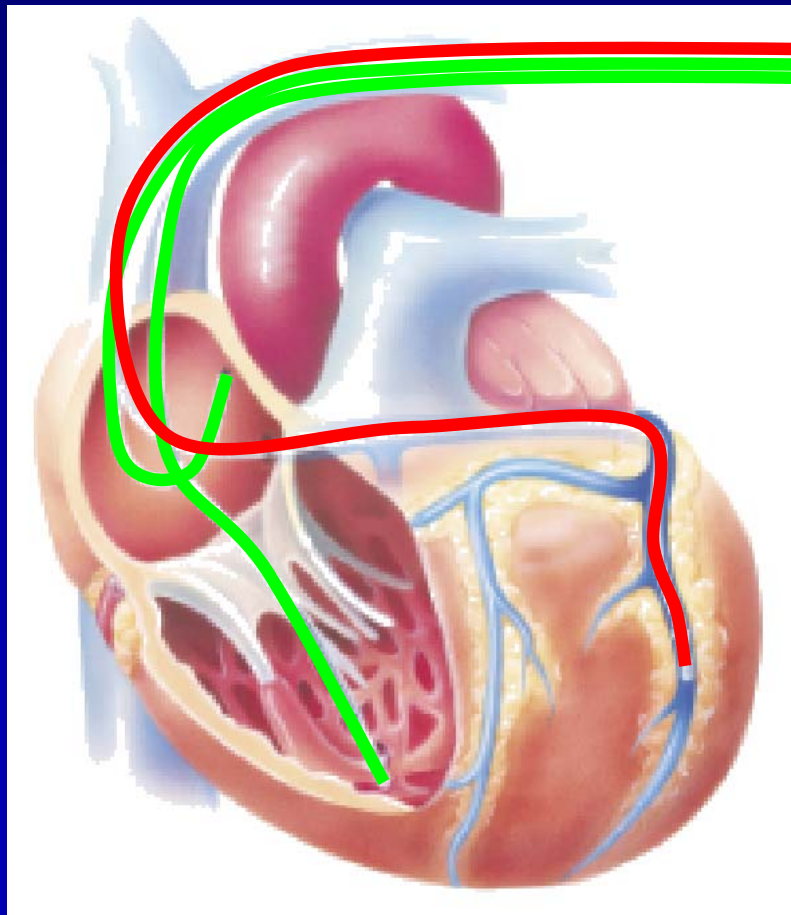
Jens-Uwe Voigt
Dpt. Cardiovascular Diseases
Cath. University Leuven
Belgium

Resynchronizuation Therapy

**What is the
State of the Art ?**

CRT Principle

bi-ventricular stimulation

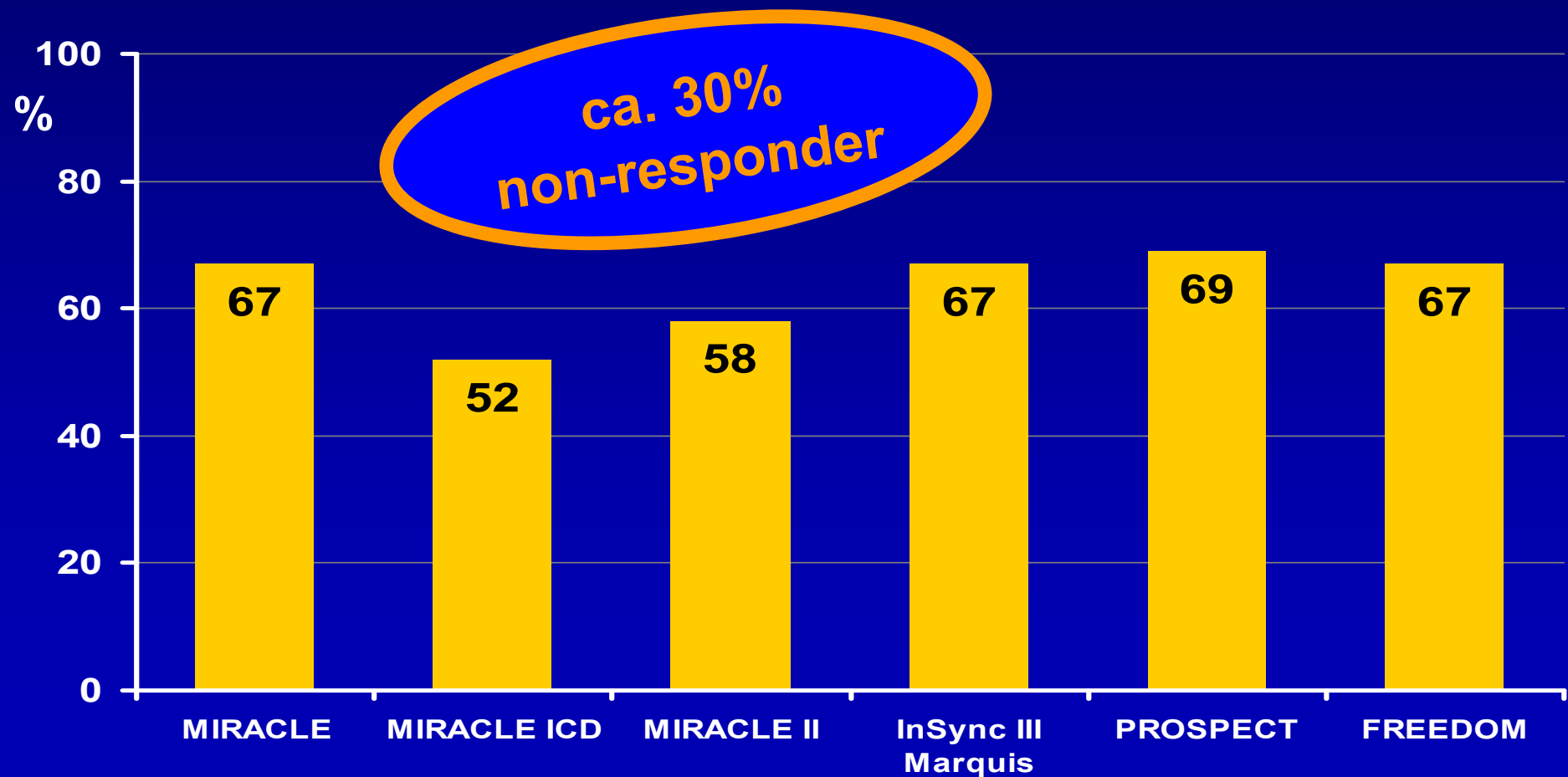


„Left ventricular pre-excitation to restore physiologic AV timing and contraction synchrony.“

Leqlerc & Kass, JACC 2002

Statistics

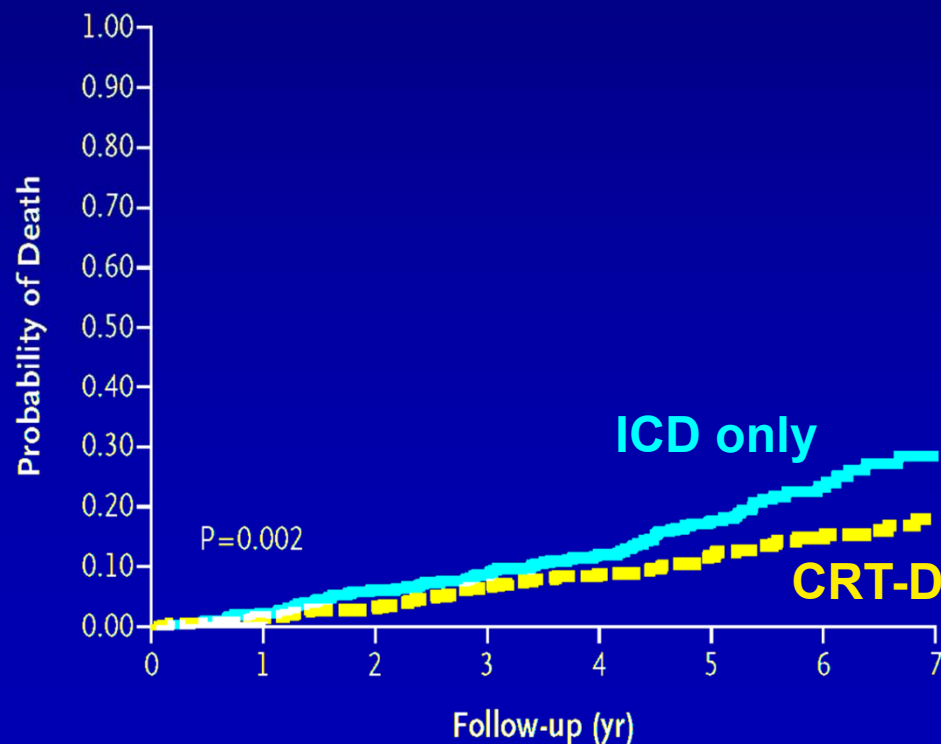
improved clinical condition after CRT



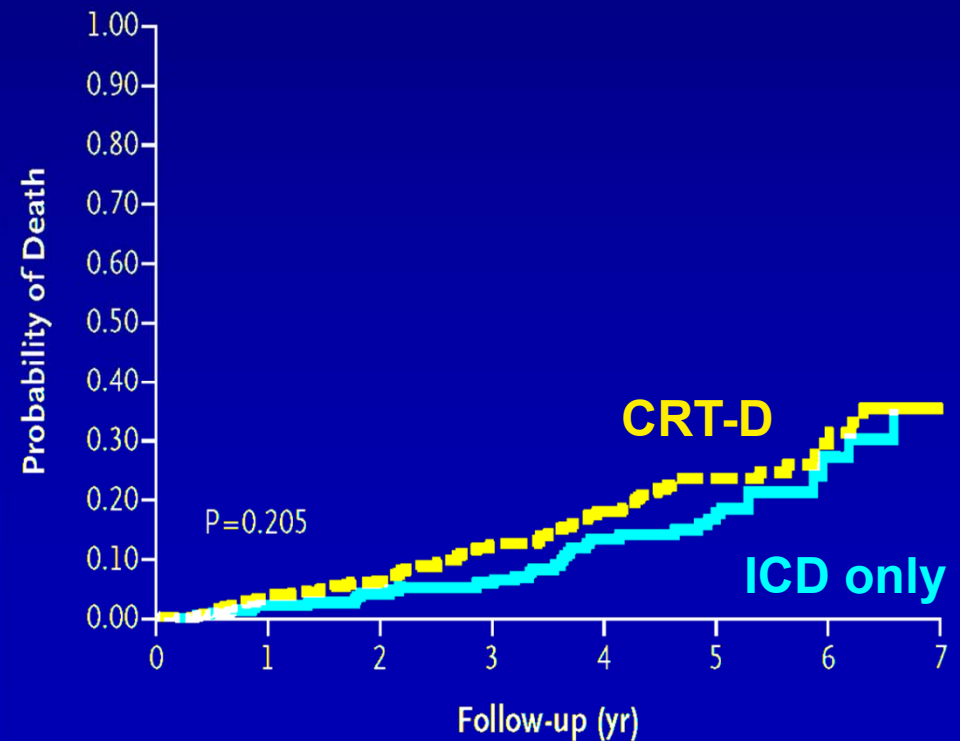
CRT may harm your patient !

benefit for LBBB – harm for non-LBBB

mortality with LBBB



mortality without LBBB



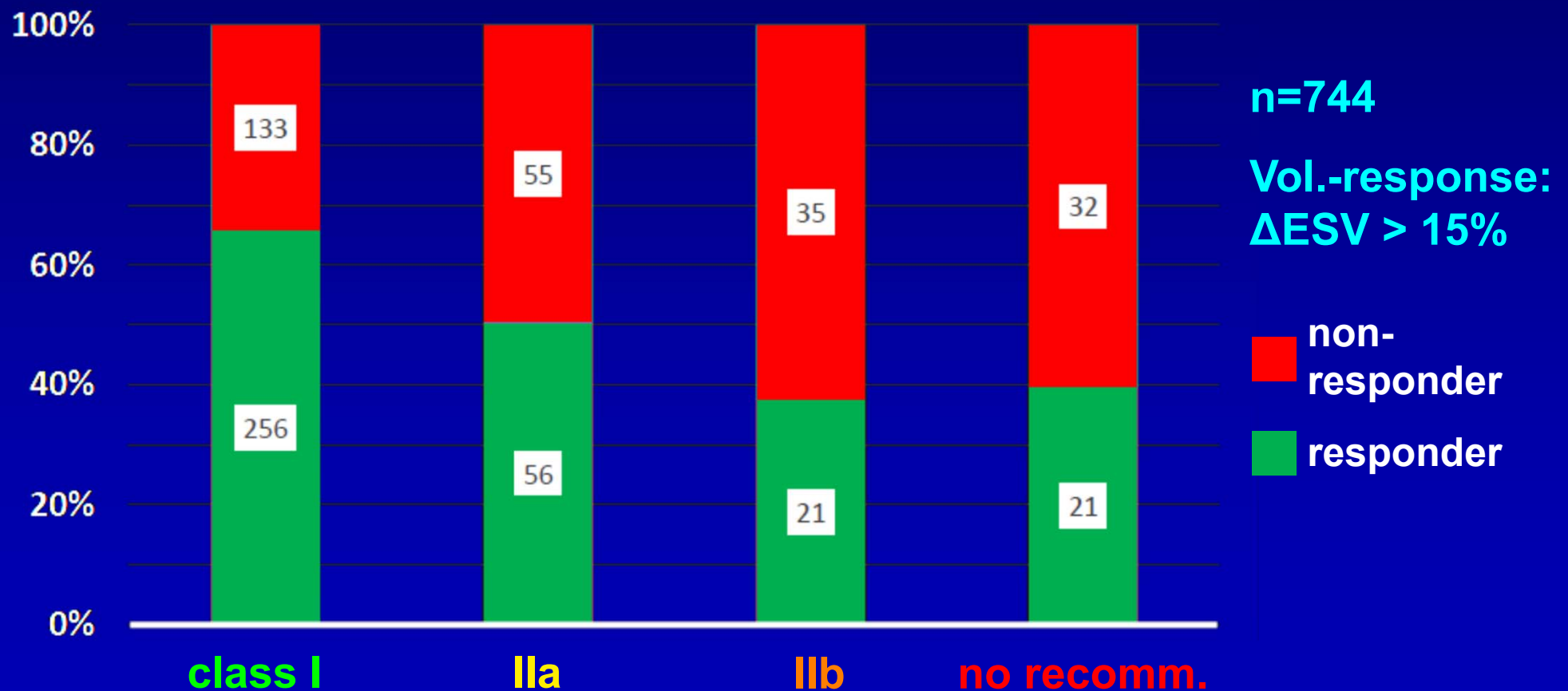
Current ESC Guidelines

patient selection: symptoms, EF and QRS width

Recommendations	Class ^a	Level ^b	Ref ^c
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration ≥ 150 msec and LBBB QRS morphology and with LVEF $\leq 35\%$ despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	A	261–272
CRT should be considered for symptomatic patients with HF in sinus rhythm with a QRS duration ≥ 150 msec and non-LBBB QRS morphology and with LVEF $\leq 35\%$ despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIa	B	261–272
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and LBBB QRS morphology and with LVEF $\leq 35\%$ despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	B	266, 273
CRT may be considered for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and non-LBBB QRS morphology and with LVEF $\leq 35\%$ despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIb	B	266, 273
CRT rather than RV pacing is recommended for patients with HFrEF regardless of NYHA class who have an indication for ventricular pacing and high degree AV block in order to reduce morbidity. This includes patients with AF (see Section 10.1).	I	A	274–277
CRT should be considered for patients with LVEF $\leq 35\%$ in NYHA Class III–IV ^d despite OMT in order to improve symptoms and reduce morbidity and mortality, if they are in AF and have a QRS duration ≥ 130 msec provided a strategy to ensure bi-ventricular capture is in place or the patient is expected to return to sinus rhythm.	IIa	B	275, 278–281
Patients with HFrEF who have received a conventional pacemaker or an ICD and subsequently develop worsening HF despite OMT and who have a high proportion of RV pacing may be considered for upgrade to CRT. This does not apply to patients with stable HF.	IIb	B	282
CRT is contra-indicated in patients with a QRS duration < 130 msec.	III	A	266, 283–285

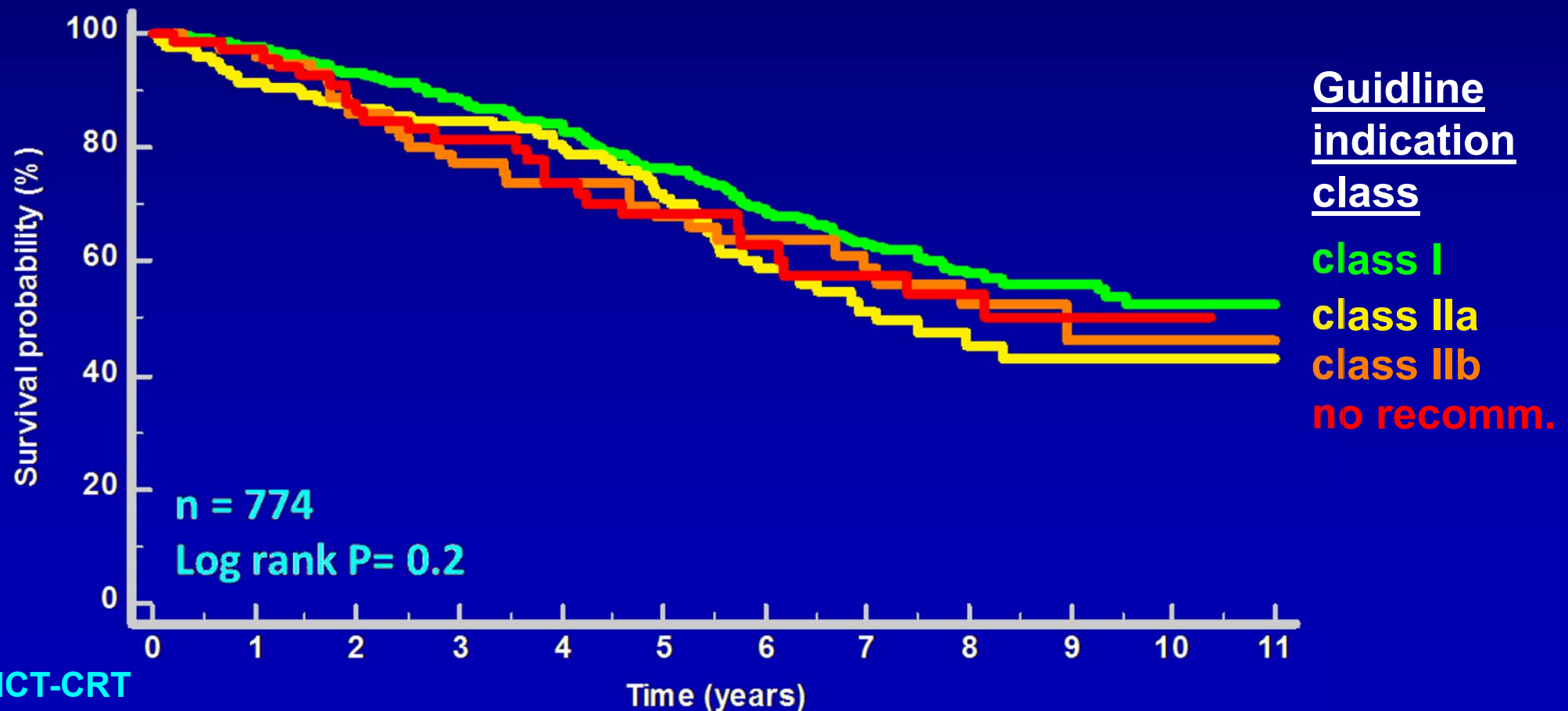
Applying Current Guidelines

volume response in the PREDICT-CRT cohort



Applying Current Guidelines

survival in the PREDICT-CRT cohort

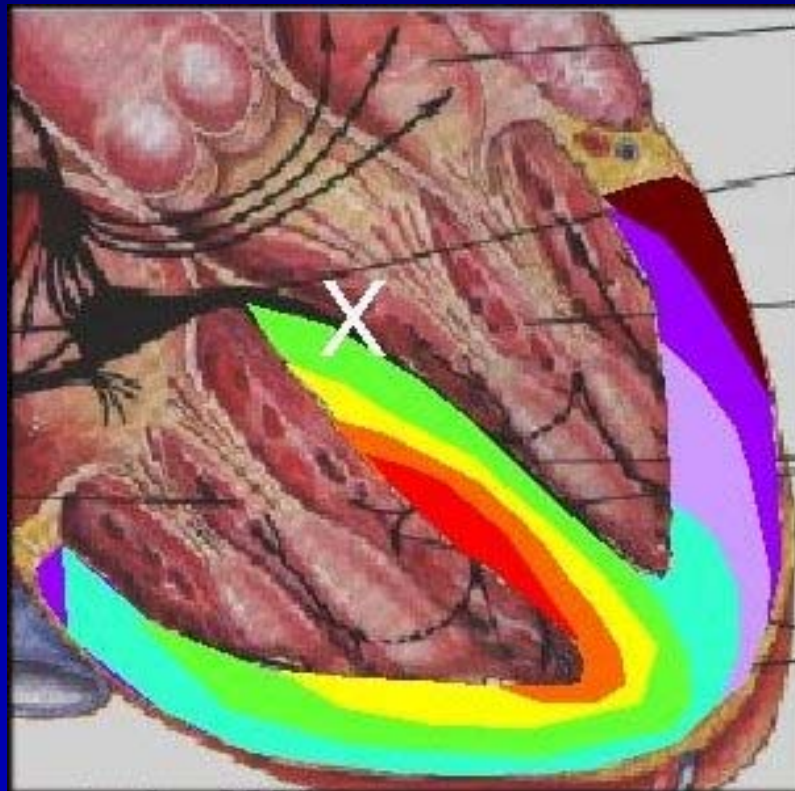


Cardiac Resynchronization Therapy

Beyond the State of the Art:

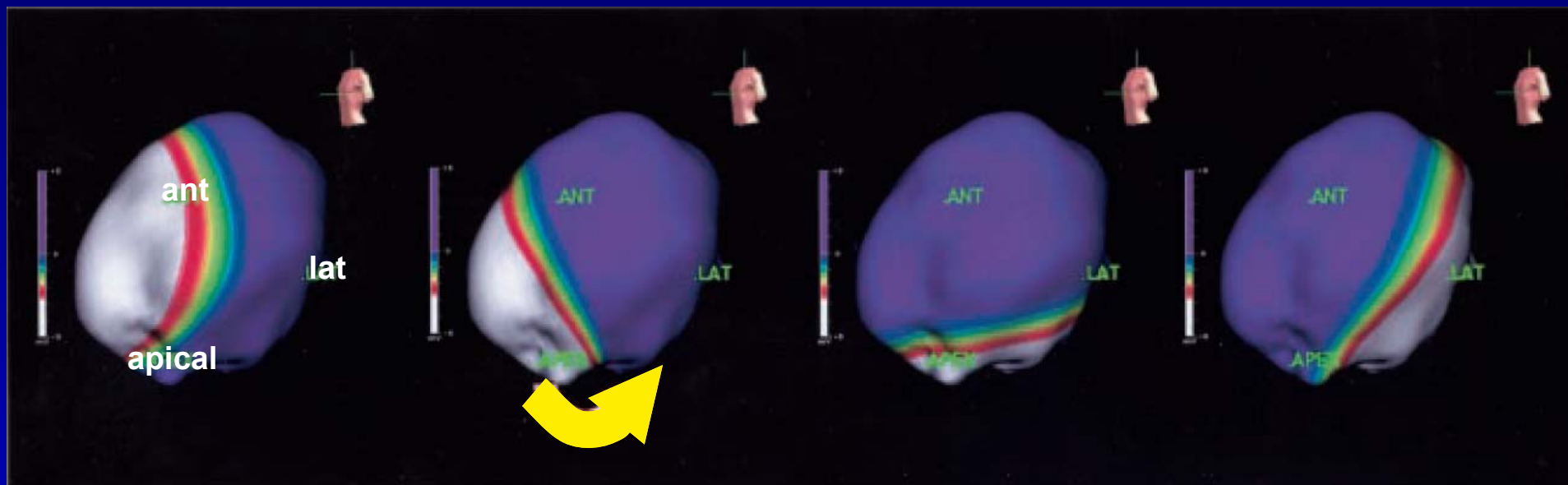
**Mechanical
Dyssynchrony**

Left Bundle Branch Block



Left Bundle Branch Block

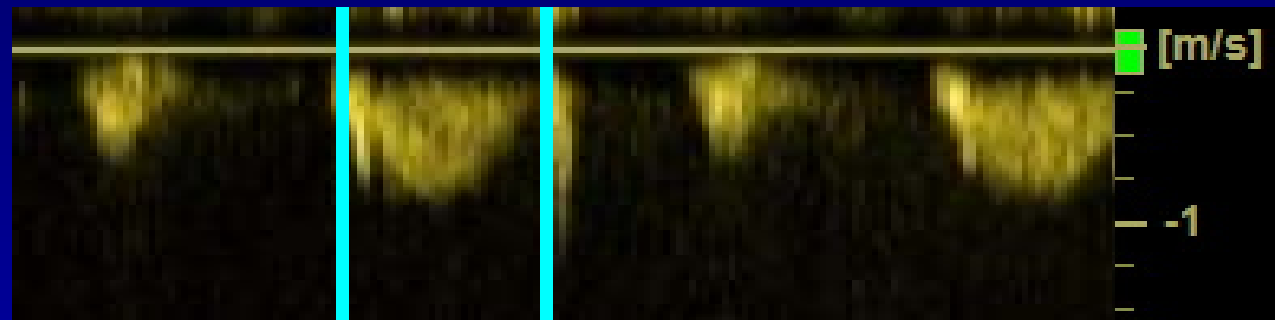
DCM, QRS width 179ms



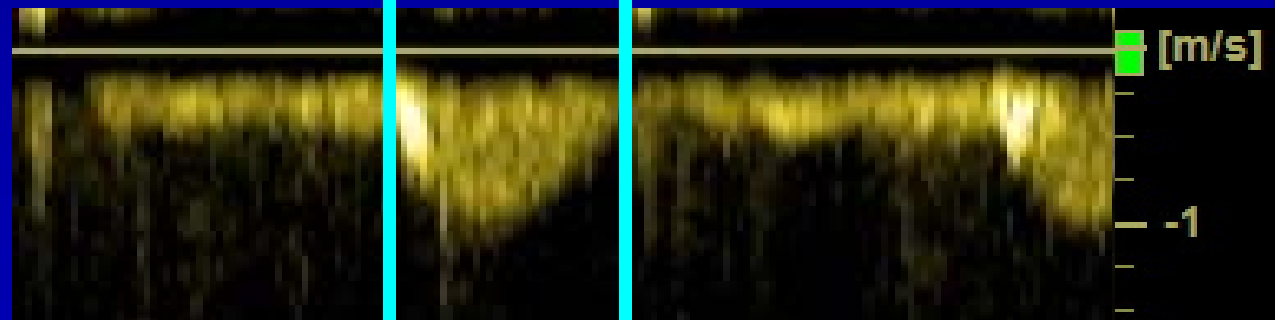
Left Bundle Branch Block

inter-ventricular asynchrony

pulmonary
valve



aortic
valve



ECG

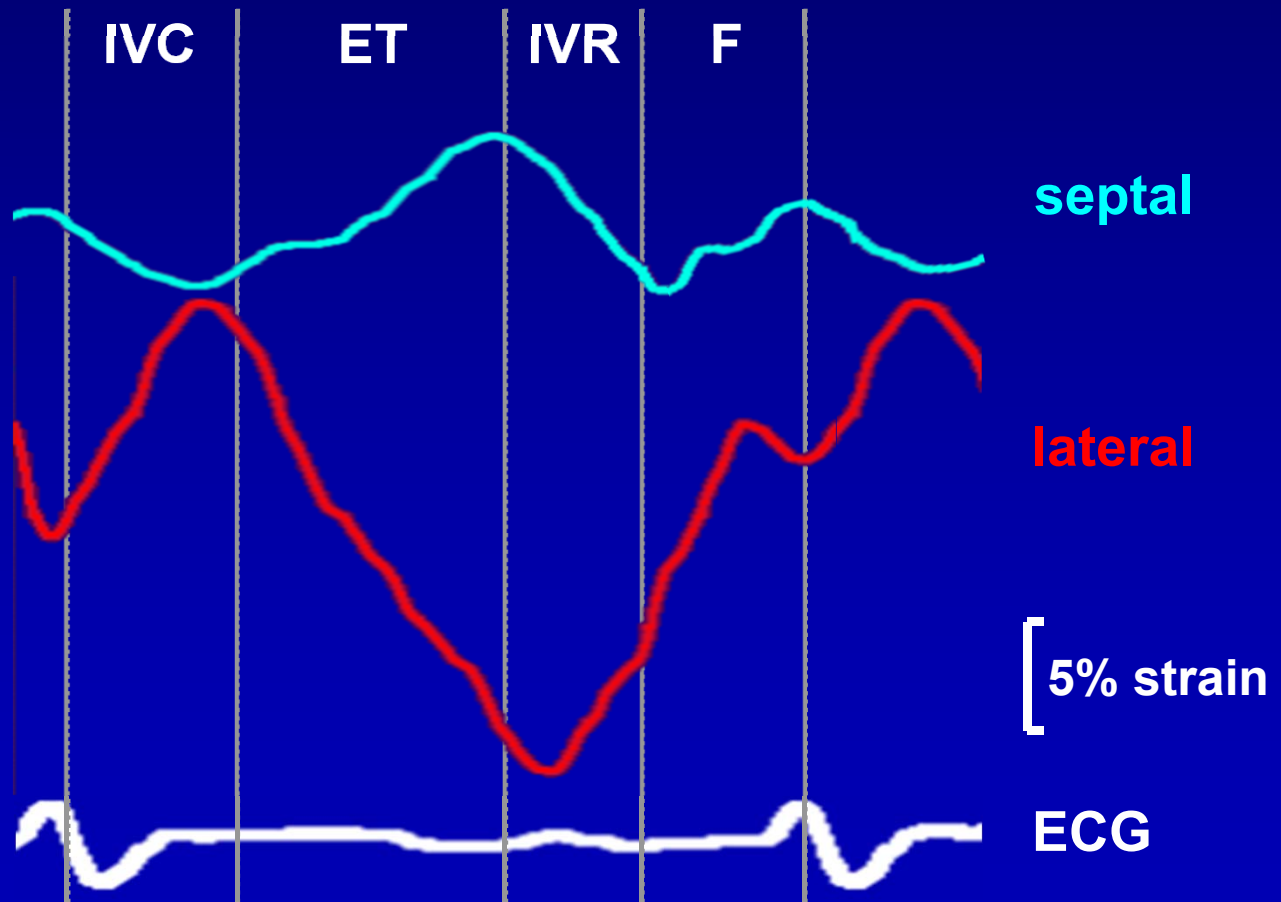
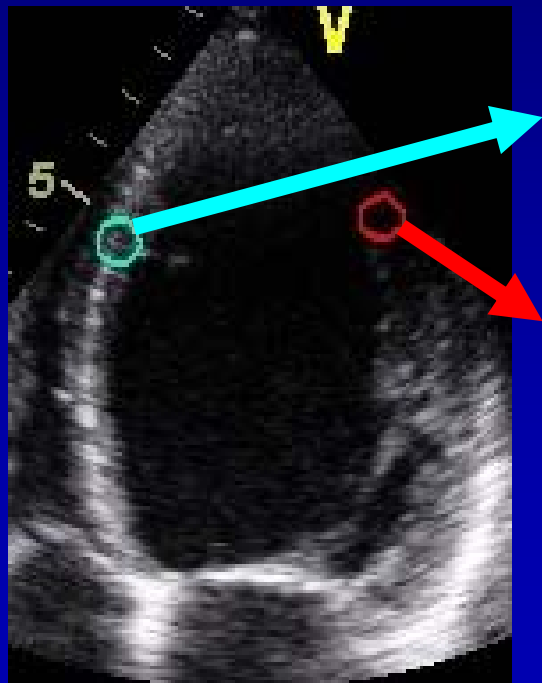


Left Bundle Branch Block

**mechanical
consequences**

Left Bundle Branch Block

intra-ventricular dysynchrony

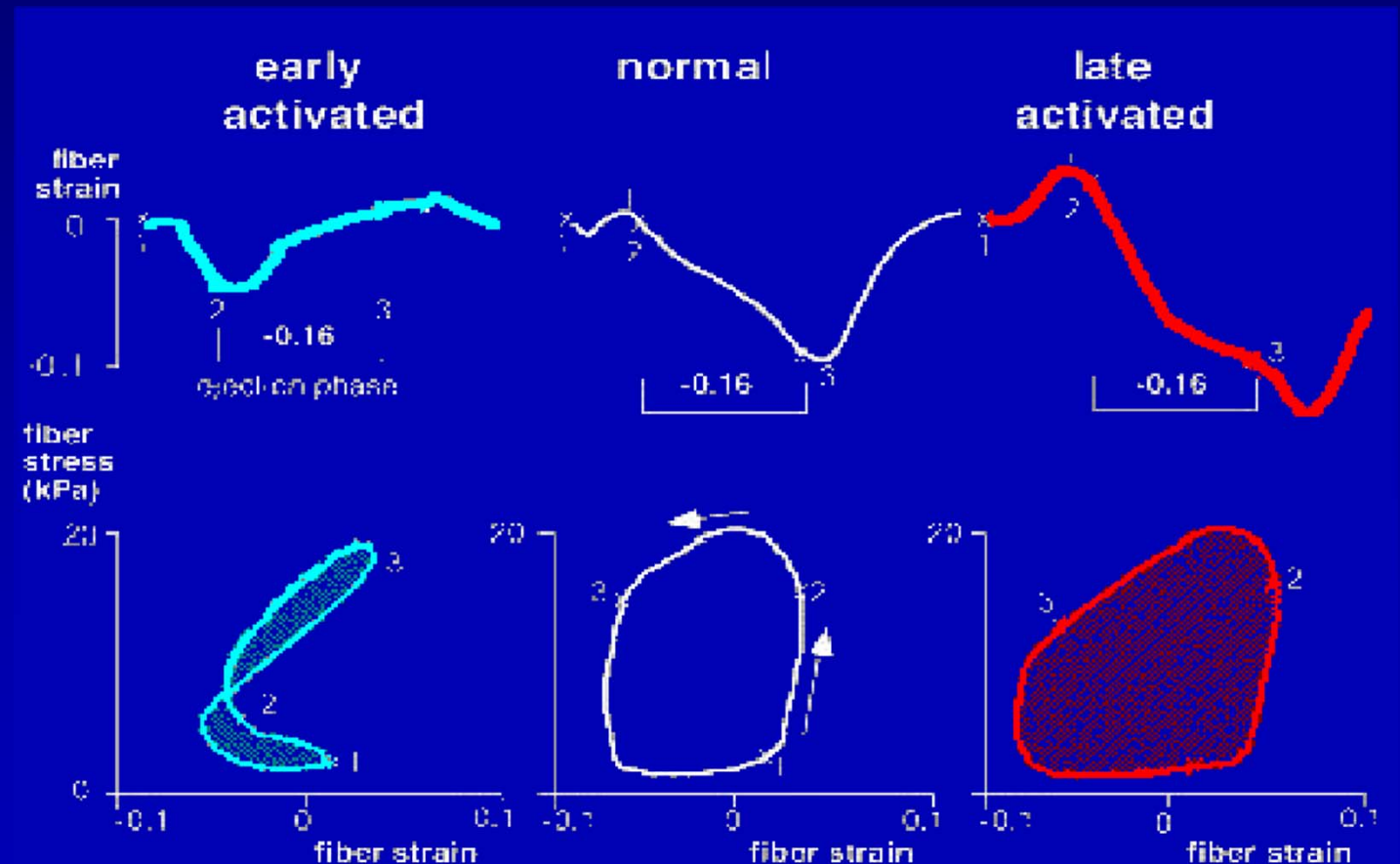


Left Bundle Branch Block

septal / lateral loading imbalance

fibre strain
(deformation)

**stress-strain-
loops**
(performed work)



Left Bundle Branch Block

mechanical consequences

septal contraction without load

ejection due to late lateral contraction

asymmetric hypertrophy

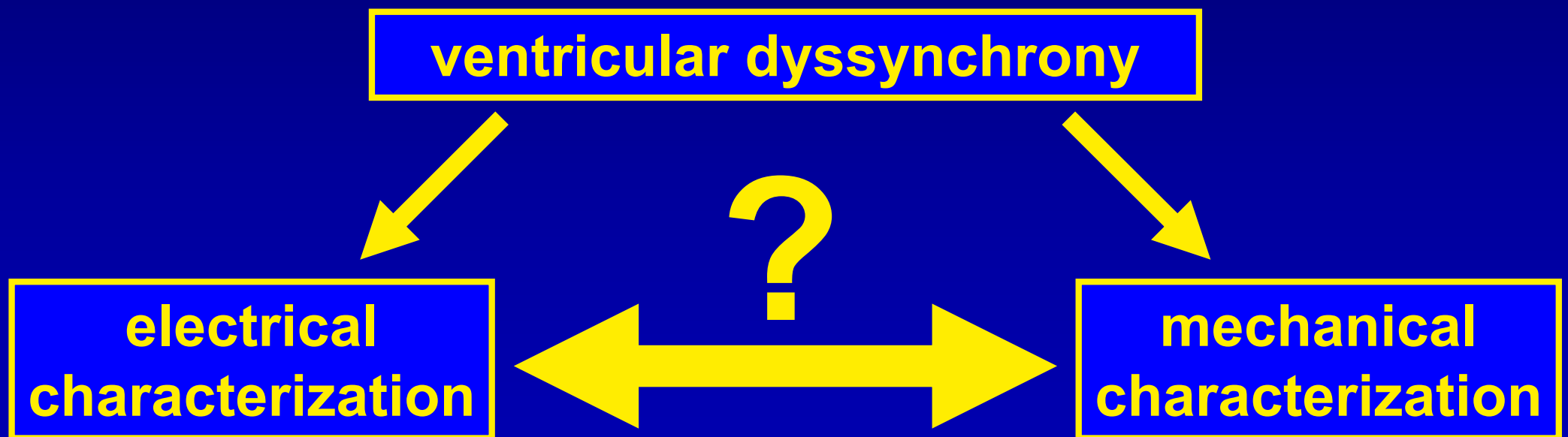
LV dilatation



LV – „remodelling“

Cardiac Resynchronization Therapy

... is a mechanical treatment !

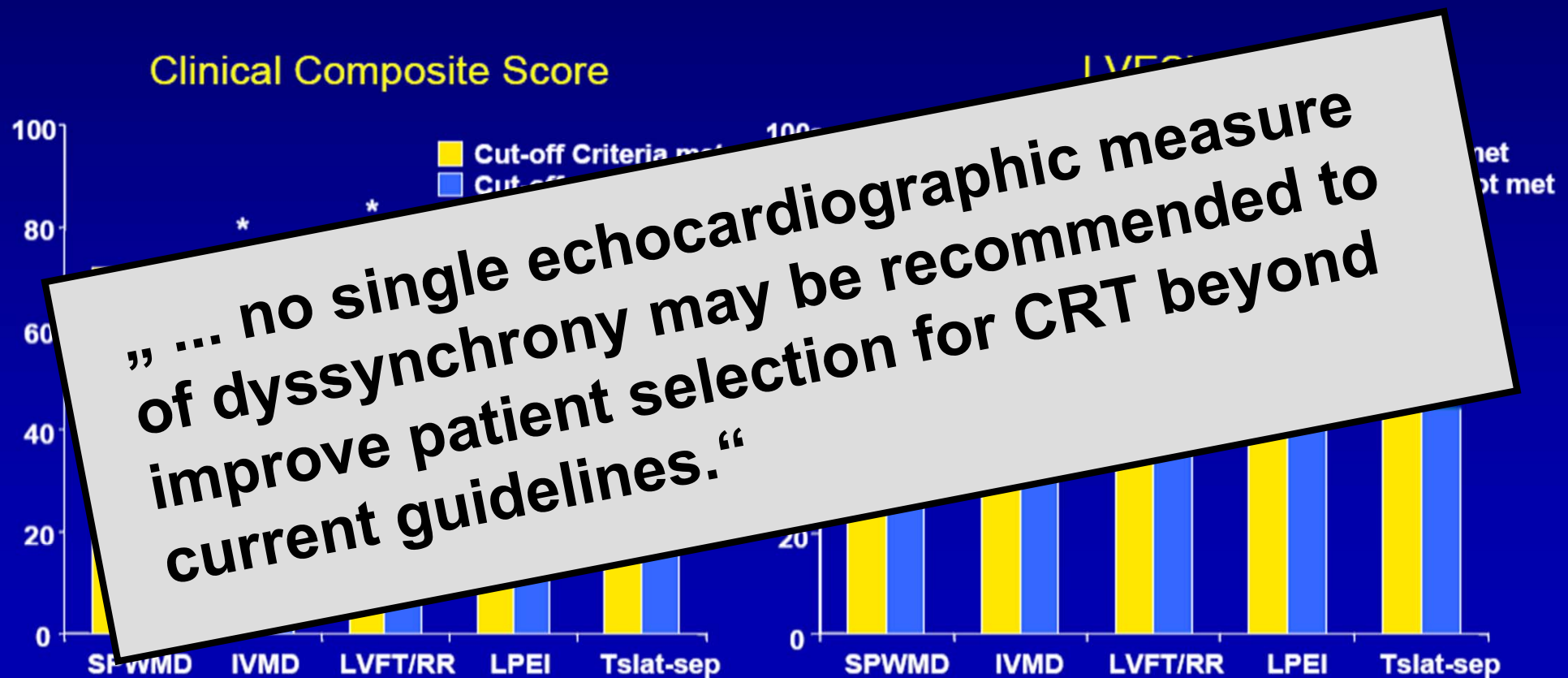


CRT Patient Selection

**How can
Echocardiography
contribute ?**

PROSPECT Study

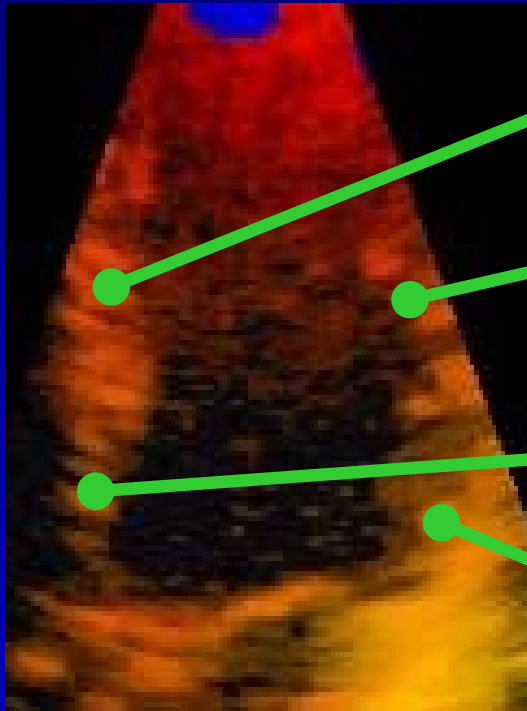
added predictive value of tissue Doppler



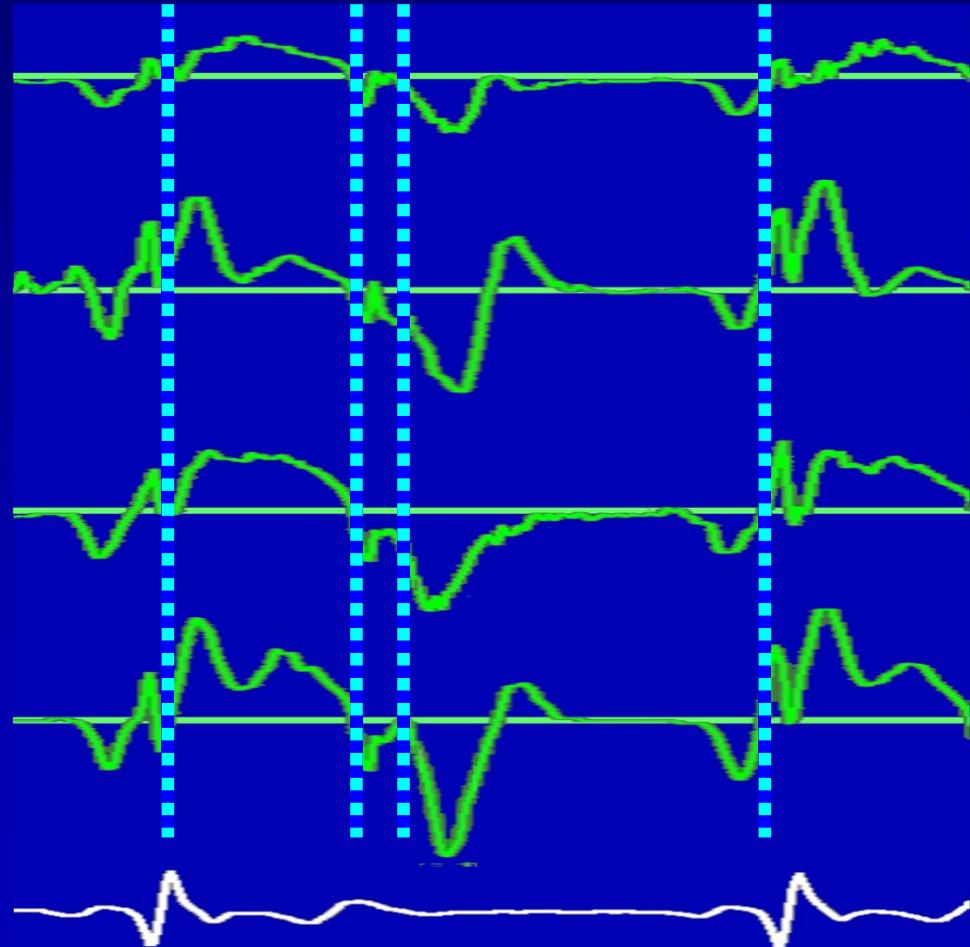
*sign. higher level of response among those meeting the cut-off ($p < 0.05$)

Conventional „Selection Parameters“

time aligned velocity peaks proof synchronicity



4 chamber view



CRT Patient Selection

Search for
specific, treatable
dyssynchrony patterns !

The Ideal Selection Criterion

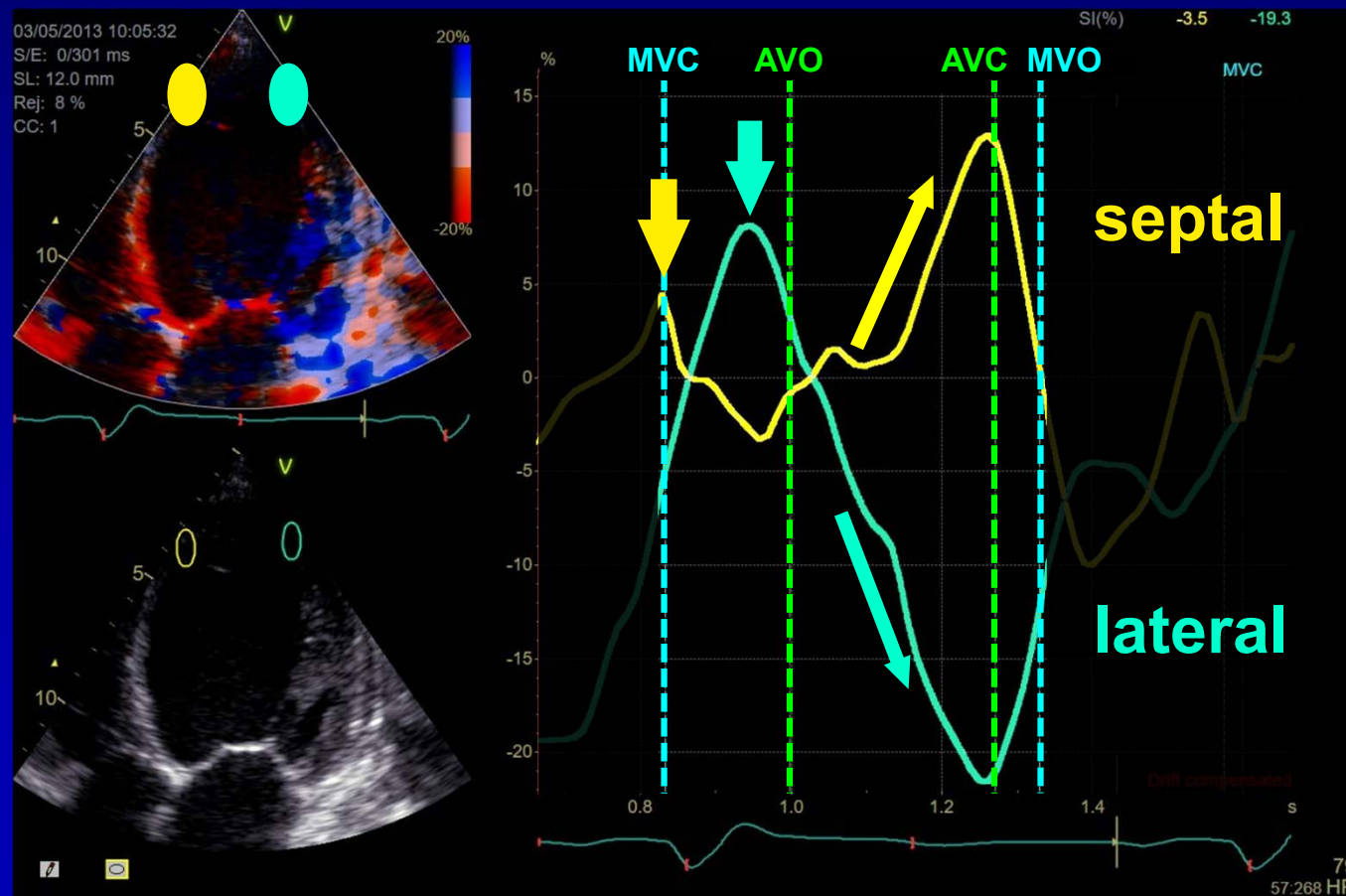
Should tell us ...

**... if there is mechanical dyssynchrony.
⇒ sensitive detection**

**... if the mechanical dyssynchrony can be treated.
⇒ characterization of specific patterns**

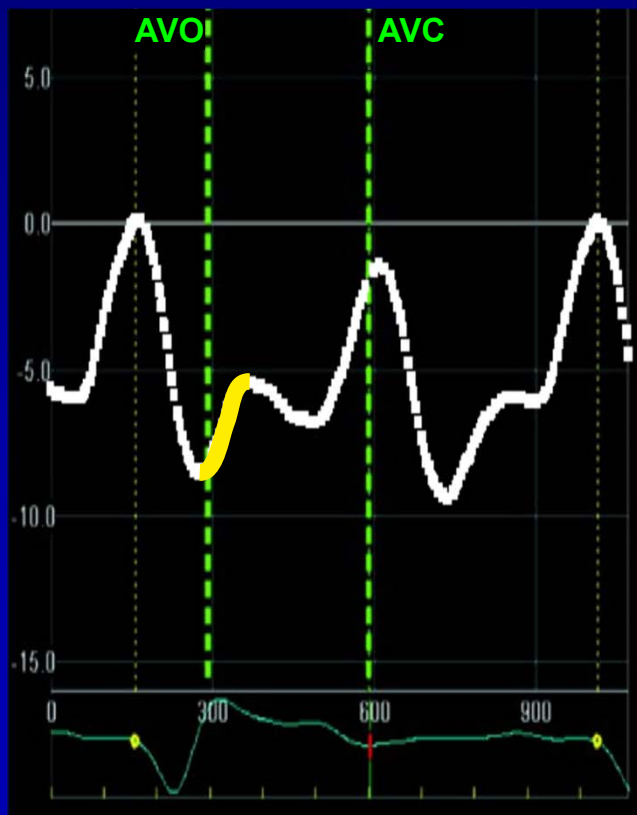
Septal Strain Patterns

intra-ventricular dysynchrony

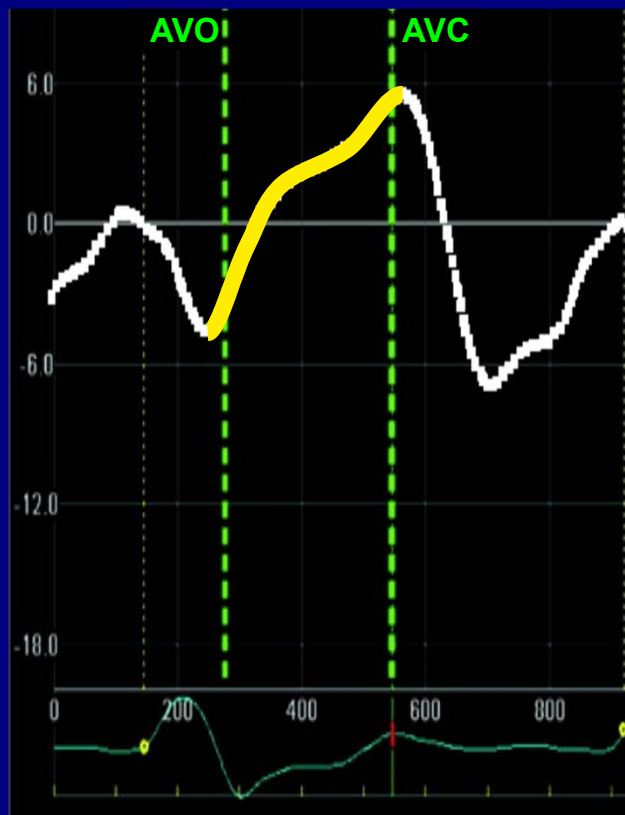


Septal Strain Patterns

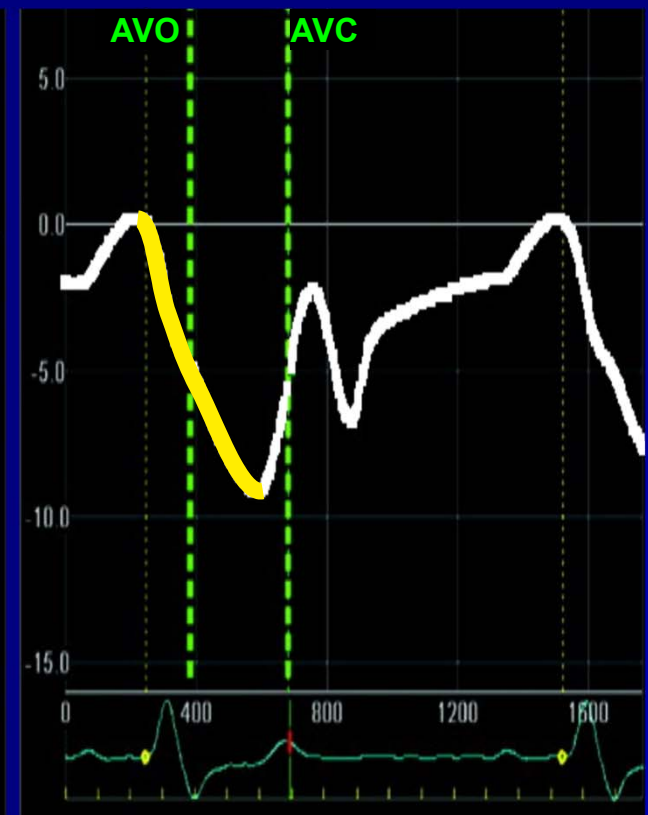
notching
contractile septum



stretching
failing septum

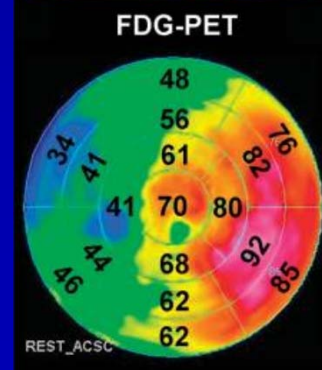
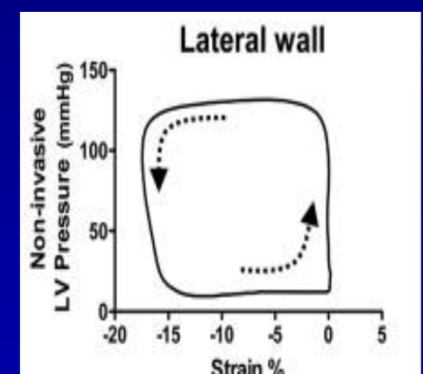
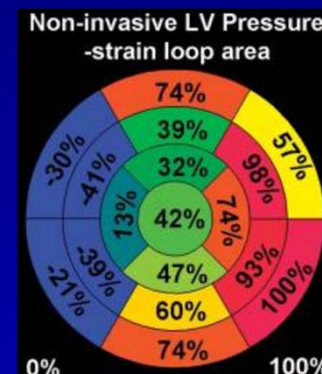
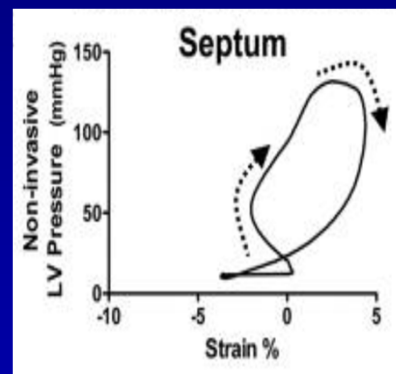
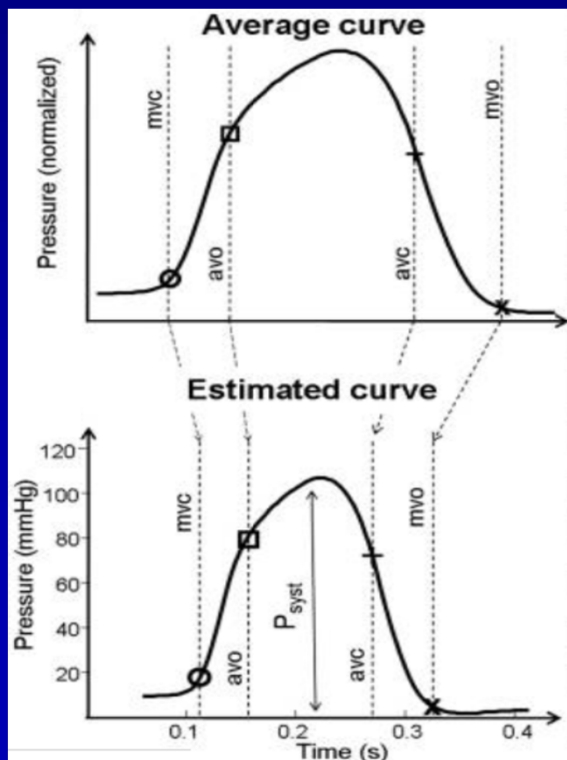


pseudonormal
lateral scar



Regional Myocardial Work

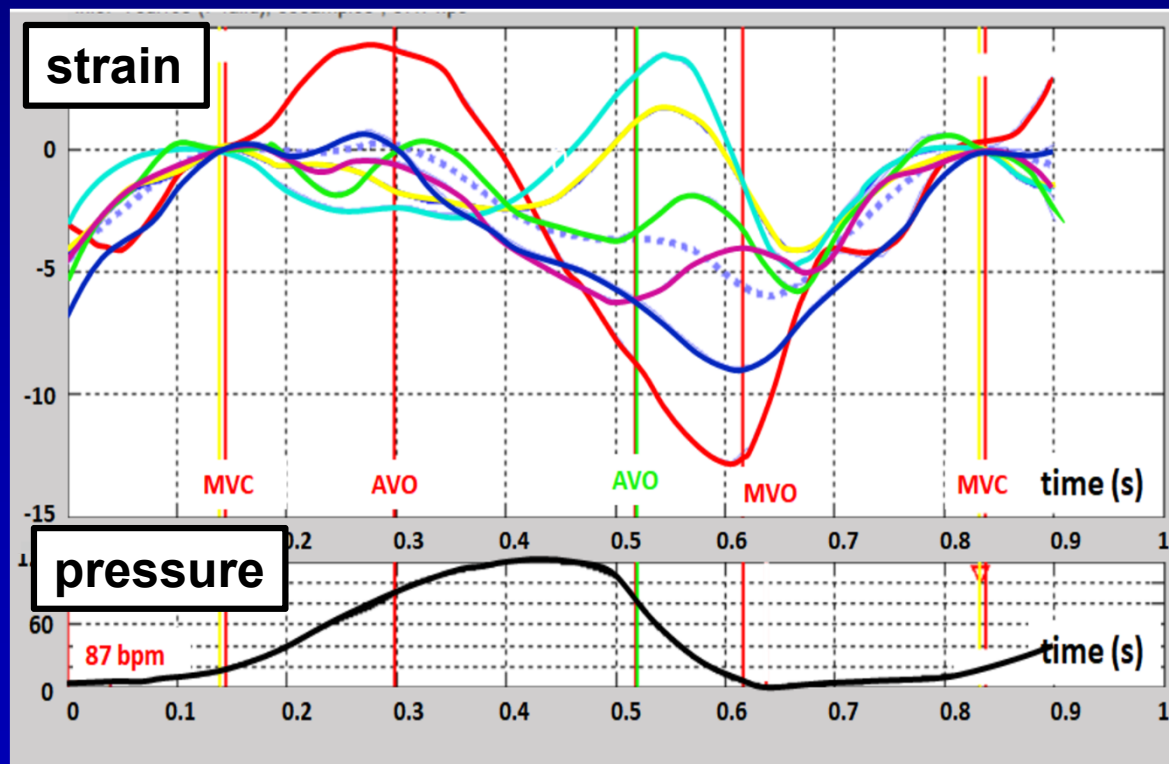
pressure-strain-loops
using estimated pressure curves



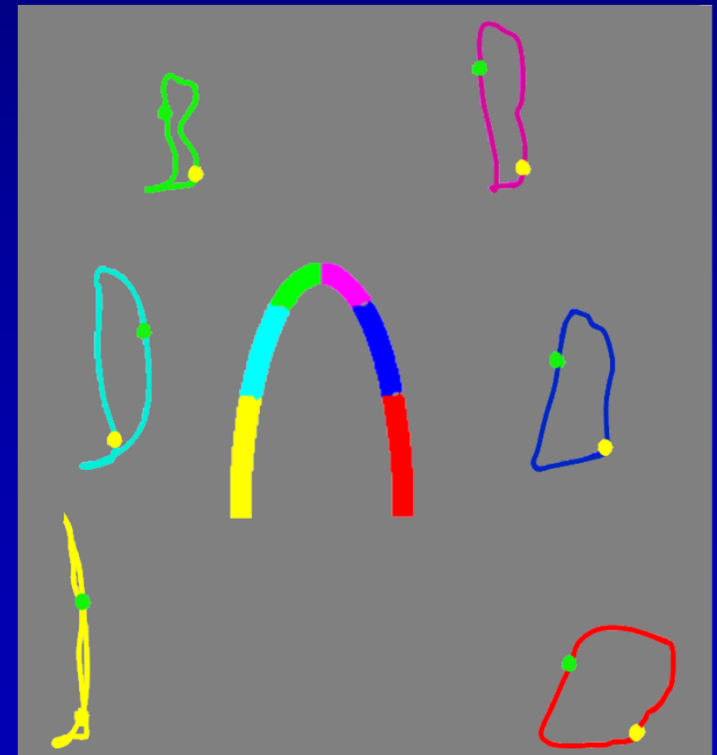
Regional Myocardial Work

... in CRT responders

non invasive data



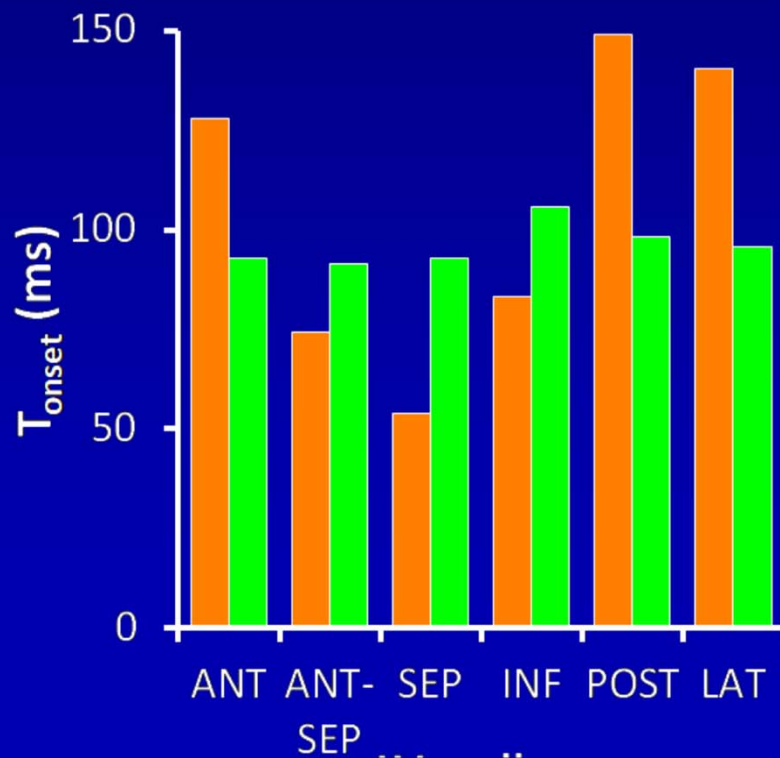
stress-strain-loops



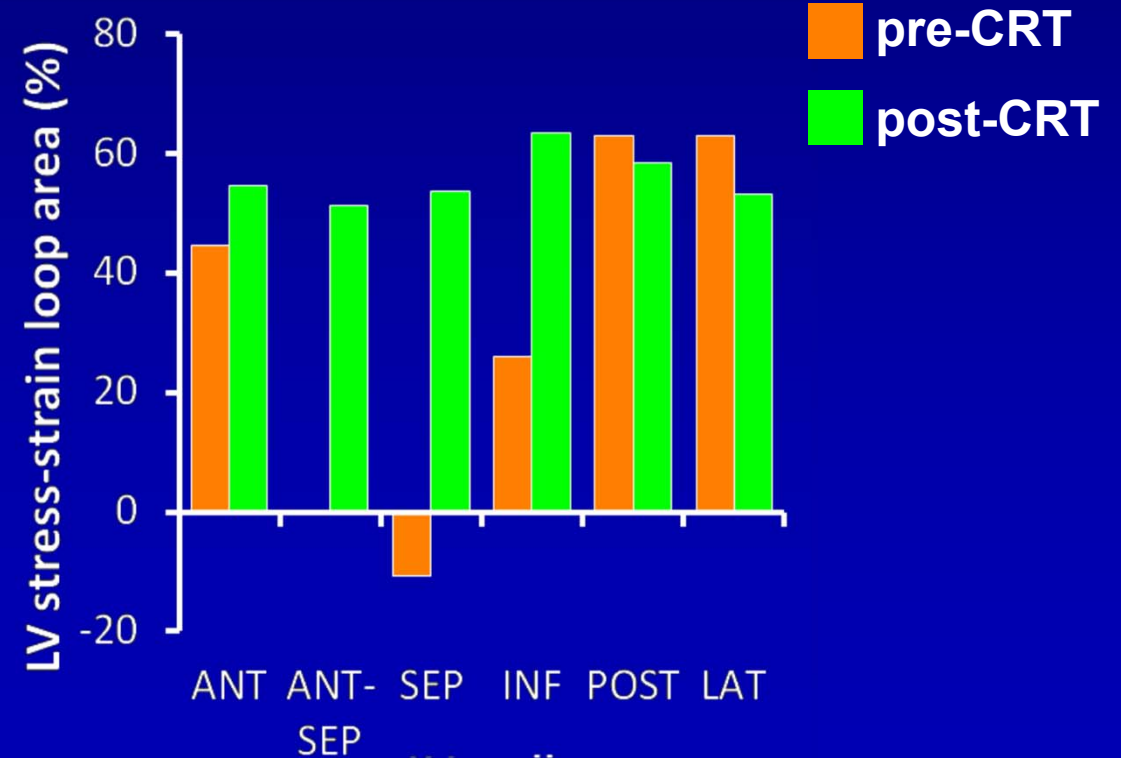
Regional Myocardial Work

... in CRT responders

time delay



segmental work

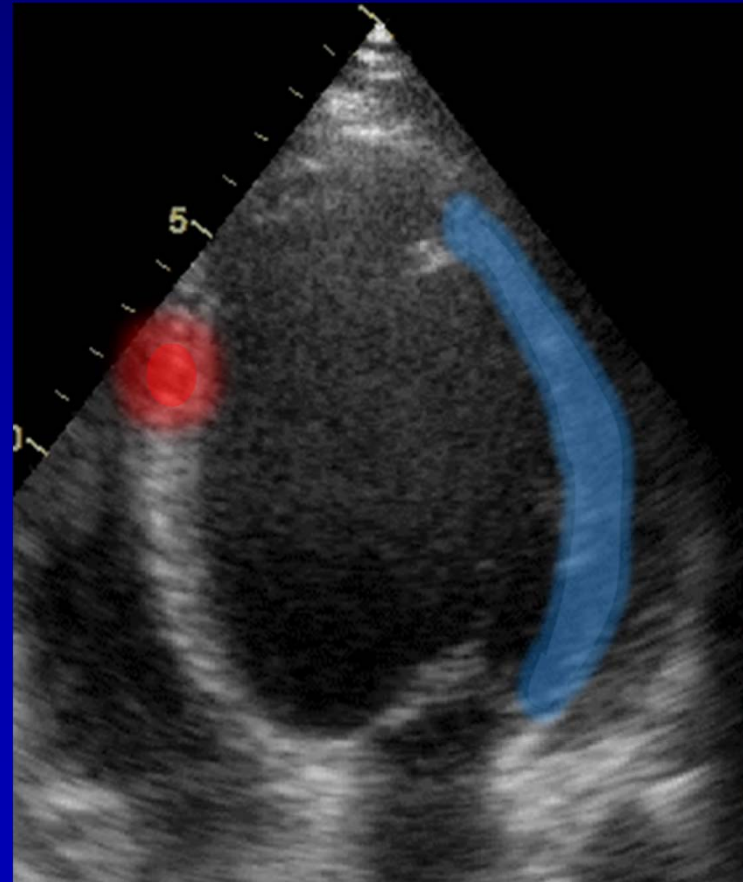


Specific Dyssynchrony Patterns

**The feasible way:
Visual Assessment**

Specific Dyssynchrony Patterns

describe the specific deformation sequence

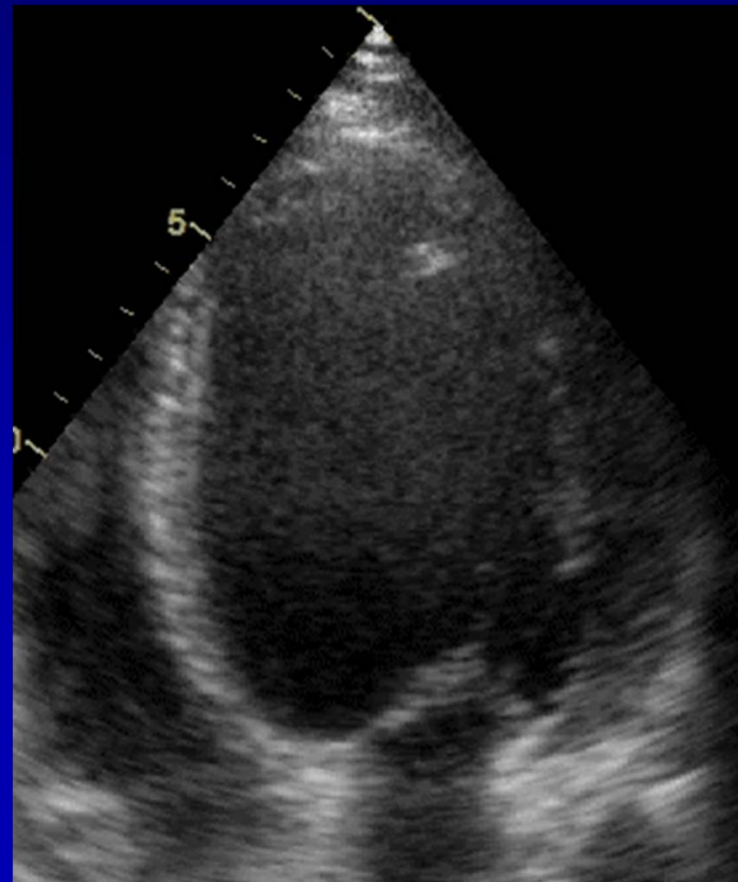


Apical Rocking

characteristic motion pattern in LBBB

typical features:

- early short apical motion towards the septum
- lateral motion during ejection



PREDICT - CRT

European Heart Journal - Cardiovascular Imaging Advance Access published November 20, 2015



European Heart Journal – Cardiovascular Imaging
doi:10.1093/ehjci/jev288

Relationship of visually assessed apical rocking and septal flash to response and long-term survival following cardiac resynchronization therapy (PREDICT-CRT)

Ivan Stankovic^{1,2†}, Christian Prinz^{3†}, Agnieszka Ciarka¹, Ana Maria Daraban^{1,9}, Martin Kotrc^{4,10}, Marit Aarones⁵, Mariola Szulik⁶, Stefan Winter⁷, Ann Belmans⁸, Aleksandar N. Neskovic², Tomasz Kukulski⁶, Svend Aakhus⁵, Rik Willems¹, Wolfgang Fehske⁷, Martin Penicka⁴, Lothar Faber³, and Jens-Uwe Voigt^{1*}

PREDICT - CRT

initial assessment

- apical rocking and septal flash (visual)
- scar distribution (visua)
- volume measurement (Simpson)

European multi-center Study:

Leuven, Cologne, Zabrze
Bad Oeynhausen, Oslo

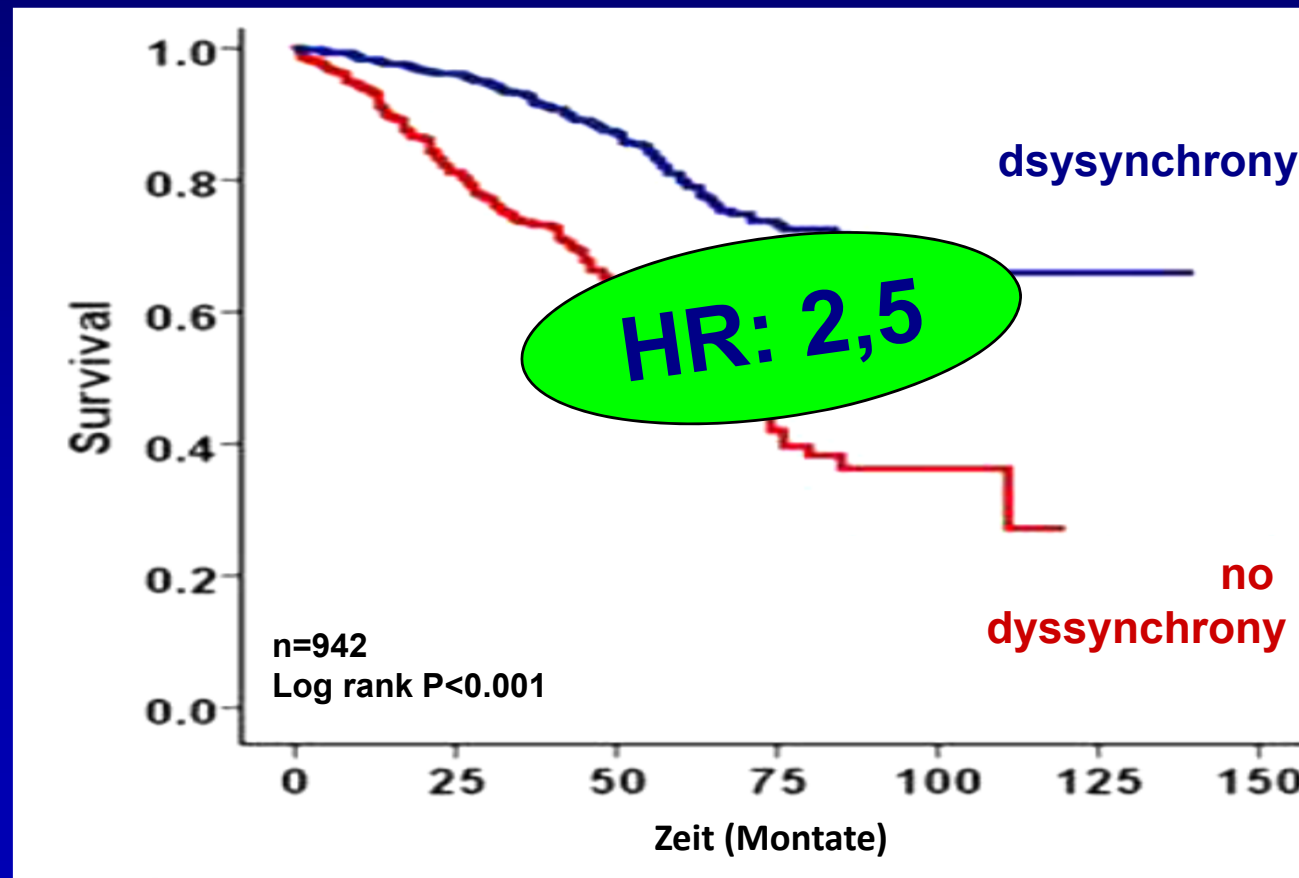


CRT result

- volume measurement (Simpson)
- CRT result: $\Delta\text{ESV} \geq 15\%$
- apical rocking and septal flash after CRT (visual)

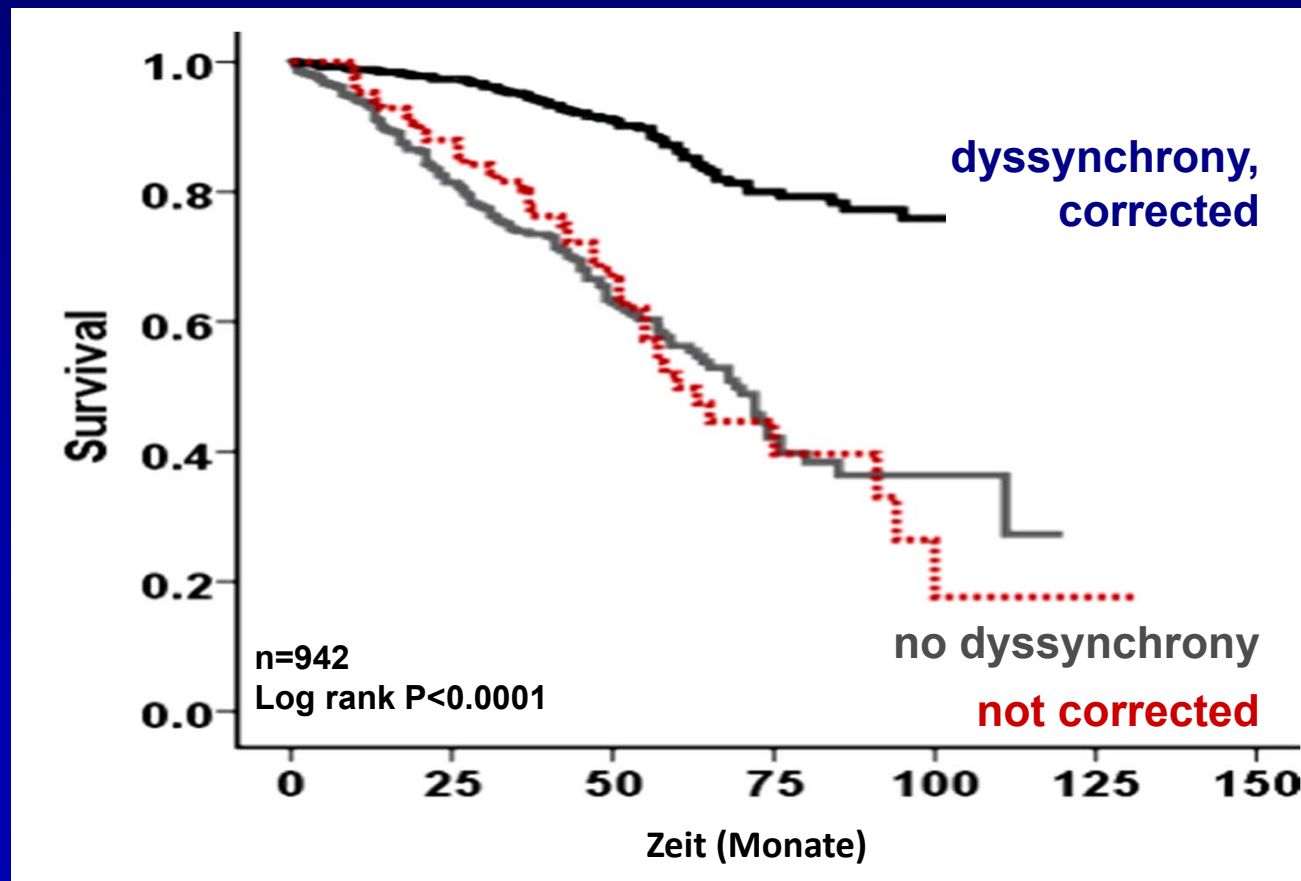
Specific Dyssynchrony Patterns

... predict survival



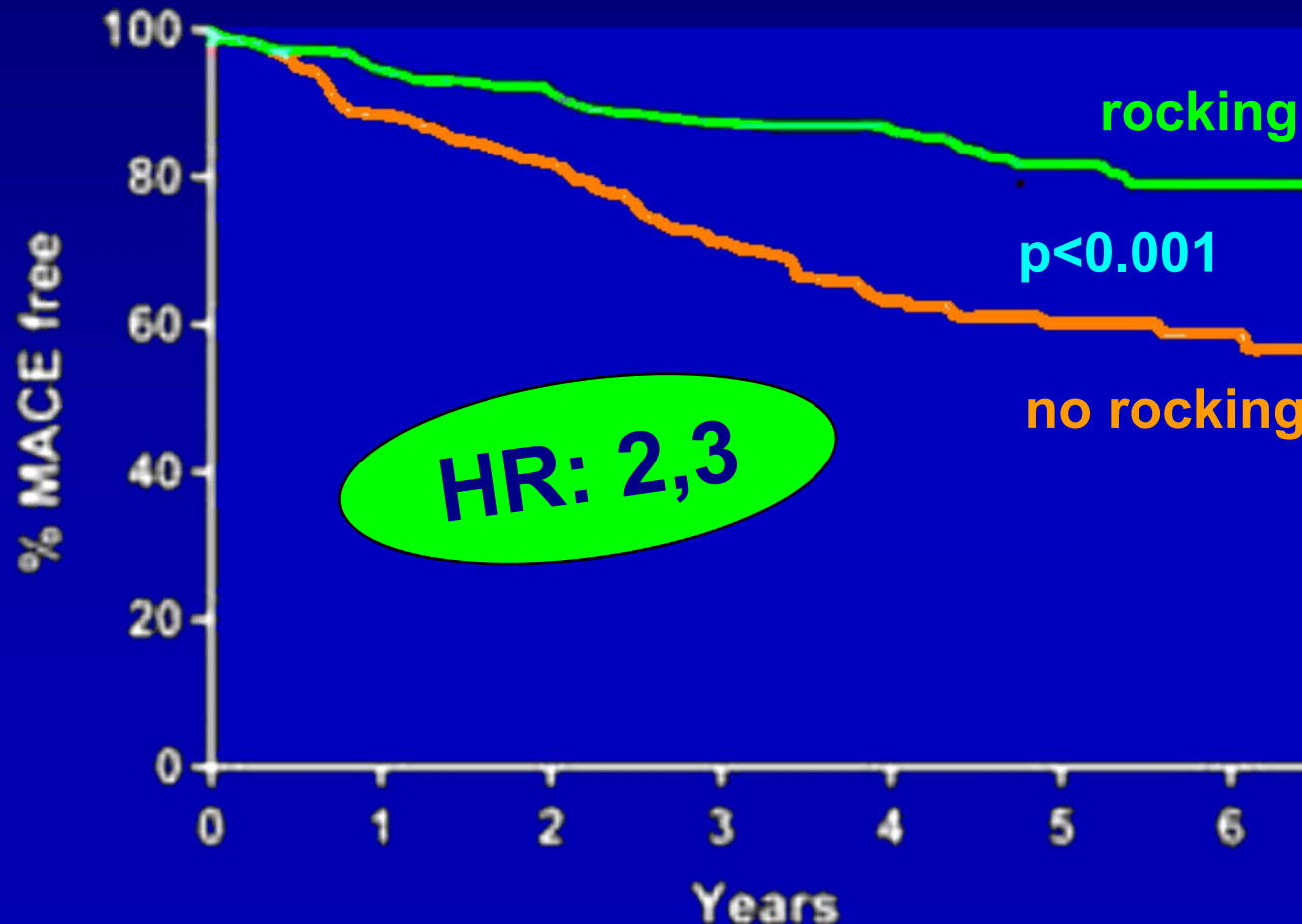
Specific Dyssynchrony Patterns

... predict therapy success



Specific Dyssynchrony Patterns

confirmation by other groups



study

n=295

apical rocking
visual

HR for MACE: 2.3

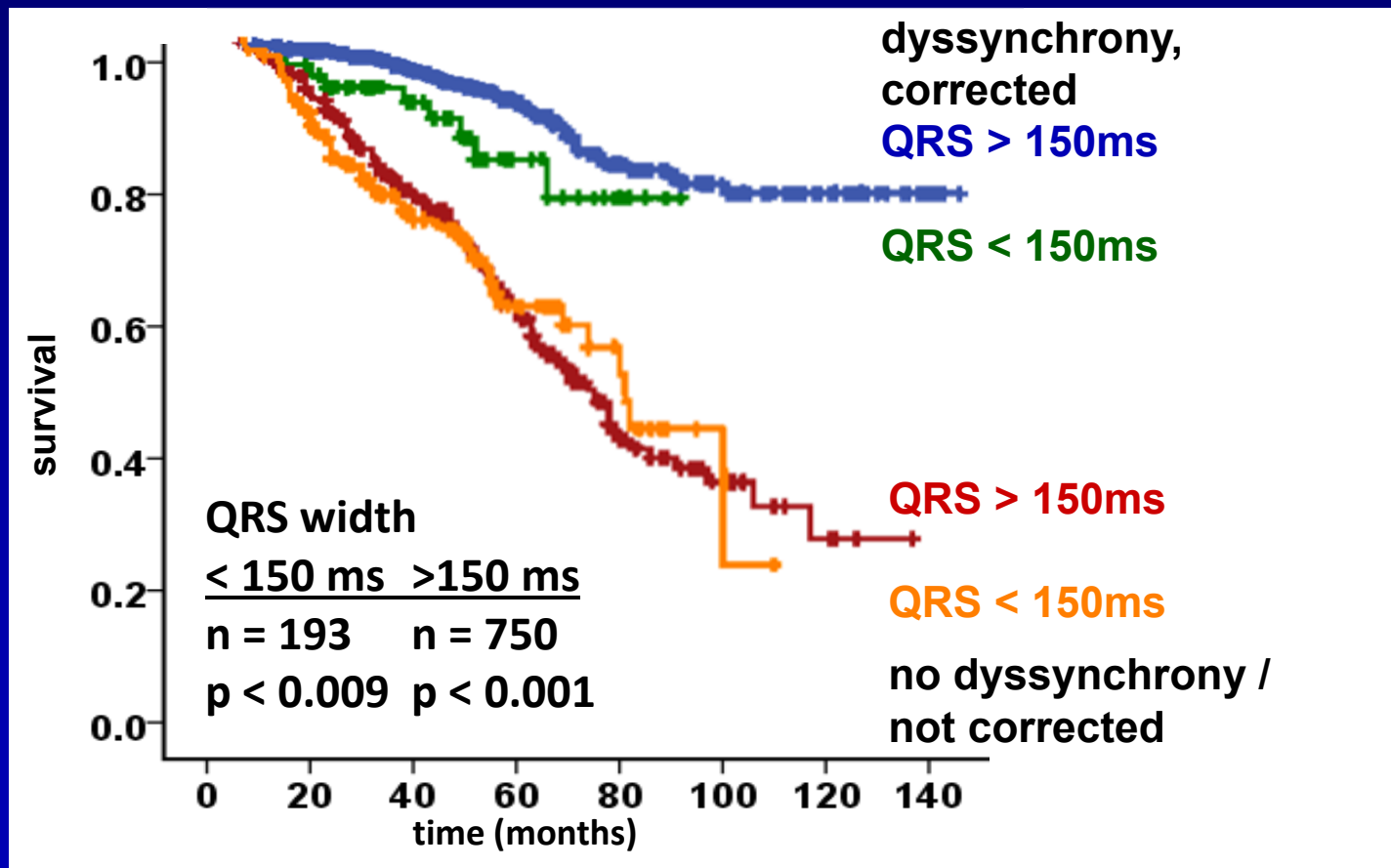
(for LBBB: 1.06 !)

Specific Dyssynchrony Patterns

What about narrow QRS ?

Specific Dyssynchrony Patterns

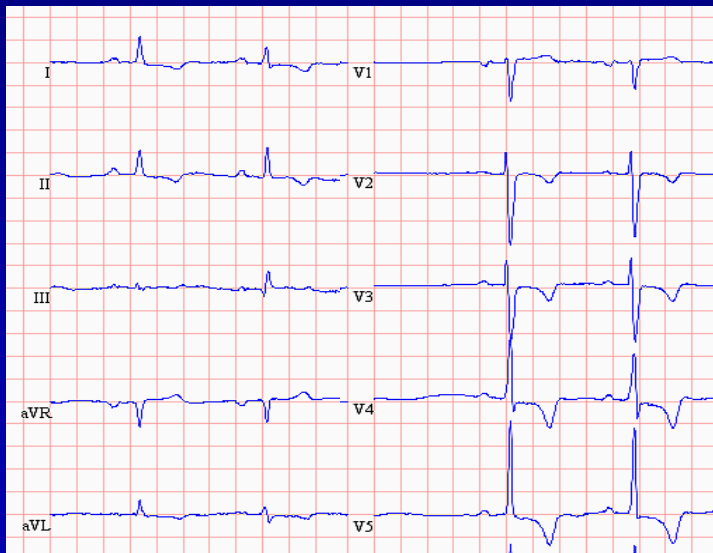
good selection independent from QRS width



Case 3: Narrow QRS Complex

no guideline indication but responder

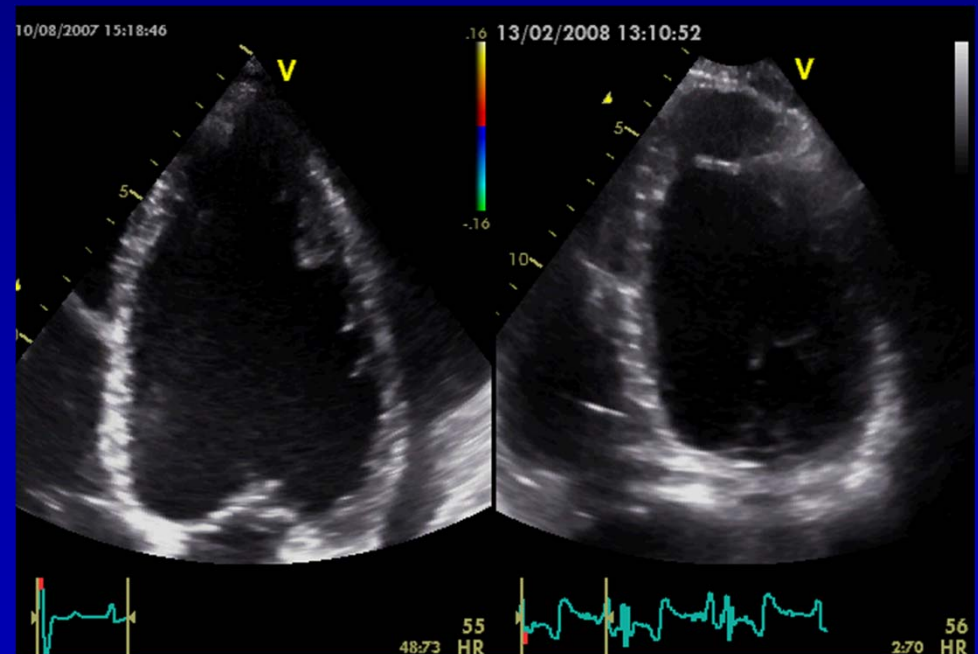
QRS 90ms



Vent. rate	56	BPM
PR interval	196	ms
QRS duration	90	ms
QT/QTc	422 / 407	ms

before CRT

after CRT



Specific Dyssynchrony Patterns

**What about
pacemaker-induced LBBB ?**

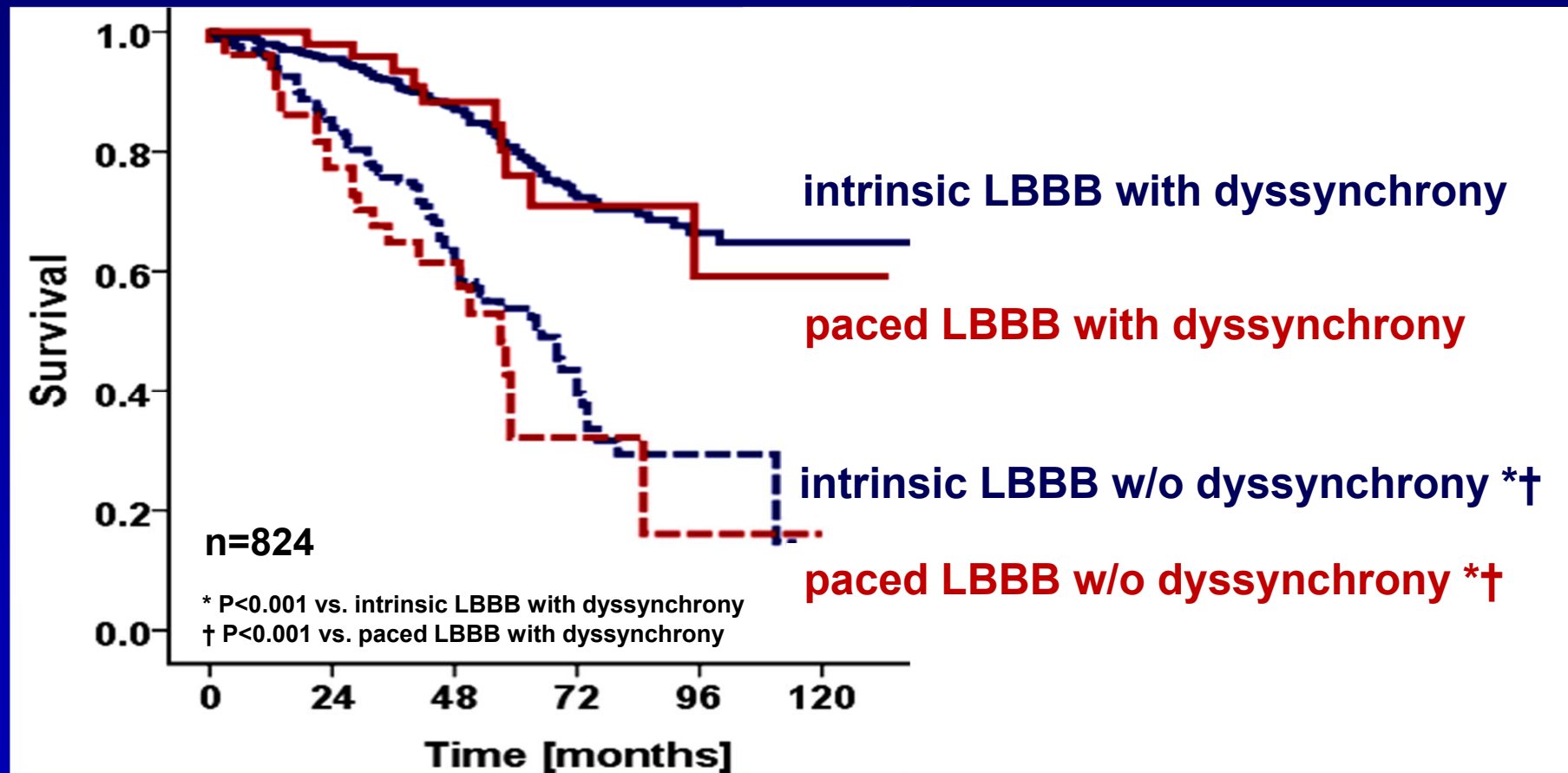
Pacemaker Induced LBBB

independent predictors of CRT response

	OR [95% CI]	p
Dyssynchrony	11.20 [6.25 – 19.78]	<0.001
RV pacing	0.71 [0.33 – 1.53]	0.385
Ischemic CMP	0.65 [0.41 – 1.04]	0.074
LVEF baseline	0.97 [0.93 – 1.00]	0.049
LVEDD baseline	0.97 [0.95 – 0.99]	0.007

Apical Rocking and CRT Success

good selection even in PM patients

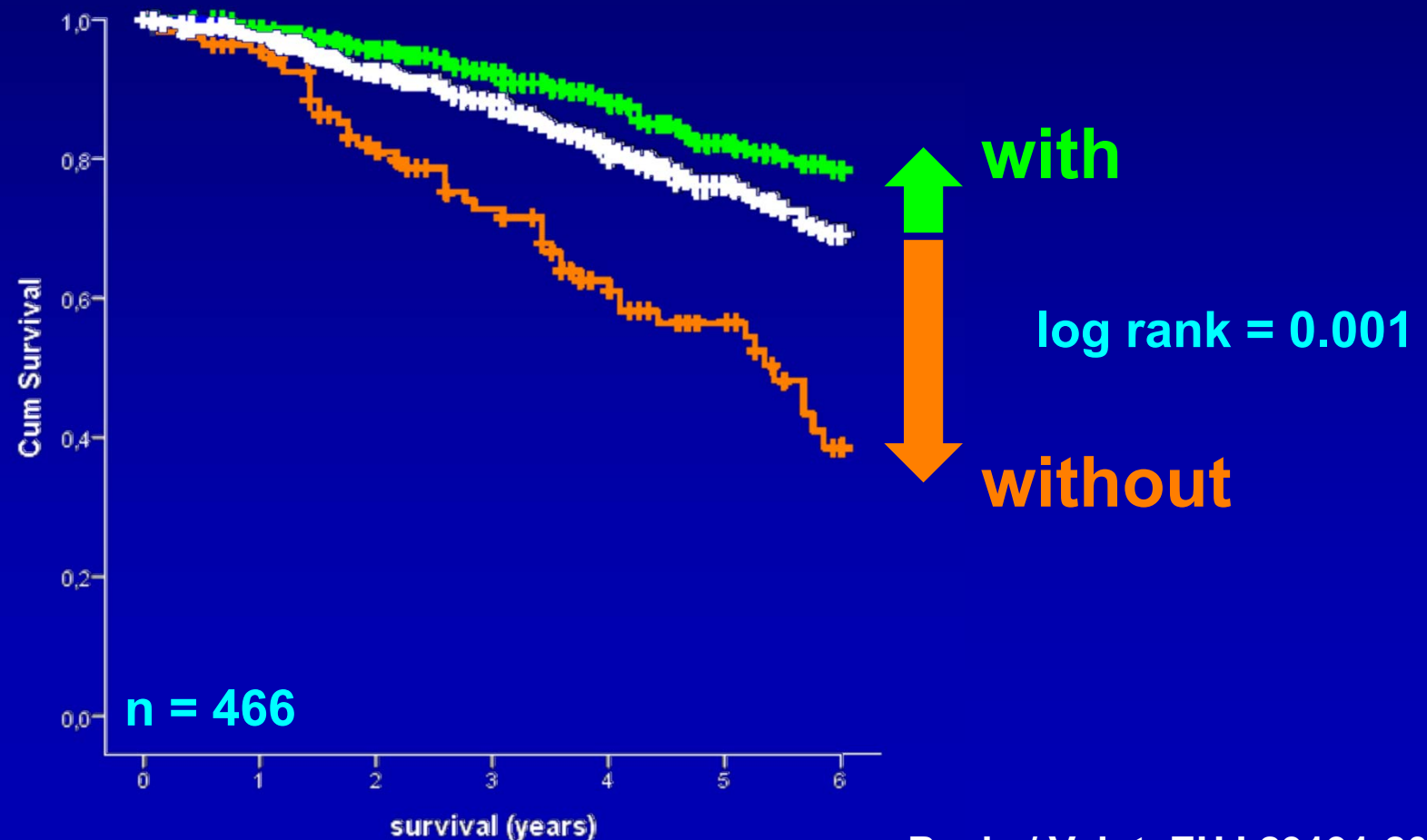


Specific Dyssynchrony Patterns

**Can they add to
current Guidelines ?**

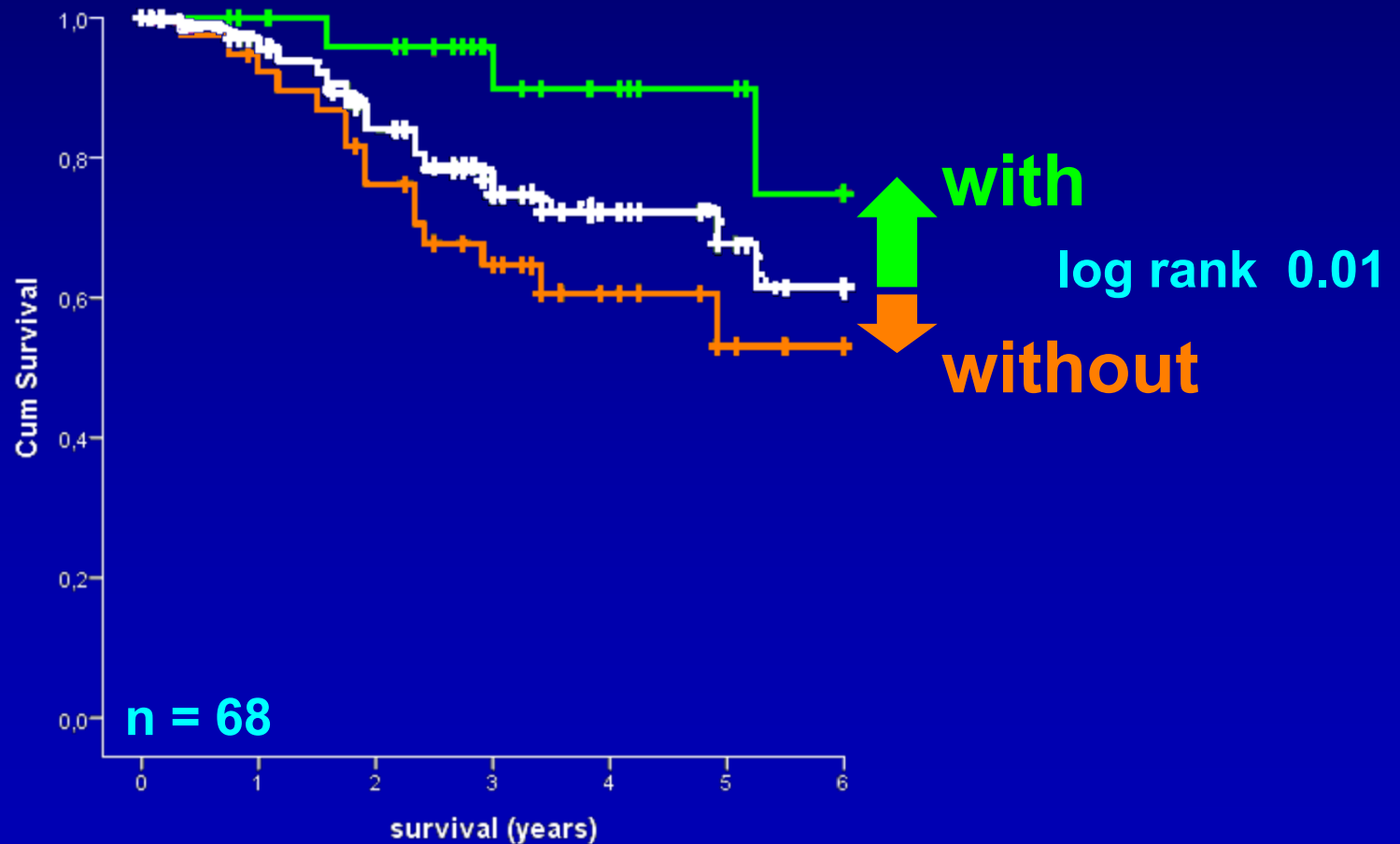
Patients with Class I Indication

Survival in ESC class I +/- Apical Rocking



Patients with Class IIb Indication

Survival in ESC class IIb +/- Apical Rocking



Summary

CRT principle is the electrical treatment of a mechanical problem.

Echocardiography is an ideal method for the assessment of myocardial mechanics.

Unspecific dysynchrony parameters have no added value and may harm the patient.

Echocardiography can improve patient selection if specific, treatable dyssynchrony patterns are used.

Summary

**Septal Flash and Apical Rocking
reflect the typical motion and deformation pattern
of an LV with LBBB, amendable by CRT.**

Detection of both markers predicts CRT response.

**In ischemic cardiomyopathy, flash and rocking may be
diminished despite LBBB, indicating a lower chance of
successful resynchronization.**

**Disappearance of flash and rocking after CRT implantation
is a sign of successful treatment.**

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