How to Assess Dyssynchrony

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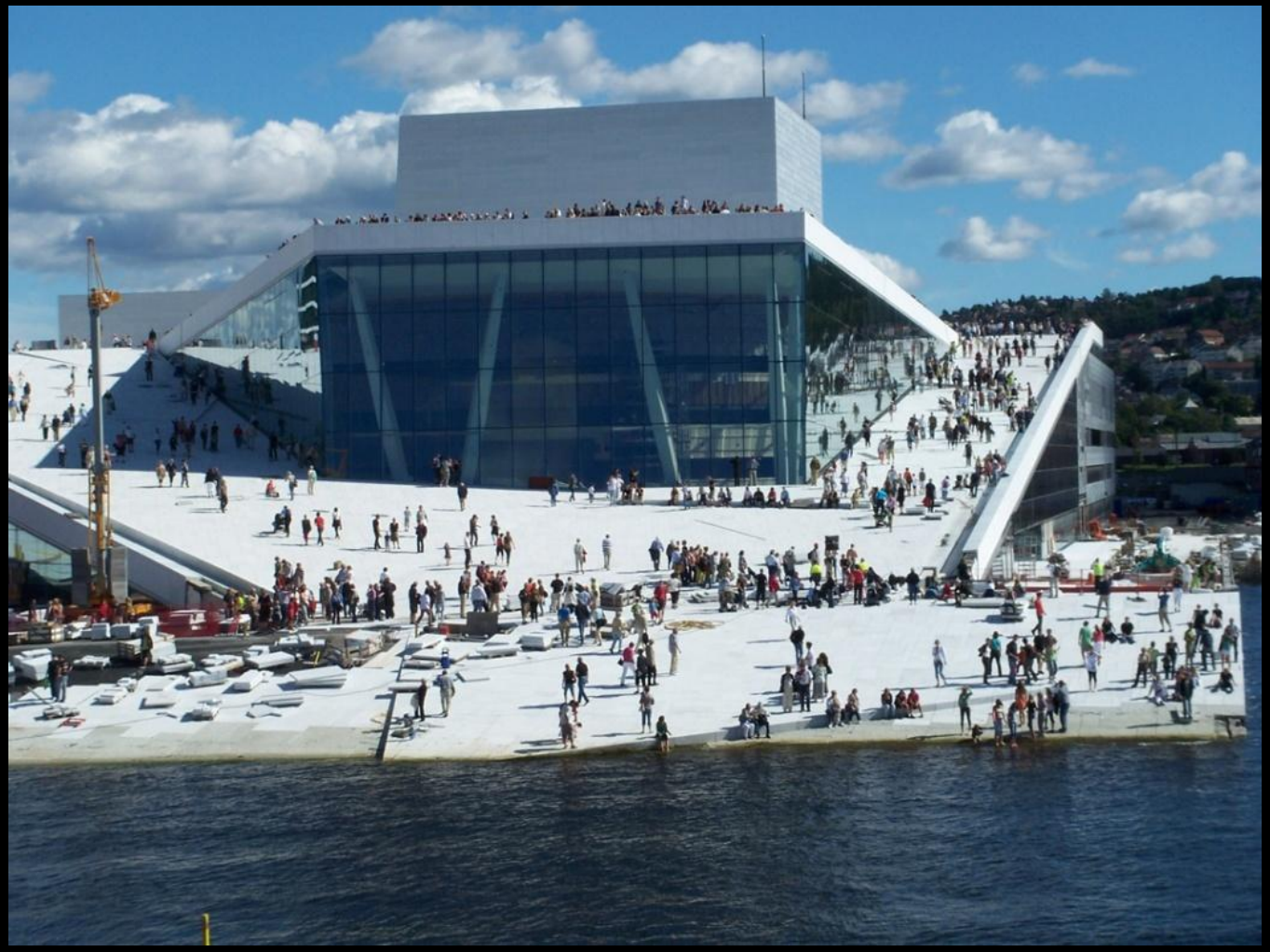
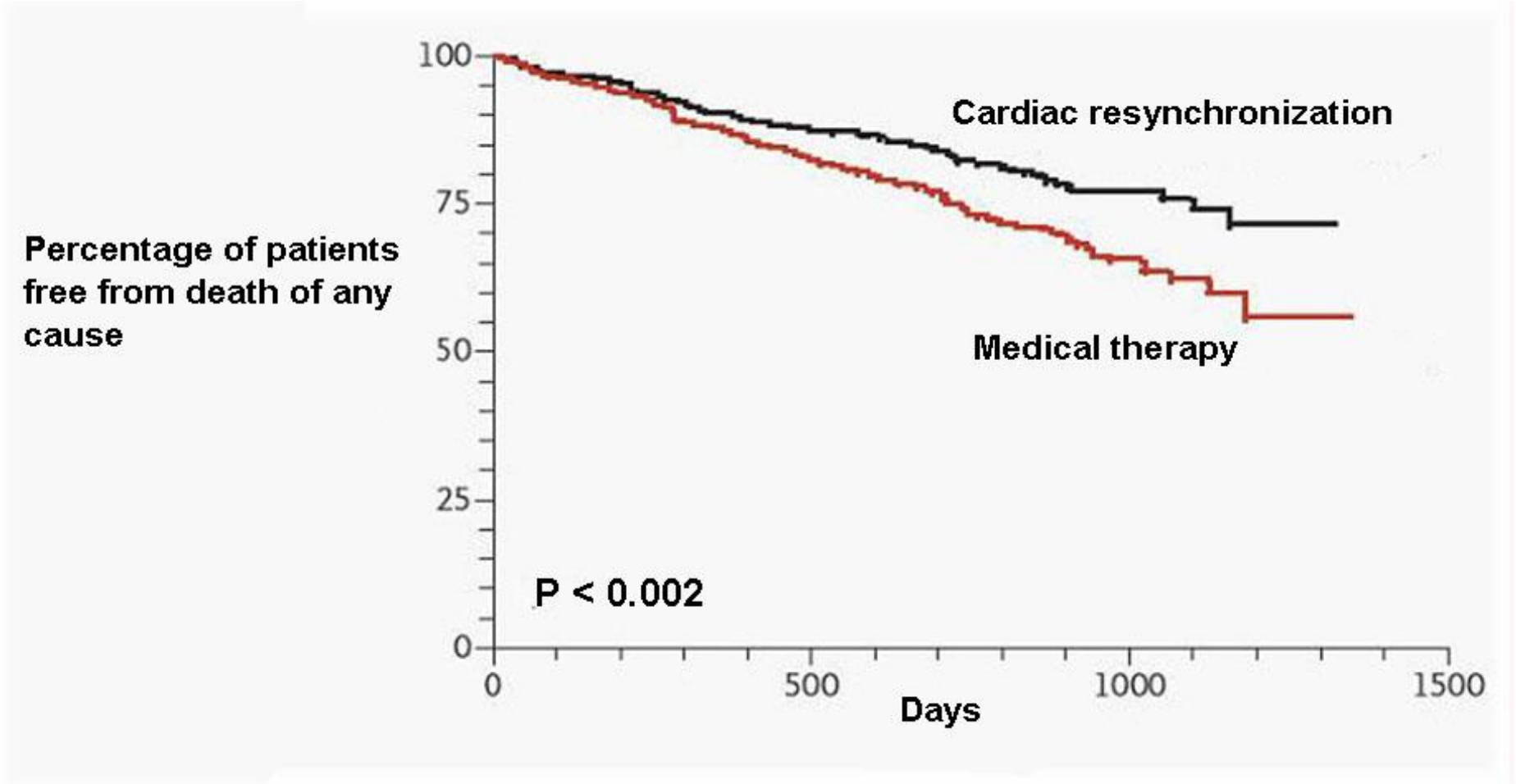


Conflicts of interest

- None

Cardiac resynchronization therapy – effect on mortality



Cleland JG et al, N Engl J Med 2005 14;352:1539-49

CRT – selection criteria

- ✓ Heart failure symptoms
- ✓ Reduced ejection fraction
- ✓ QRS width and morphology

About 1/3 of patients show no clinical response to CRT!!

”*Cardiac Resynchronization Therapy.*

…QRS duration greater than 0.12 seconds…….. While imperfect, no other consensus definition of cardiac dyssynchrony exists as yet, although several echo-cardiographic measures appear promising.”

ACC/AHA Guideline Update 2009

Echocardiography for cardiac resynchronization therapy: recommendations for performance and reporting

a report from the American Society of Echocardiography Dyssynchrony Writing Group endorsed by the Heart Rhythm Society.

J. Gorcsan et al, J Am Soc Echocardiogr. 2008 Mar;21(3):191-213.

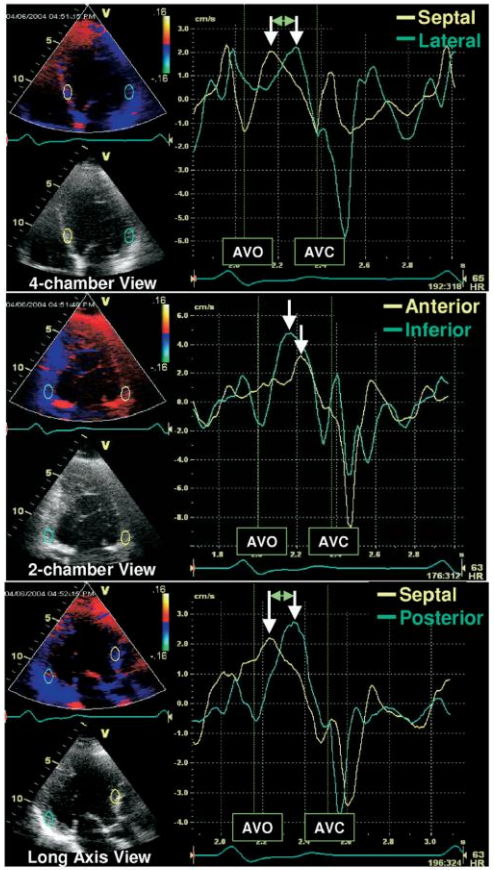
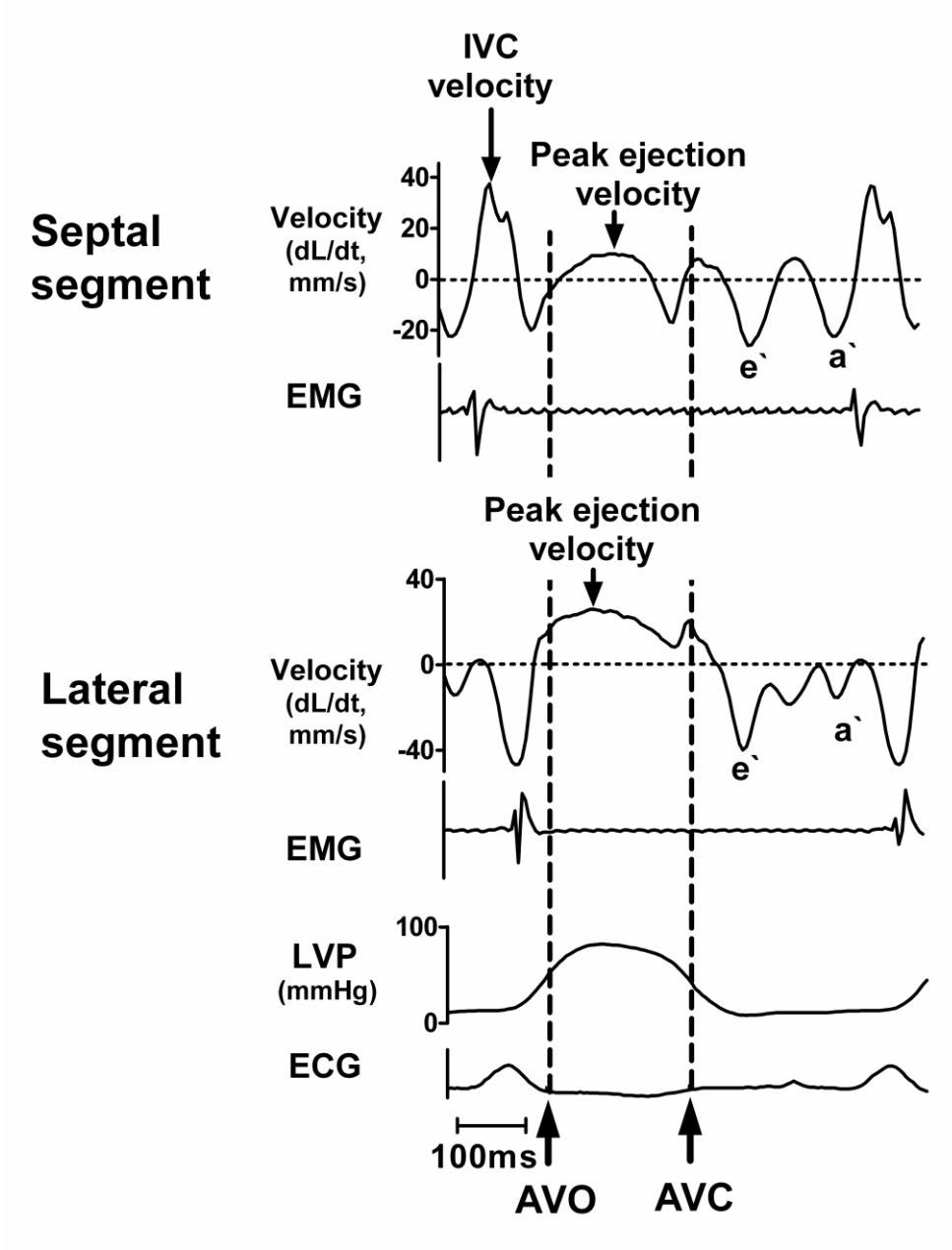


Figure 3 Color-coded tissue Doppler study from 3 standard apical views of patient who responded to resynchronization therapy. Time-velocity curves from representative basal or midlevels are shown. Maximum opposing wall delay was seen in apical long-axis view of 140 milliseconds between septum and posterior wall, consistent with significant dyssynchrony (≥65 milliseconds).

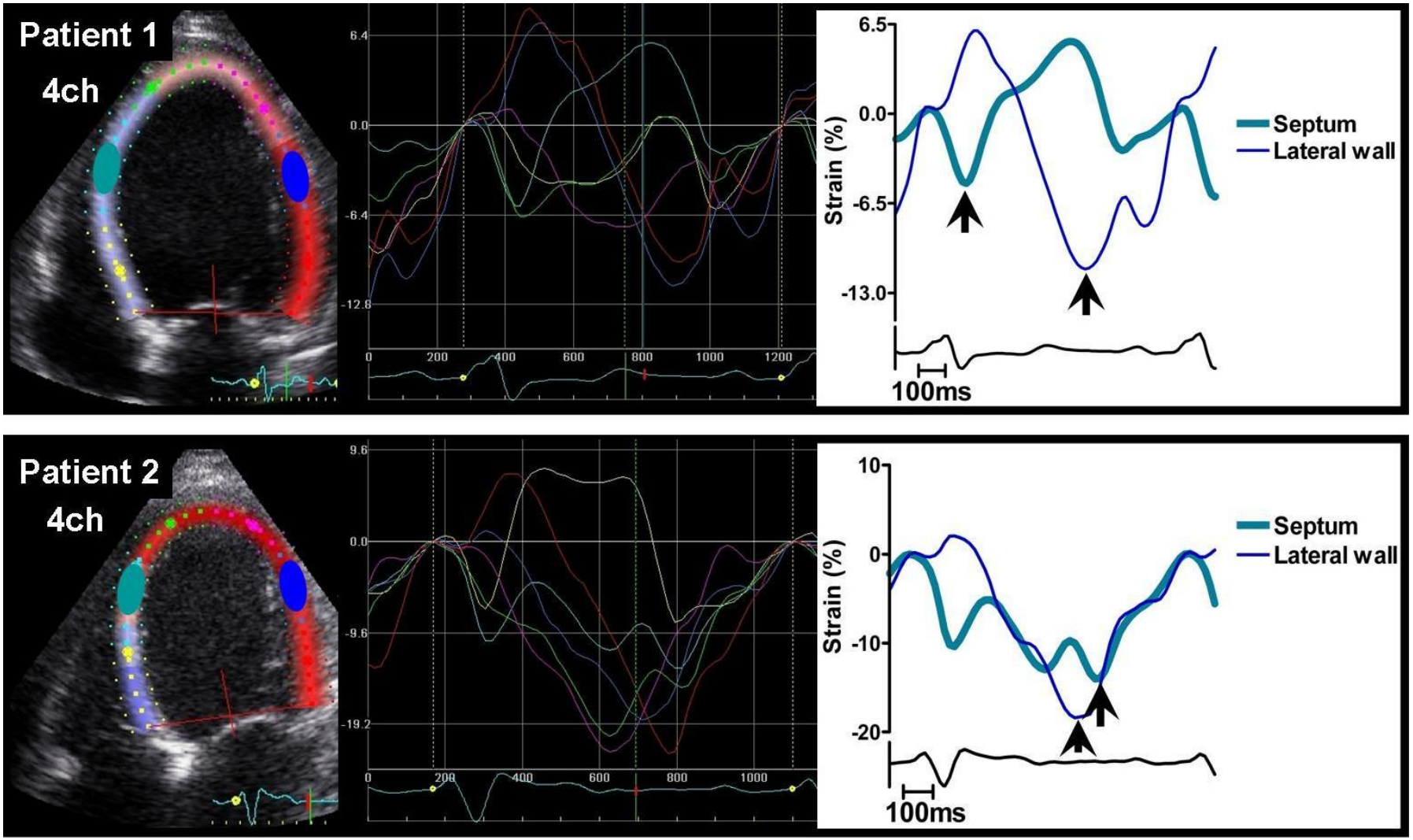
The rise and the fall of dyssynchrony indices

How could we be so wrong?

Was it too much focus on technology and not enough on physiology?

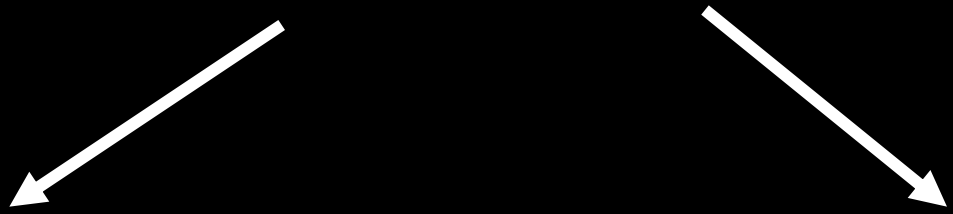


Smiseth et al. European Heart Journal - Cardiovascular Imaging. In press



K. Russell et al.,2011.

Etiologies of dyssynchrony



Primary electrical dyssynchrony

Primary mechanical dyssynchrony

Ischaemia
Cardiopyopathy
Non-uniform load

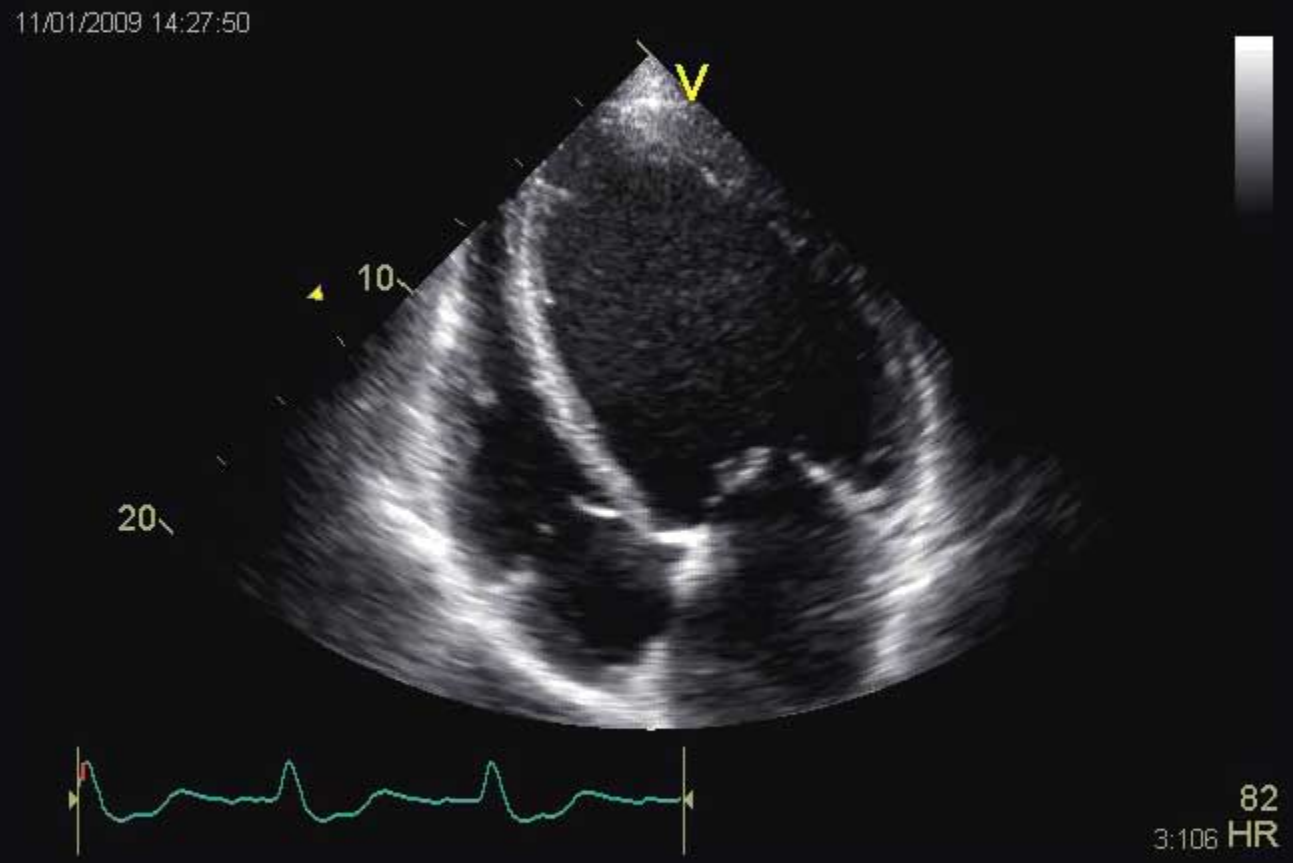
CRT likely to be effective

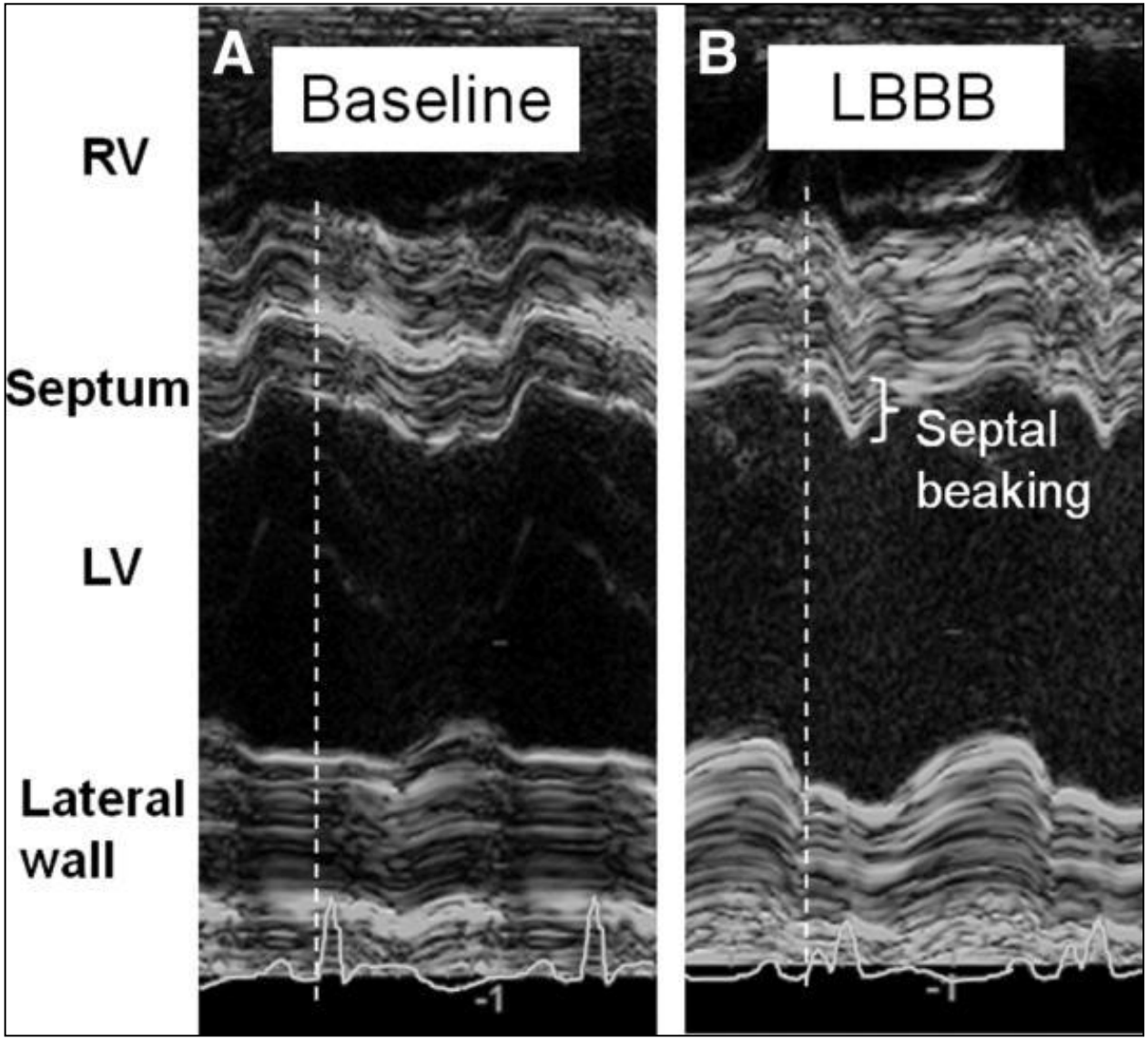
CRT <u>not</u> likely to be effective

Imaging in CRT – new strategies

1. Identify dyssynchrony mechanism

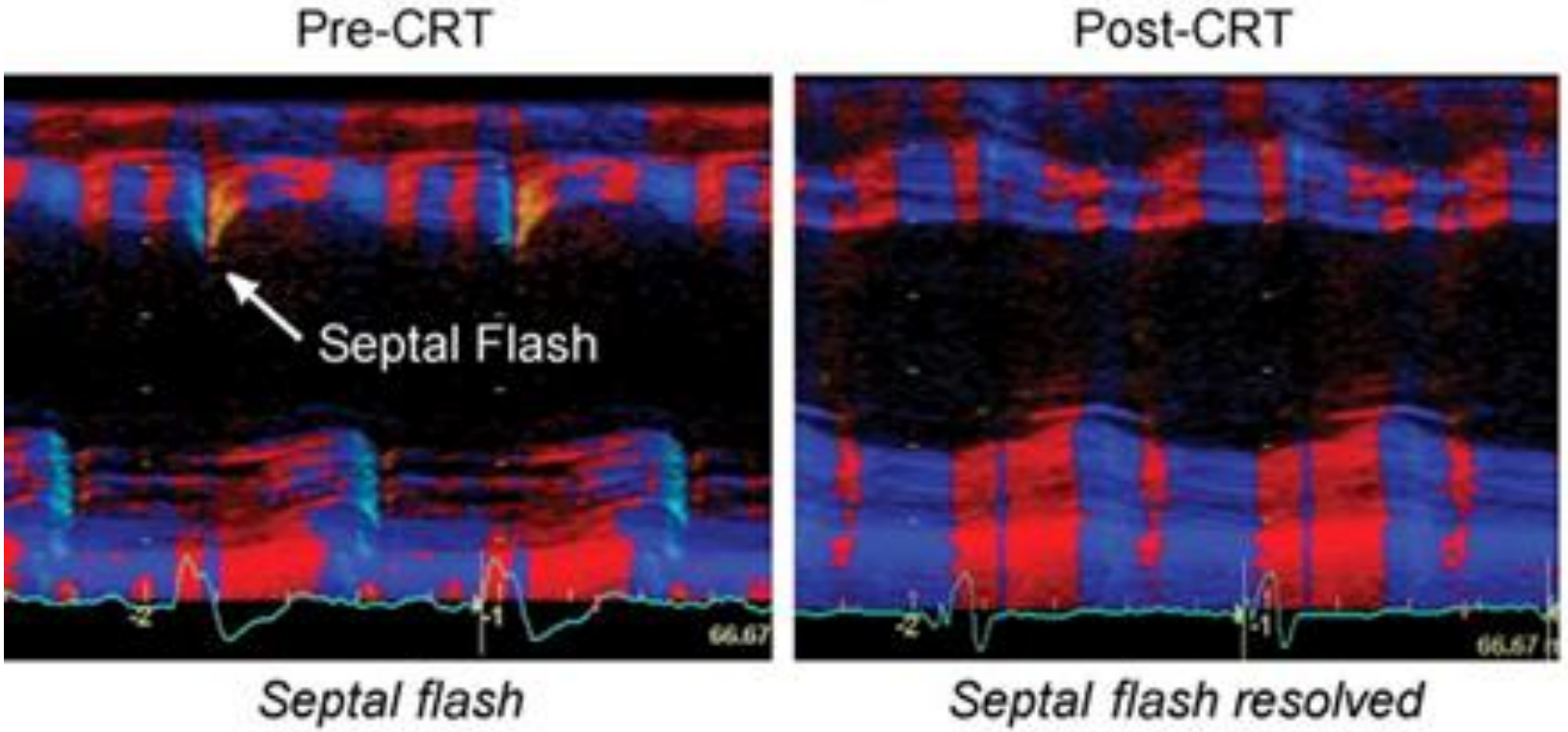
2. Quantify mechanical impact


11/01/2009 14:27:50
V
10
20
82
3:106 HR

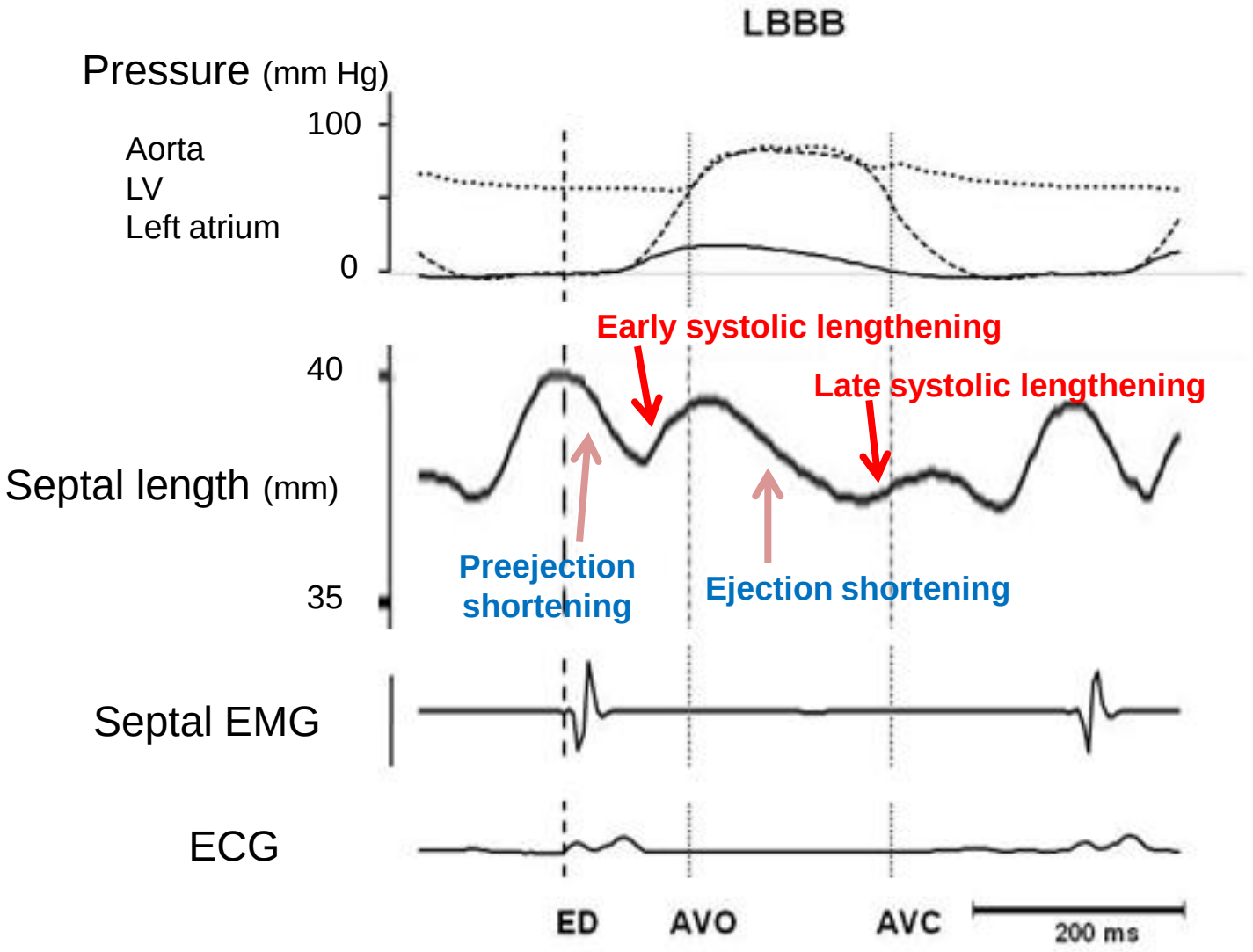


Gjesdal et al., Circulation: Cardiovascular Imaging. 4(3):264-273, May 2011.

Intra-ventricular dyssynchrony

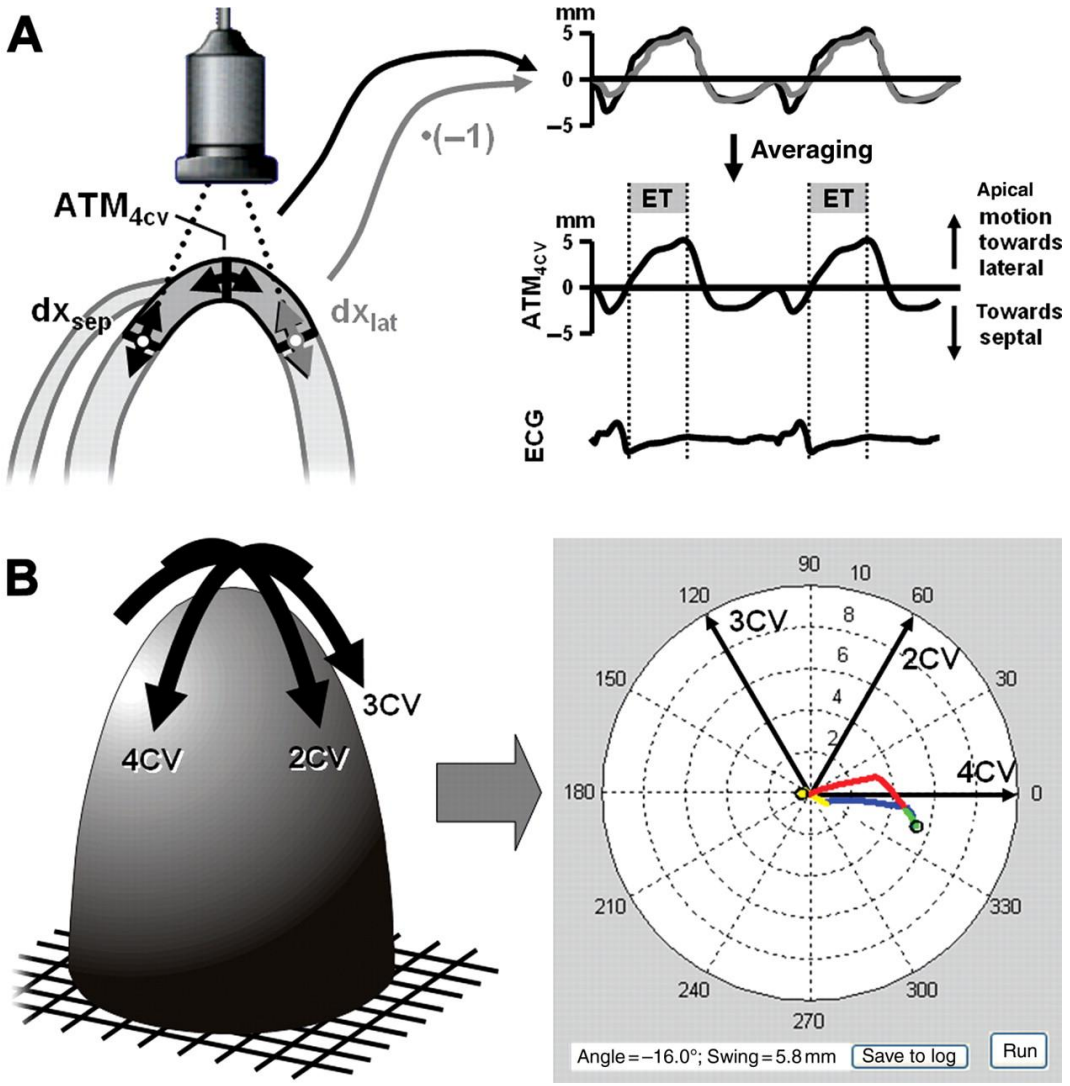


Modified from Parsai C et al. Eur Heart J 2009;30:940-949



Modified from O. Gjesdal et al., Circ. CV Imaging 2011

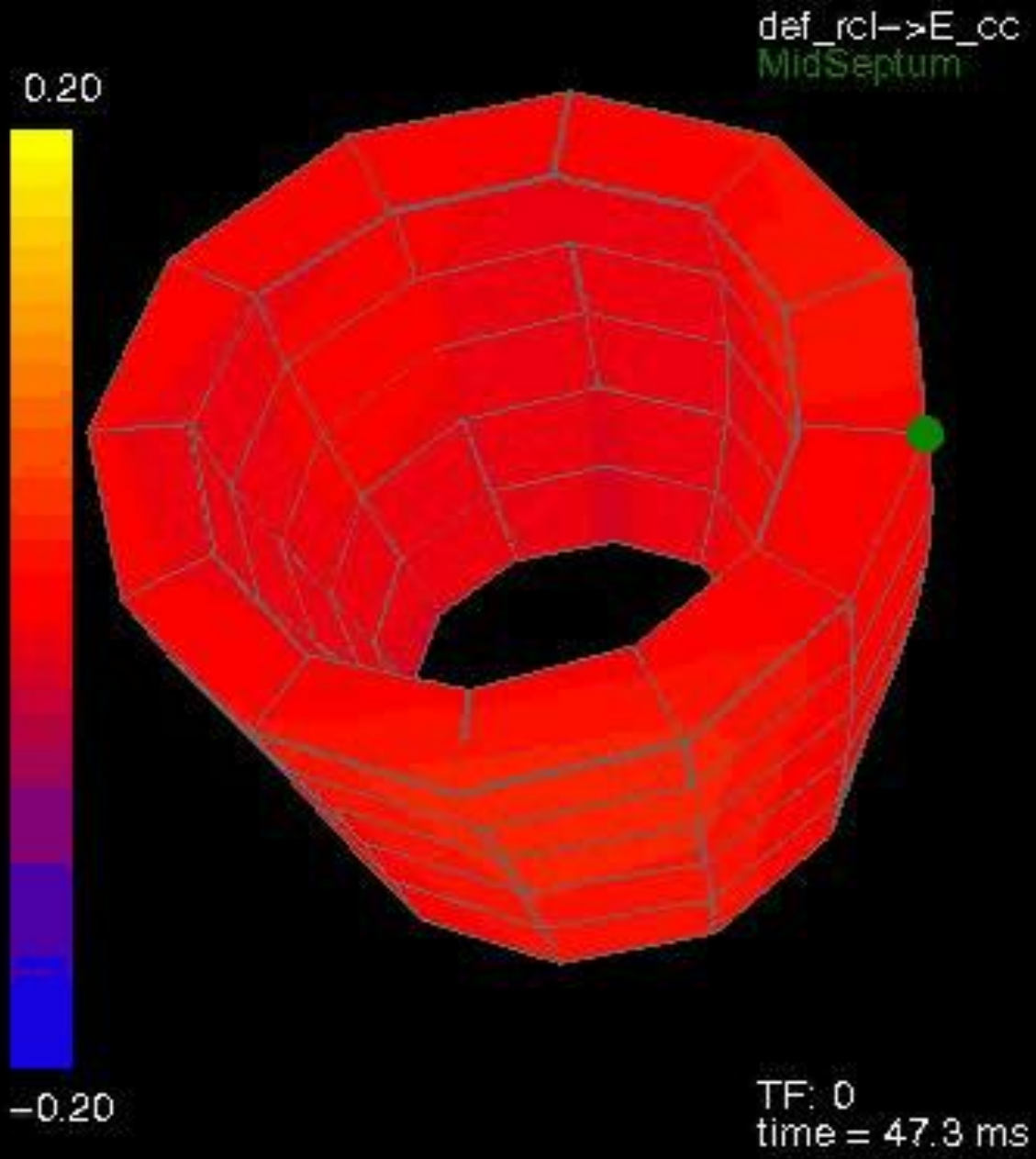
Apical rocking



Szulik M et al. Eur J Echocardiogr 2010;11:863-869

European Heart Journal Cardiovascular Imaging

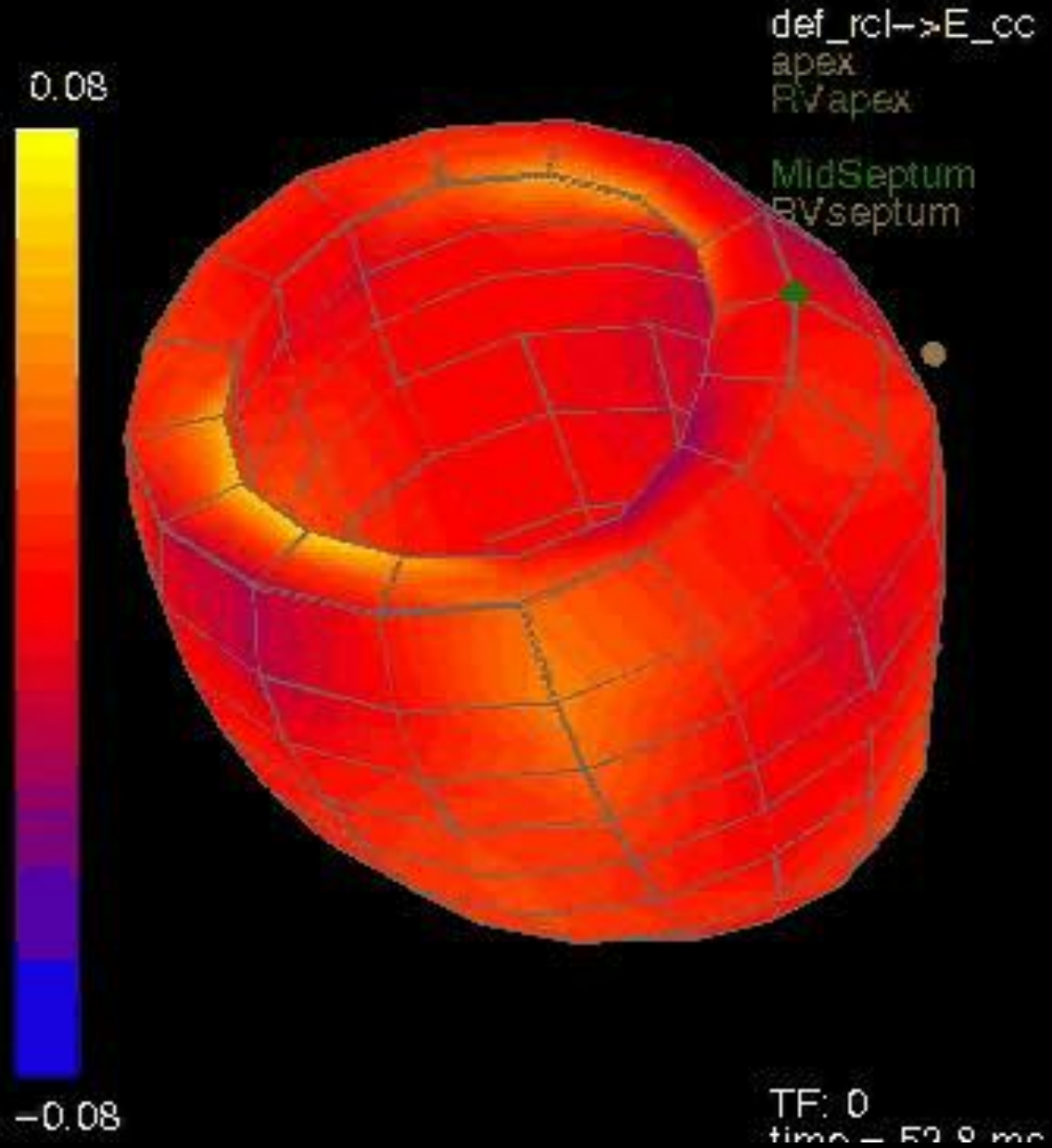
Normalt heart: Syncrony



Strain$_c$ **by MRI**

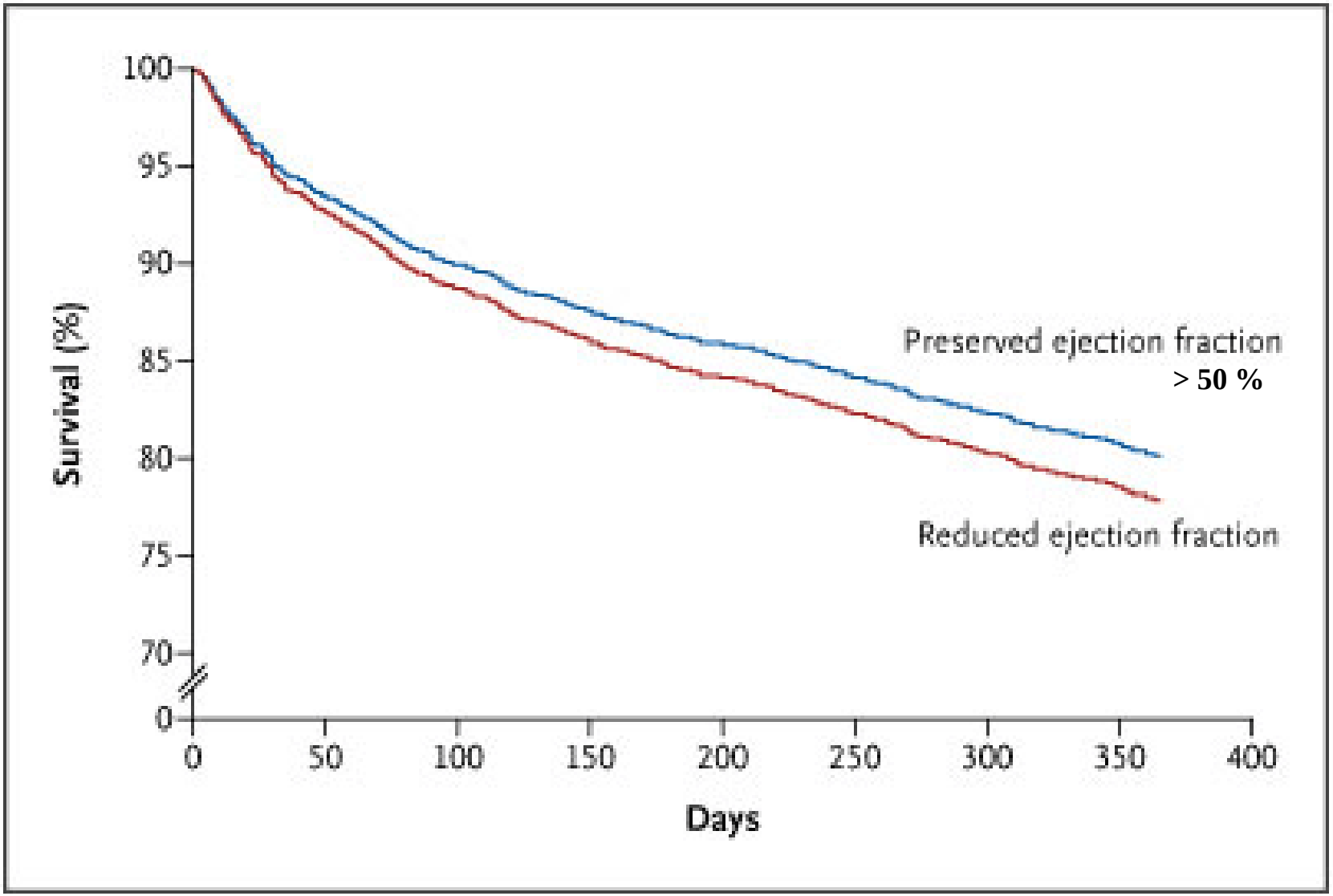
CW Curry, Circulation 2000.

Heart failure with dyssynchrony



$Strain_c$ **by MRI**

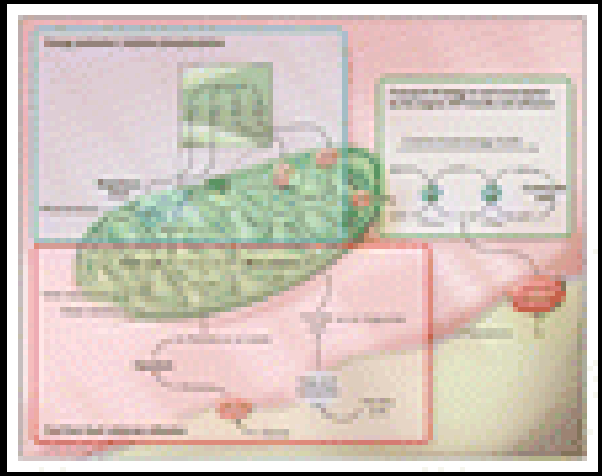
CW Curry, Circulation 2000.



RS Bhatia et al. N Engl J Med 2006;355:260-9

The Failing Heart – An Engine Out of Fuel

Abnormalities of cardiac energy metabolism make an important contribution to chronic heart failure.



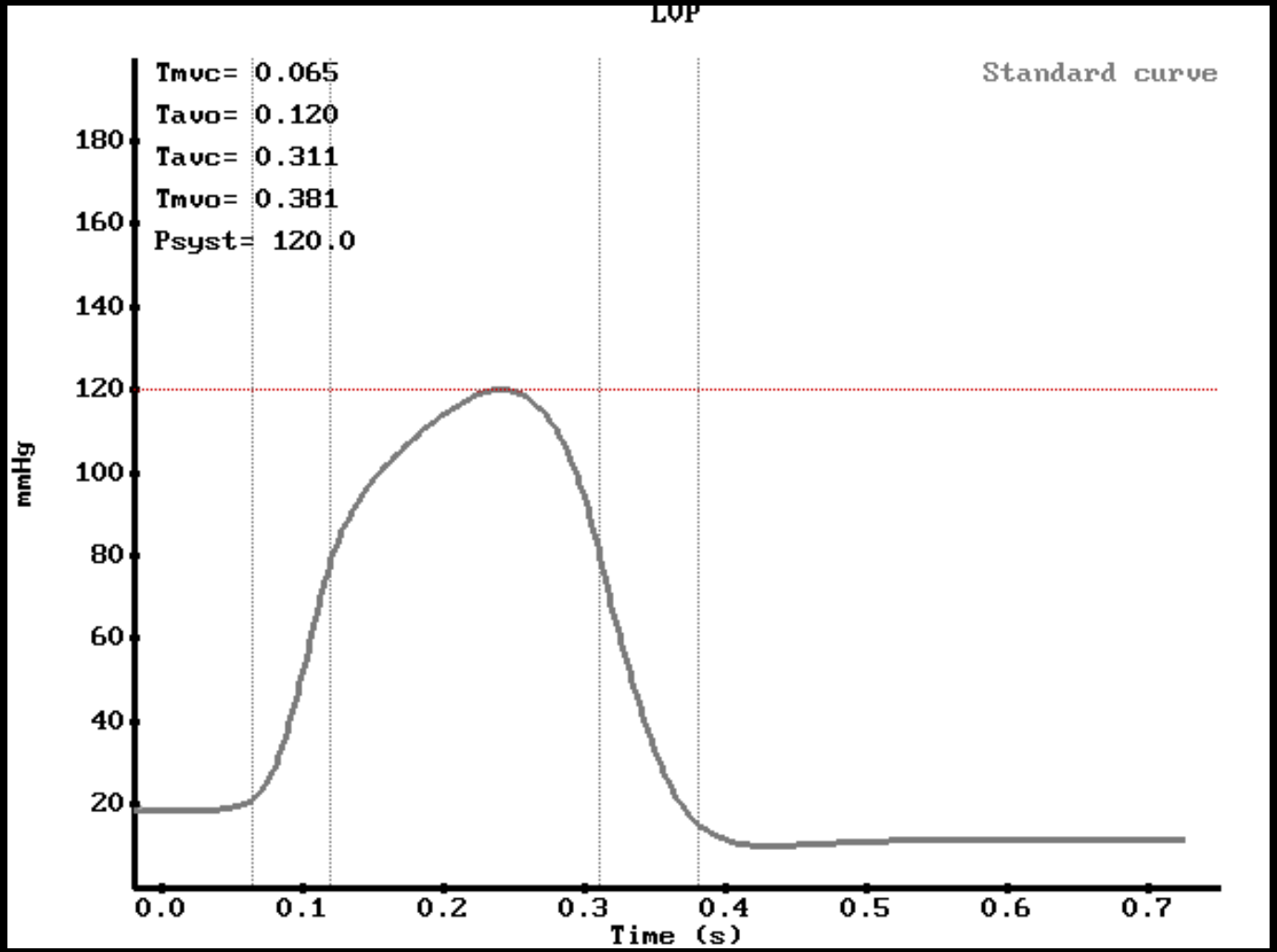
Neubauer S, N Engl J Med 2007; 356:1140-1151

Wasted Work Fraction (WWF)

A novel measure of ventricular function

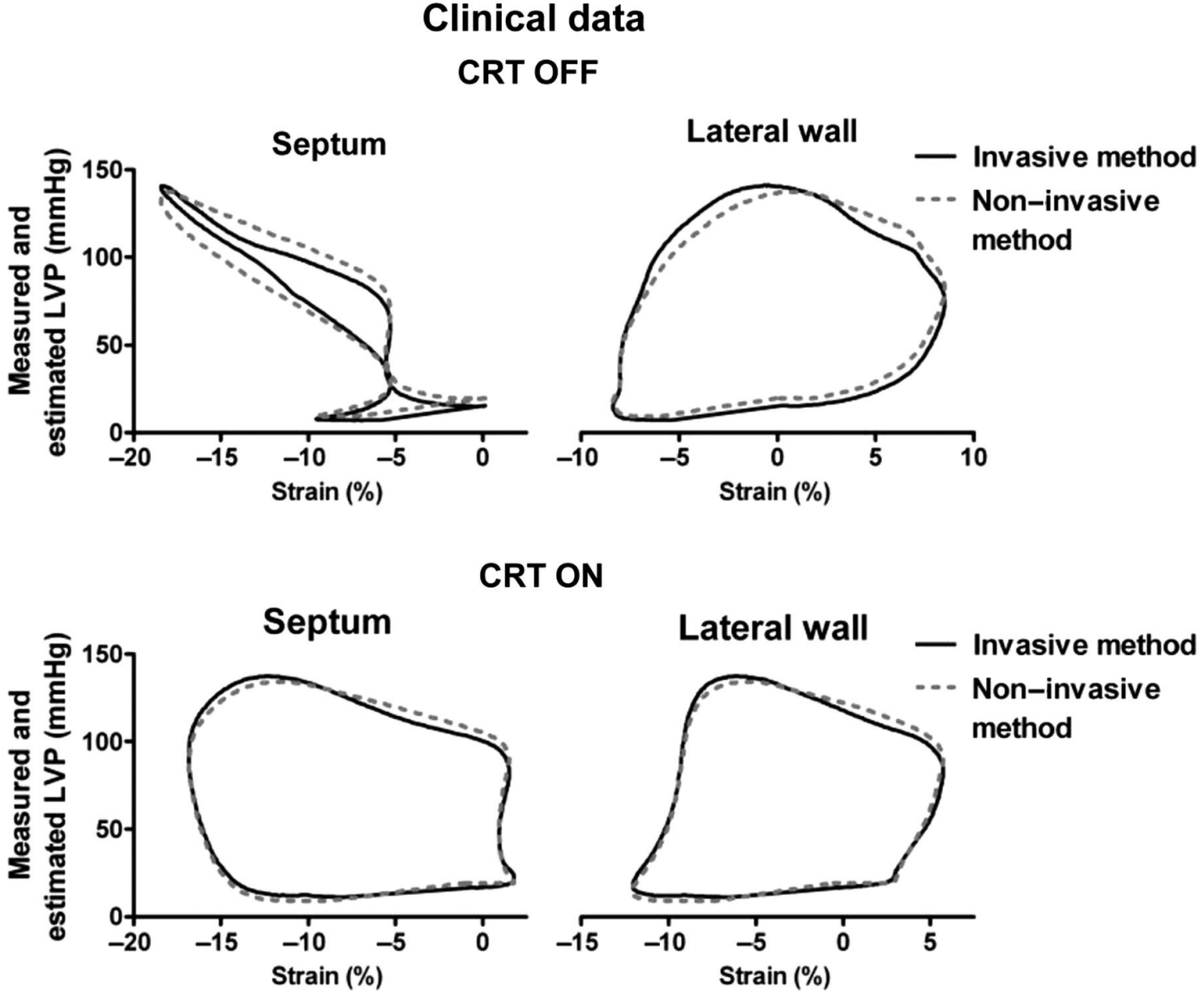
Non-invasive LV pressure

A reference curve is adjusted according to durations of IVC, ejection and IVR



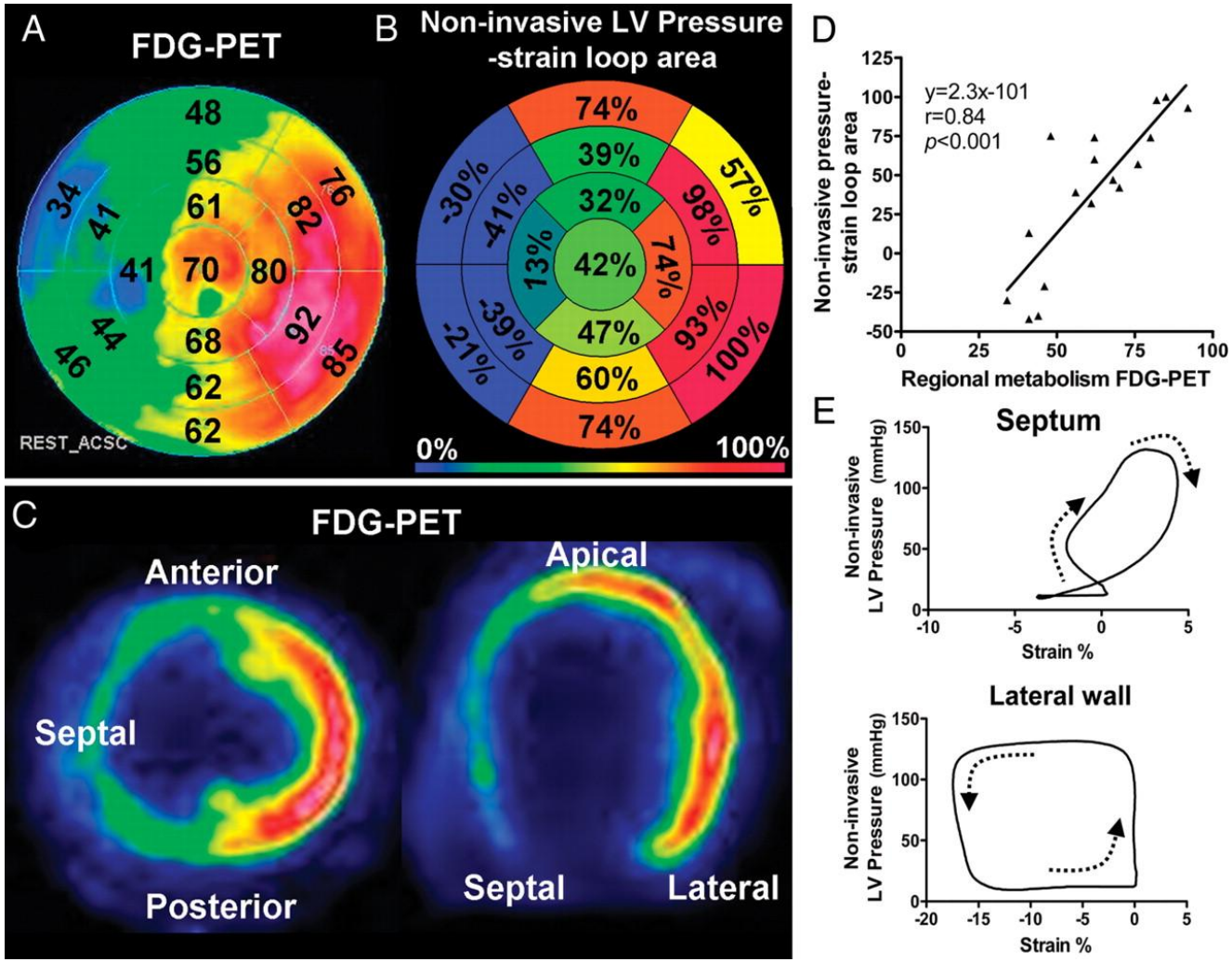
K. Russell, M. Eriksen and O.A. Smiseth, 2012

Clinical data



Russell K et al. Eur Heart J 2012;eurheartj.ehs016

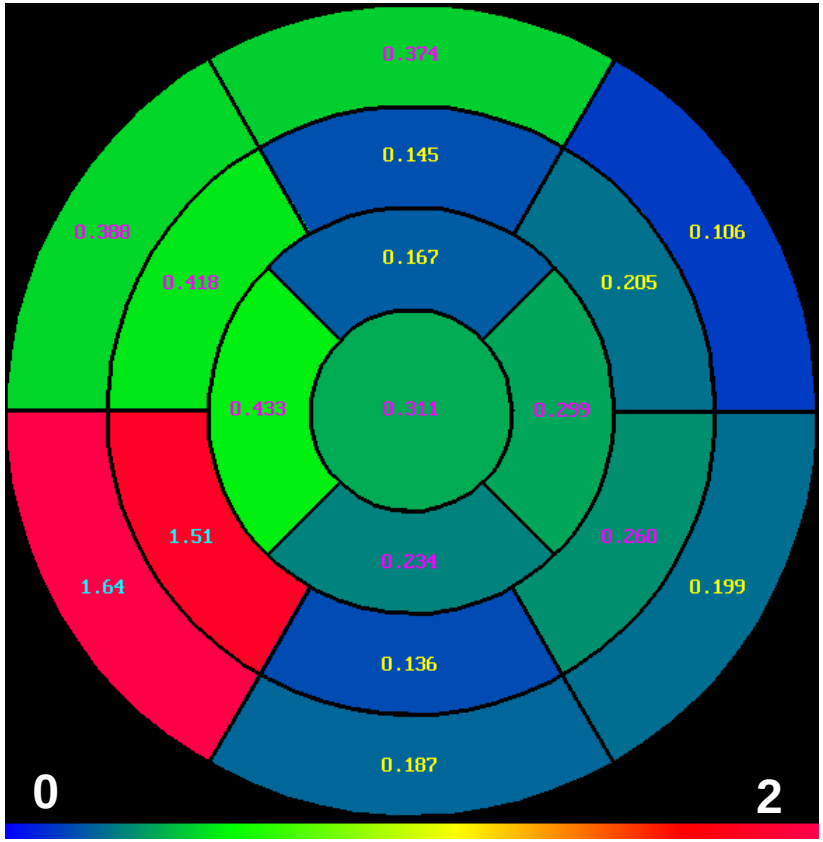
LV pressure-strain loop area reflects myocardial metabolism



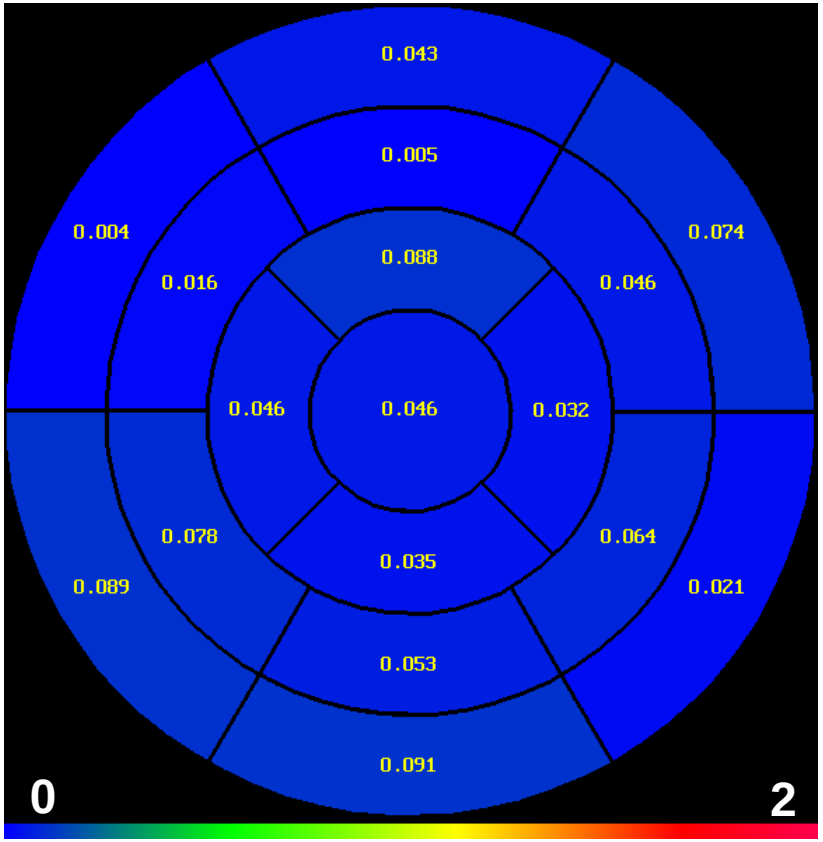
Russell K et al. Eur Heart J 2012;eurheartj.ehs016

European Heart Journal

Regional Wasted Work Ratio



Before CRT



After CRT

$$Global\ WWR = \frac{\sum W_{neg}}{\sum W_{pos}} \approx 0.34$$

$$Global\ WWR = \frac{\sum W_{neg}}{\sum W_{pos}} \approx 0.05$$

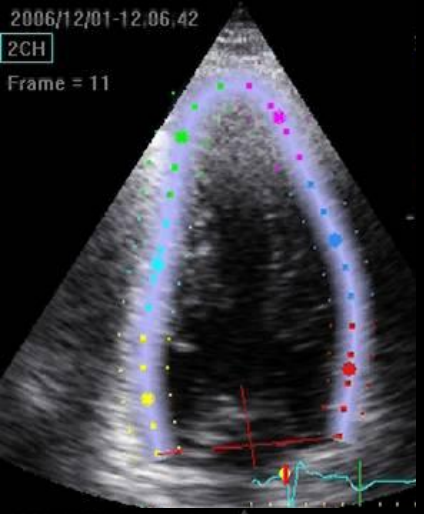
K. Russell et al., 2012

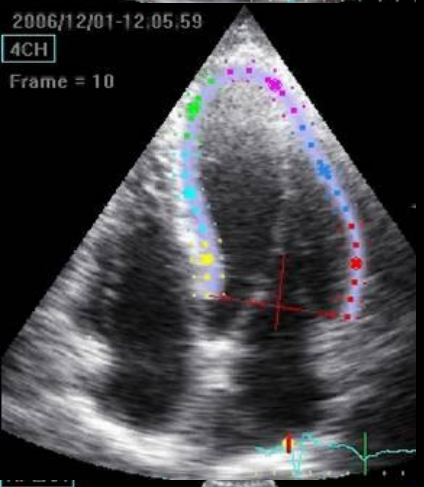
Major problem
Selection of post-MI patients for ICD therapy

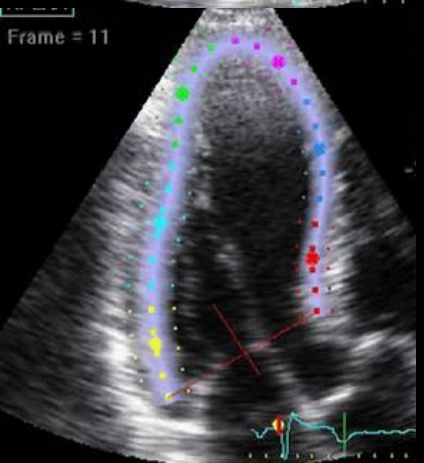
Patients with EF >30% and other risk factors may have higher mortality and a higher risk of sudden death than some patients with EF < or =30%.

The majority of patients who die suddenly after myocardial infarction do not fulfill current ICD indications (EF<35%)

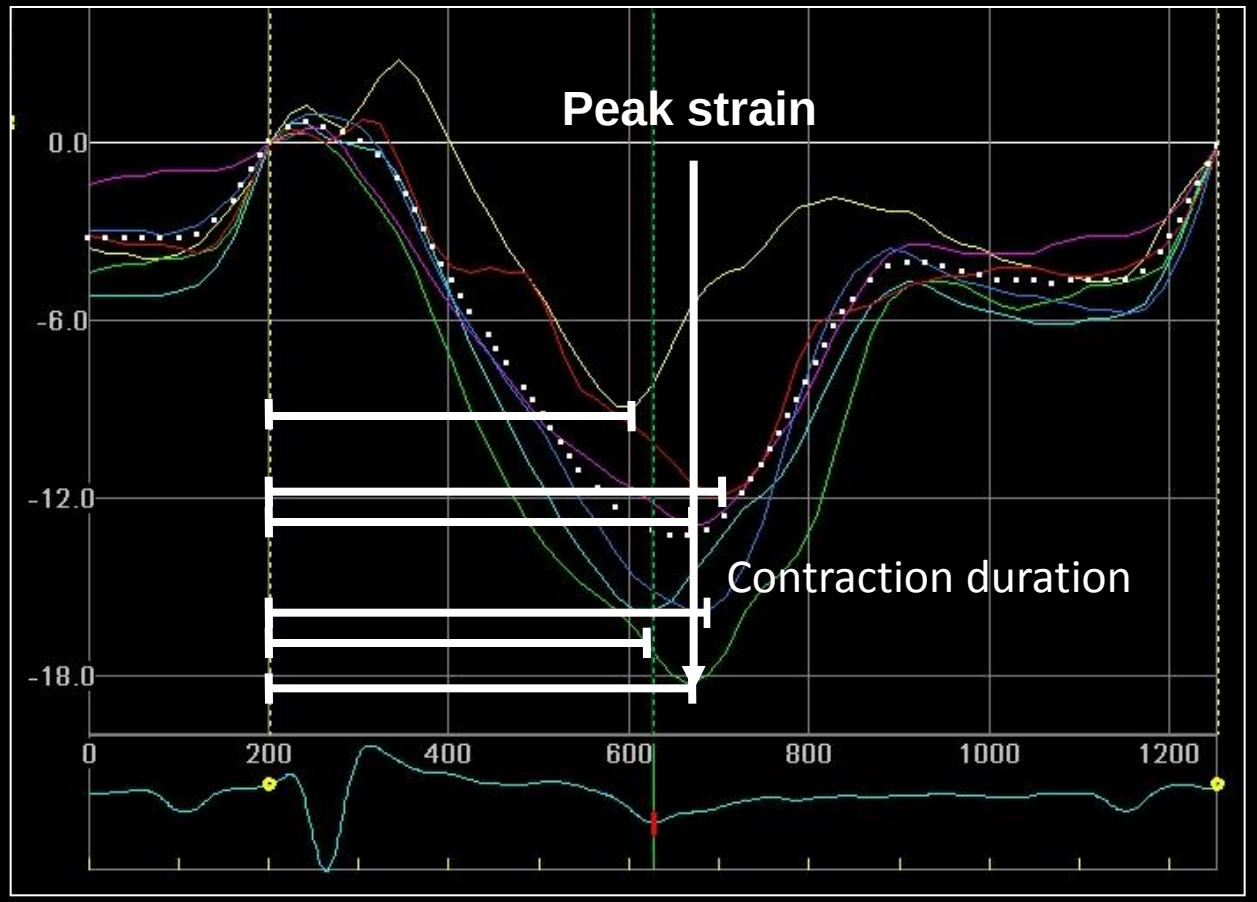
AF Buxton et al., JACC 2007





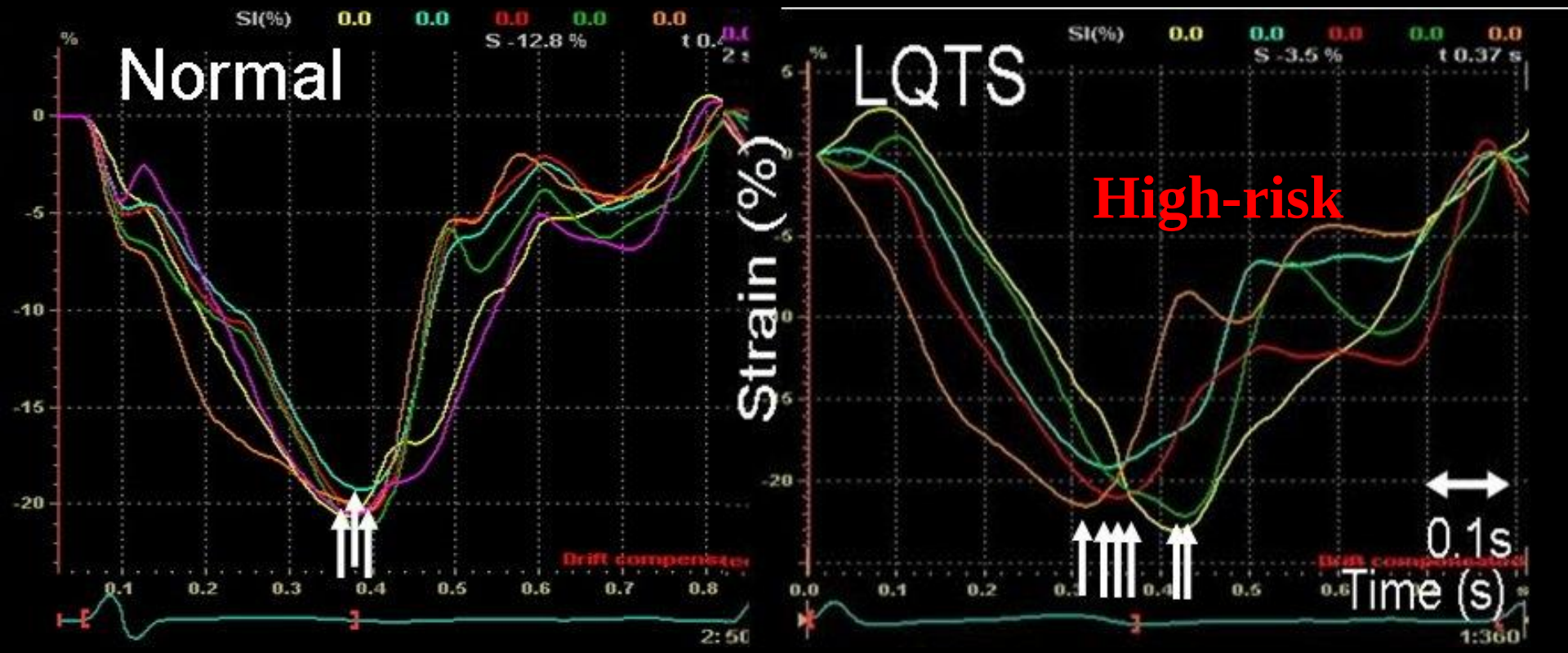


Mechanical dispersion



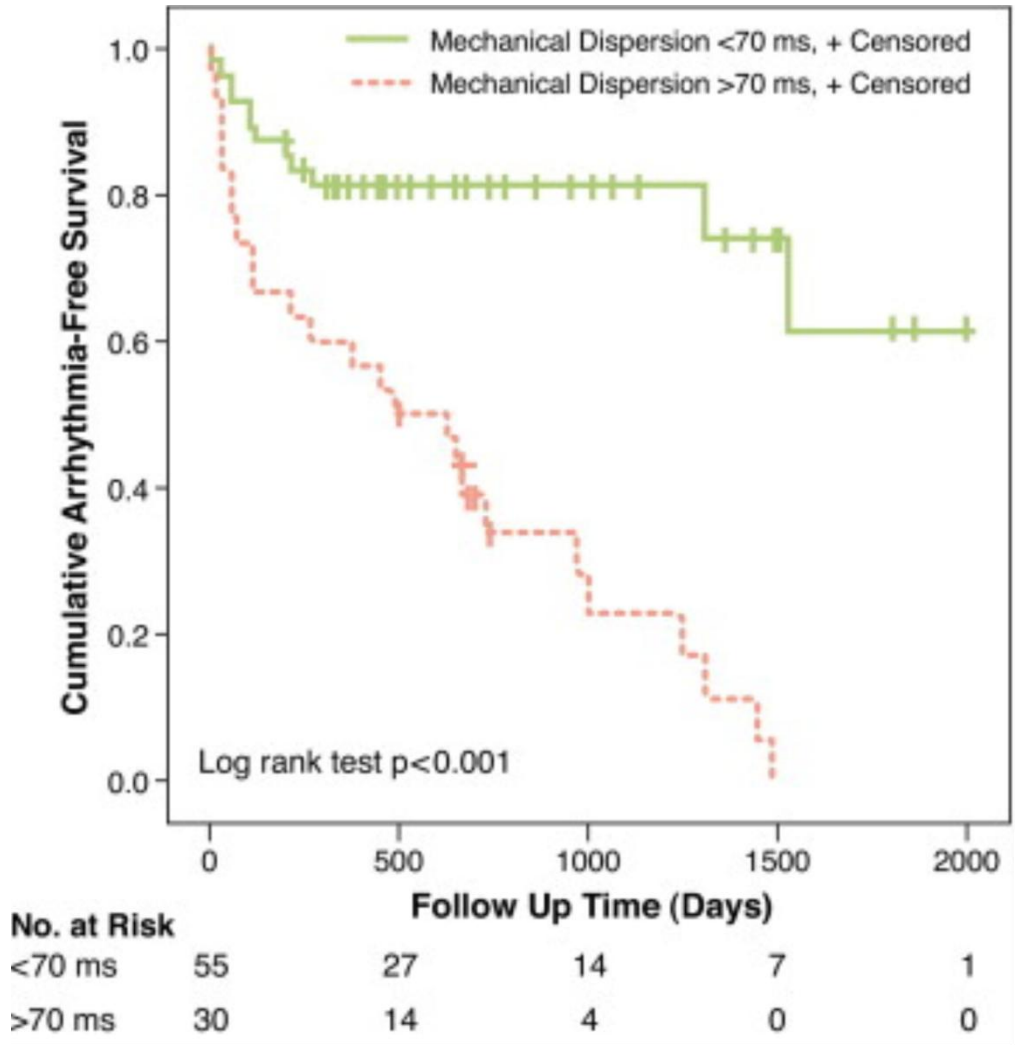
Mechanical dispersion =
Standard deviation (SD) of time to peak strain
in 16 LV segments

Mechanical Dispersion
by strain



Kristina Haugaa,….. Thor Edvardsen. Circulation 2010

From: Mechanical Dispersion Assessed by Myocardial Strain in Patients After Myocardial Infarction for Risk Prediction of Ventricular Arrhythmia



K. Haugaa et al. J Am Coll Cardiol Img. 2010;3(3):247-256.

Conclusions

- ✓ **The main target of CRT is electrical dyssynchrony. Therefore, it is critical to rule out primary mechanical dyssynchrony (load, ischaemia)**
- ✓ **There is currently no accurate clinical measure of electrical dyssynchrony.**
- ✓ **Septal flash and apical rocking are promising measures along with myocardial strain. Their added value remains to be proven.**
- ✓ **The impact of dyssynchrony on regional work can be assessed by noninvasively as Wasted Work Fraction**

Future directions

- ✓ New methods for selection of candidates for CRT should differentiate between electrical and primary mechanical dyssyncrony

- ✓ Focus should be shifted from just measuring time indices to quantification of the LV mechanical disadvantage of dyssynchrony