How to Assess Dyssynchrony

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Conflicts of interest

• None
Cardiac resynchronization therapy – effect on mortality

Percentage of patients free from death of any cause

Cardiac resynchronization

Medical therapy

\[ P < 0.002 \]

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

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 midwalls 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 (n=60 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?
K. Russell et al., 2011.
Etiologies of dyssynchrony

Primary electrical dyssynchrony

CRT likely to be effective

Primary mechanical dyssynchrony

Ischaemia
Cardiomyopathy
Non-uniform load

CRT not likely to be effective
Imaging in CRT – new strategies

1. Identify dyssynchrony mechanism

2. Quantify mechanical impact
Intra-ventricular dyssynchrony

Pre-CRT

Post-CRT

Septal flash

Septal flash resolved

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

[Diagram showing apical rocking with labelled measurements and graph]

Normal heart: Syncrony

Strain by MRI

TF: 0
time = 47.3 ms

CW Curry, Circulation 2000.
Heart failure with dyssynchrony

Strain by MRI

CW Curry, Circulation 2000.
Survival (%) over time for two groups: Preserved ejection fraction (> 50 %) and Reduced ejection fraction.
The Failing Heart – An Engine Out of Fuel

Abnormalities of cardiac energy metabolism make an important contribution to chronic heart failure.
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
LV pressure-strain loop area reflects myocardial metabolism

Russell K et al. Eur Heart J 2012;eurheartj.ehs016
Regional Wasted Work Ratio

Before CRT

\[ \text{Global WWR} = \frac{\sum W_{neg}}{\sum W_{pos}} \approx 0.34 \]

After CRT

\[ \text{Global WWR} = \frac{\sum W_{neg}}{\sum W_{pos}} \approx 0.05 \]

K. Russell et al., 2012
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 = Standard deviation (SD) of time to peak strain in 16 LV segments
Mechanical Dispersion
by strain

Normal

LQTS

High-risk

Kristina Haugaa,..... Thor Edvardsen. Circulation 2010
From: Mechanical Dispersion Assessed by Myocardial Strain in Patients After Myocardial Infarction for Risk Prediction of Ventricular Arrhythmia

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 dyssynchrony

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