Myocardial Function Imaging: How to do it in the clinic?

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Myocardial Function Imaging

Why to Quantify Myocardial Function?

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Assessment of Myocardial Function

conventional echo:
wall thickening
endocardial motion
longitudinal shortening?
timing of events?

Assessment of Myocardial Function

conventional echo:
visual, subjective
semi-quantitative
poor temporal resolution
image quality dependent

We need to objectify echocardiography!

Myocardial Function Imaging

How to Measure Myocardial Function?

Tissue Doppler & Tracking

Tissue Doppler

myocardial velocity measurement
Assessing Myocardial Function

How far / fast does the myocardium move?

How much / fast does the myocardium deform?

Deformation Imaging

myocardial deformation properties
strain, strain rate

\[ Strain = \frac{\Delta l}{l_0} \]

\[ Strain \ Rate = \frac{d Strain}{dt} \]
Tracking Based Deformation Imaging

following patterns in the image

frame 5
frame 11
frame 17
to calculate
velocity, motion, deformation, (deformation rate)

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Tracking Based Deformation Imaging

longitudinal and radial strain

30
20
10
0
-10
-20
strain [%]

radial strain
longitudinal strain

AVC
MVO
MVC
AVO
ECG

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Tracking Based Deformation Imaging

different solutions

Deformation Imaging

How to interpret data?
... normal patterns

Deformation Imaging

tissue Doppler based deformation analysis

strain rate curved M-Mode

regional and temporal strain rate distribution

shortening
lengthening
threshold

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Deformation Imaging

strain rate curve

amplitude and time course of regional strain rate

(-) shortening
(+) lengthening

Deformation Imaging

strain curve

amplitude and time course of regional length changes
downslope: shortening
upslope: lengthening

Measurable Strain/-Rate Components

Doppler based measurements always along the ultrasound beam!

Measurable Strain Rate Components

circumferential
radial

Measurable Strain Rate Components

longitudinal

tracking provides additional information

parameters
velocity
motion
strain
strain rate
global strain
components
longitudinal
radial
circumferential
torsion
How to interpret data?
... pathologic patterns

Pattern I: Reduced Strain Amplitude
e.g. reduced longitudinal strain after radiotherapy

Pattern II: Altered Temporal Sequence
e.g. post-systolic shortening in acute ischemia

Myocardial Function Imaging
Is it difficult to do?
... a step-by-step approach

"Deformation Imaging is Difficult!"
"... difficult to acquire ..."
"... time demanding post-processing ..."
"... tissue Doppler is better ..."
( "... curves are noisy ...")
( "... data are not reproducible ...")

You need to learn it!
Is Data Acquisition Difficult?

How to acquire good data.

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Angle Dependence

align beam to motion direction

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Frame Rate Dependence

Optimizing Frame Rate

depth, sector, PRF

Avoid Aliasing

velocity exceeds range

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Is Post-Processing Difficult?

Start with Doppler, not with Tracking.

Doppler: Easy Quality Assessment

Strain Rate curved M-mode reveals artifacts

Doppler: Easy Quality Assessment

bad curve

good curve

Tracking: Curves Hide Problems

smoothing and drift compensation: on

Tracking: Curves Hide Problems

smoothing and drift compensation: off

Tracking: Applying A-Priori Knowledge

generic

a-priori: „LV long axis“
Tracking Problems

enddiastolic trace  
endsystolic trace

Myocardial Function Imaging

Can we use it in the routine?

Follow the EAE Teaching Course!

Current and Evolving Echocardiographic Techniques for the Quantitative Evaluation of Cardiac Mechanics: ASE/EAE Consensus Statement on Methodology and Indications

Mor-Avi, Lang, Badano, Belohlavek, Cardim, Denmeaux, Galderisi, Marwick, Nagueh, Sengupta, Sicari, Smiseth, Smulevitz, Takeuchi, Thomas, Vannan, Voigt, Zamorano

Further Reading