Fundamentals of Tissue Doppler Imaging

Amal Hamdy, MD
Al-Azhar University
**Basic Principles**

- TDI signal is a modification of the routine Doppler flow signal. It is obtained by using thresholding and filtering algorithms that reject echoes originating from the blood pool (*by-passing the high pass filter*).

- Set-up of the machine by activating the TDI function allows decreasing the system gain and *using a low pass filter* and eliminates the signal produced by blood flow.
Basic Principles cont..

- Data are stored with high temporal resolution in a format giving signals that can tolerate mathematical processing such as derivation, integration and Fourier analysis of velocity profiles without distortion.

- Doppler shift obtained from myocardial tissue motion are of higher amplitudes (reflectivity 40 dB higher), and move about 10 times slower than blood (velocity range: 0.06 to 0.24 m/s).
Low velocity High amplitude

High velocity Low amplitude
Understanding of the normal pattern of myocardial movement is necessary for comprehensive assessment of TDI data.

Circumferential & Radial

- Thickening & Thinning
- (+ Rotation)

Longitudinal

- Shortening & Lengthening

+ Whole heart motion & Translational motion
Can be displayed in *different modes*

- PWTD
- Color-coded data superimposed on 2D images in real time
- Offline signals obtained from digitally stored cine-loops and displayed as:
  - TVI signals
  - Standard or curved M-mode
  - Tissue tracking
  - Strain and strain rate imaging
  - Tissue synchronization imaging
  - 2D strain / speckle tracking / AFI
Instrument adjustment
Apical 4-Ch, 2-Ch & Long axis views (for longitudinal function)

Parasternal views (for radial function)  4-Ch for RV function
TDI Modes

PWTD

Off-line
Multiple segments from the same cardiac cycle
Velocities decrease from base to apex
TDI Modes (cont..)

TDI on standard and curved M-mode
Strain rate imaging

What is meant by strain rate?

Rate of deformation, or an algorithm that calculates the spatial differences in tissue velocities between neighboring samples within the myocardium aligned along the Doppler beam

\[ SR = \frac{(V_2 - V_1)}{L} \]
Strain rate imaging
Strain & Strain Rate

(Both are related but represent different parts of one aspect)

Strain

Shortening

Positive strain
(Radial)

Negative strain
(Longitudinal)

Deformation

Thickening

SR

Rate of deformation
Tissue tracking

What is meant by TT?

Amount of displacement of a myocardial segment
Tissue synchronization

Synchrony

Dys-synchrony
2D strain / Speckle tracking / AFI

Choi JO et al, ECHOCARDIOGRAPHY 2008; 25: 873
Clinical Applications

• Ventricular function evaluation (quantitative)
  ➢ Regional & global LV function
  ➢ LV filling pressure evaluation (E/Em)
  ➢ RV function

• Role in CAD
  ➢ Diagnosis of ischemia, assessment of SWM
  ➢ Diagnosis of viability
  ➢ Quantitative DSE

• Role in CRT
  ➢ Selection of pts.
  ➢ Lead positioning
  ➢ Optimization after CRT

• Role in APs
  ➢ Localization of APs
  ➢ Shorten time of EPS
Ventricular function assessment

Normal  Thalassemia

Strain imaging

Ventricular function assessment (cont..)

Severe AS
Ventricular function assessment (cont..)

Severe AS
Quantitative Dobutamine Stress Echo
2D strain / Speckle tracking

Normal

CAD
Any imaging technique has its limitations and should be considered just complementary and need to be integrated in the workup of pt’s care starting from clinical evaluation to the more elaborate, complicated and sometimes technically difficult diagnostic procedures.
Thank you