Systolic Function
How to Measure, How Accurate is Echo, Role of Contrast

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No Disclosures as related to this topic
Except . . . .

Thanks to our Course Director:
Michael H. Picard
Massachusetts General Hospital
Harvard Medical School
Nothing to disclose
LV function in clinical practice:
What is the echocardiographer asked?

- Diagnosis – systolic (and diastolic) dysfunction
  - Etiology for symptoms
- Assessing response to treatment
- Assessing risk and prognosis
  - Need for interventions
    - Defibrillators, valve surgery, meds, CRT
  - Timing of interventions

Systolic function by echo: an important marker of risk

GISSI - 2
SOLVD Registry Data
Quintones et al. JACC 2000;1237-1244

When is it appropriate to use echo to quantify ventricular function?

- When ever echo is performed
- Why?
  - Echo measures of ventricular function are all validated and standard
  - Requesting MDs expect it and will use it
    - Keeps echo competitive with other modalities
- If concern that image quality is insufficient to measure LV systolic function
  - Then use contrast
  - Consider methods that do not require border delineation
Assessing Global function – LV EF

- Qualitative
- Single dimension
- Volumetric
  - Area length Method
  - Simpson’s Rule Method / Method of Discs
  - Three dimensional
ASE Best Practices: Modified Biplane Simpson’s Rule (EDV-ESV/EDV)

\[ V = \pi/4 \sum a_i b_i L/20 \]

Single plane ok if no WMA

Diastole ↔ Systole

3D echo for volume and EF triplane imaging and manual tracing

Linear regression of LVEF in all patients, measured by 3D echocardiography by Simpson’s method (3DS) vs radionuclide angiography (RNA)

\[ y = 3.7 + 0.9x \]

\[ n = 25 \]

\[ r = 0.99 \]

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Results of LVEF measurements plotted as differences between methods and analysis of agreement

Potential problems with LVEF

• Load dependency
• Measurement issues
  – Endocardial dropout
    • Overestimation of volume
  – Foreshortening of the ventricle
    • Underestimation of volume
    • Less effect on EF

Potential pitfalls of EF measurement (continued)

– Geometric assumptions
  • Influence EF measure when LV distorted
– Regional dysfunction
  • Over or under-represented with some methods
– Paradoxical septal motion, other discoordinations of contraction
  • Underestimation of EF
– Heart rate effects
  • Tachycardia
– Reproducibility
Assessment of Regional Systolic Function

Assess each region based on thickening and systolic motion:
1. Hyperkinesis or Normal
2. Hypokinetic
3. Akinetic
4. Dyskinetic
5. Aneurysmal

Real-time 3D echo and automated border detection:
assessment of LV volumes and EF

What if image quality inadequate?
Use contrast for LVO to assess LV global and regional function

Segmental Wall Motion

Comparison with RNA of echo LV EF by Simpson’s method, fundamental or harmonic, contrast or non-contrast

Nahar et al. AJC 2000;86:1358
Interobserver Variability Lowered with Contrast Down to MRI Levels

Other measures of LV systolic function that do not rely on endocardial border delineation

- Isovolumic indices
  - \( \frac{dP}{dt} \)

- Ejection phase indices
  - Time interval (Doppler)
    - Tei index
  - M mode
    - Fractional shortening (FS)
    - Velocity of circumferential fiber shortening (Vcf)

Quantitation of global LV systolic function

- Isovolumic indices
  - \( \frac{dP}{dt} \)
    - Easy to measure – MR CW Doppler
    - Automated
    - Mean \( \frac{dP}{dt} \) correlates well but underestimates \( \frac{dP}{dt} \) max (\( \frac{dP}{dt} \) max depends on time of peak systolic pressure)
    - Instantaneous \( \frac{dP}{dt} \) accurate measure of \( \frac{dP}{dt} \) max
  - MR must be present
  - Maximum spectra must be recorded
    - Can use contrast to enhance weak signal
  - Not truly isovolumic
Measuring mean $\frac{dP}{dT}$

- CW Doppler of MR
- Measure time interval for velocity to increase from 1 m/s to 3 m/s
- $\frac{dP}{dt} = \frac{32}{t}$

Kolias, et al. JACC 2000;36:1594

Improved $dP/dt$ after CRT

Fan et al. JASE 2004;17:553

dP/dt by echo for HF outcomes

Kolias, et al. JACC 2000;36:1594
Quantitation of global LV systolic function: Ejection phase indices

Doppler total ejection isovolume index

Tei index
- Doppler measure
- No geometric assumptions
- Less dependent on load
- Requires accurate IVRT, ET, ICT
- Pseudonormalization

Prognostic value of Tei Index in CHF

Cardiac amyloidosis
Tei et al, JACC 1996;28:658-64

Idiopathic dilated cardiomyopathy
Am J Cardiol 1998;82:1071-1076

Integration of 2D strain for LV function

New algorithms do not require border delineation
Summary

- Quantitation of LVEF
  - 2D Biplane Simpson or 3D
  - Still the foundation of LV systolic function
  - Limitations exist but it remains a trusted measure that has prognostic value
- Semi-quantitative assessment of regional LV function
  - Qualitative function, quantitative location and size
- Use of contrast to improve LV function assessment
- Specialized conditions may require novel measures (strain, speckle tracking, torsion)
Questions?