Why M-Mode Is Great

- Precise representation of timing
- Enhanced understanding of pathologies
- Enhanced understanding of hemodynamic effects
- Visual representation of diagnoses

Today's plan:
A tour of important M-Modes and correlating spectral Doppler—pulse wave (PW) and continuous wave (CW)

Normal Aortic Valve M-Mode

- Parallelogram in shape
- Midline closure
- RCC = right coronary cusp
- NCC = non-coronary cusp
- IVCT = isovolumetric contraction time
- IVRT = isovolumetric relaxation time

Normal Mitral Valve M-Mode

- Anterior (top) and posterior leaflets
- E = Early diastolic filling
- E' slope = early to mid-diastolic filling
- A = atrial kick or atrial contraction
- C = electrical onset of systole
- C-D = closure during systole
- D = denotes valve opening

Anatomical M-mode

Question 1

In which condition would you expect to see normal motion of the interventricular septum (IVS) on M-mode?

- a. right ventricular (RV) pacing
- b. Severe tricuspid regurgitation
- c. Atrial septal defect
- d. Aortic valve replacement
- e. Aortic insufficiency
Question 2

When comparing two-dimensional with M-mode echocardiography, which of the following statements is true?

- A. the axial resolution of M-mode echocardiography is superior to that of two-dimensional echocardiography.
- B. the temporal resolution of M-mode echocardiography is superior to that of two-dimensional echocardiography.
- C. the axial resolution of M-mode echocardiography is inferior to that of two-dimensional echocardiography.
- D. the lateral resolution of M-mode echocardiography is superior to that of two-dimensional echocardiography.

Question 3

We did a transthoracic echocardiogram and noted that the patient had a systolic ejection murmur. Which additional finding is consistent with an echo-dense mass?

- A. There is severe aortic regurgitation.
- B. The left ventricular ejection fraction is high.
- C. The stroke volume is normal.
- D. The stroke volume is low.

Question 4

A 51-year-old woman is referred to you for a systolic murmur. Due to its persistent nature, an echocardiogram is performed (Fig. 3). Based on this M-mode recording for ventricular size, what is your diagnosis?

- A. Normal ventricular size.
- B. Hydrotic mitral valve.
- C. Hypertrophic obstructive cardiomyopathy.
- D. Acute severe mitral regurgitation.

M-mode and The Septum

Severe left ventricular systolic dysfunction

Septal Movement with Breathing

Inspiration
- Septal shift toward left
- Accommodate incoming preload

Expiration

Right Ventricular Pacing

- Normal septal thickening
- Paradoxical septal motion
  - Definition = early systolic anterior (toward RV) motion of the septum
  - Offset in activation from inferolateral and septal walls compared to normal
Severe Tricuspid Regurgitation

Constrictive Pericarditis

Post Cardiac Surgery

Left Bundle Branch Block

M-Mode and Resolution

Temporal
- M-Mode superior to 2D
- Due to higher sampling rate
- 1000 frames per second (2D is 30-60)

Axial
- M-Mode similar to 2D
- Due to same transducer frequency
- Longitudinal or depth resolution

Lateral
- M-Mode inferior to 2D
- Due to single scan line used
M-Mode and Hemodynamics

- Point septal separation (PSS; dotted line)
  - Normal: < 7 mm
  - Mid range: 7-12 mm
- Mitral annulus with chronic aortic regurgitation
  - Aorta: > 12 mm
- Cardiomyopathy
- Low output state/low forward stroke volume
- End diastolic dimension (EDD) and end systolic dimension (ESD)
  - Convention to use 2D for measurements

E-point septal separation (EPSS; dotted line)
- Normal: < 7 mm
- Mid range: 7-12 mm
- Dilated ventricle with chronic aortic regurgitation
- Abnormal: >12 mm
- Cardiomyopathy
- Low output state/low forward stroke volume
- End diastolic dimension (EDD) and end systolic dimension (ESD)
  - Convention to use 2D for measurements

B-bump and Elevated LV End Diastolic Pressure

- B-bump
- Elevated LV End Diastolic Pressure

Atrial Fibrillation
Severe LV Systolic Dysfunction

- Beat to beat variability in aortic valve opening
- Beat to beat variability in cardiac output

Low Cardiac Output

- Slow tapered closure of aortic valve
- Cardiomyopathy with low flow state
- Significant mitral regurgitation

L-wave

- Robust pulmonary vein flow
- Seen in bradycardia
- Can be normal finding
- Mid-diastolic flow velocity >20 cm/s can represent markedly delayed relaxation and elevated filling pressures
M-Mode and Valvular Disease

**Bicuspid Aortic Valve**
- Eccentric closure line
- Most common is RCC-LCC fusion

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**Severe Aortic Regurgitation**
- Early opening of aortic valve
- Diastolic flow in descending aorta
- High frequency fluttering of the mitral valve in diastole
- Normal septal motion

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**Severe Aortic Regurgitation**
- Premature early closure of mitral valve
- Dilated LV (if chronic)
- Rapid equilibration of LV and aortic diastolic pressures
- Here regurgitation is not holosystolic
  - Equilibrates quickly
  - Early diastolic flow
  - IC point occurs well before QRS

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**Critical Aortic Stenosis**
- Abrupt, very early posterior motion of right cusp
- Early systolic premature closure
- Fluttering of the aortic leaflets post "dip" due to aortic regurgitation
- Can help to distinguish from valvular aortic stenosis

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**Subaortic Membrane**
- Abrupt, very early posterior motion of right cusp
- Early systolic premature closure
- Fluttering of the aortic leaflets post "dip" due to aortic regurgitation
- Can help to distinguish from valvular aortic stenosis
Hypertrophic Obstructive Cardiomyopathy

- Systolic anterior motion of the mitral valve
- Increased septal thickness narrows LVOT
- Anterior displacement of the mitral valve
- Elongated mitral valve
- Hyperdynamic systolic function

- Mid systolic premature closure of aortic valve
- Similar to stress induced cardiomyopathy with dynamic LVOT obstruction

Dagger and Lobster Claw

- Duration to mitral leaflet septal contact related to gradient
- Mid Systolic Cessation of Flow

Mid Cavitary Obliteration

Mitral Stenosis

- Reduced E-F slope
- Septal “dip” exaggerated
- Right ventricular flow unimpeded
- Left ventricular flow impeded, dip toward LV
- Thickened leaflets
- Often absence of A-wave due to atrial fibrillation
- Large left atrium

Mitral Valve Prolapse

- Mid to late systolic murmur
- Not holosystolic
Mechanical Valves

M-Mode and Arrhythmia, Pericardial disease, and Other Important Findings

Complete heart block
Atrial fibrillation

Mitral Annular Calcification

Left Atrial Myxoma

Cardiac Tamponade
Pulmonary Hypertension

- Flying W sign
- Reflecting elevated pulmonary vascular resistance

Mid-systolic notch
Rapid pulmonary acceleration time

FEIGENBAUM H. ECHOCARDIOGRAPHY. 1ST ED. PHILADELPHIA, PA: LEA & FEBIGER; 1972

Severe Pulmonic Stenosis

KLEIN, A. CLINICAL ECHOCARDIOGRAPHY REVIEW, 2017

Severe Pulmonic Regurgitation

Tricuspid Annular Plane Systolic Excursion (TAPSE): Right Ventricular Function

Abnormal TAPSE = 1.7 cm
Inferior Vena Cava:
Right Atrial Pressure Estimate

**Question 1**
In which condition would you expect to see normal motion of the IVC in systole on M-mode?

- b. Severe tricuspid regurgitation.
- c. Atrial septal defect.
- d. Aortic valve replacement.
- e. Aortic insufficiency.

**Question 2**
When comparing M-mode with 2-D mode echocardiography, which of the following statements is true?

- a. The axial resolution of M-mode echocardiography is superior to that of two-dimensional echocardiography.
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**Question 3**
This M-mode echocardiogram was taken from the apical view of a 60-year-old man with dyspnea. Fig. 2. The blood pressure is 110/60 mm Hg. What may be said about the patient's hemodynamic status?

- a. There is severe aortic regurgitation.
- b. The left ventricular pressure is high.
- c. The stroke volume is normal.
- d. The stroke volume is low.

**Question 4**
A 37-year-old woman is referred to you for a cardiac workup. She is complaining of palpitations. An echocardiogram is performed Fig. 3. Below is a M-mode recording through the aortic valve, what is your diagnosis?

- b. Subaortic stenosis.
- c. Hypertrophic obstructive cardiomyopathy.
- d. Acute aortic valve regurgitation.

Thank You and Good Luck!