Echocardiographic view for Cardiac Electrophysiology

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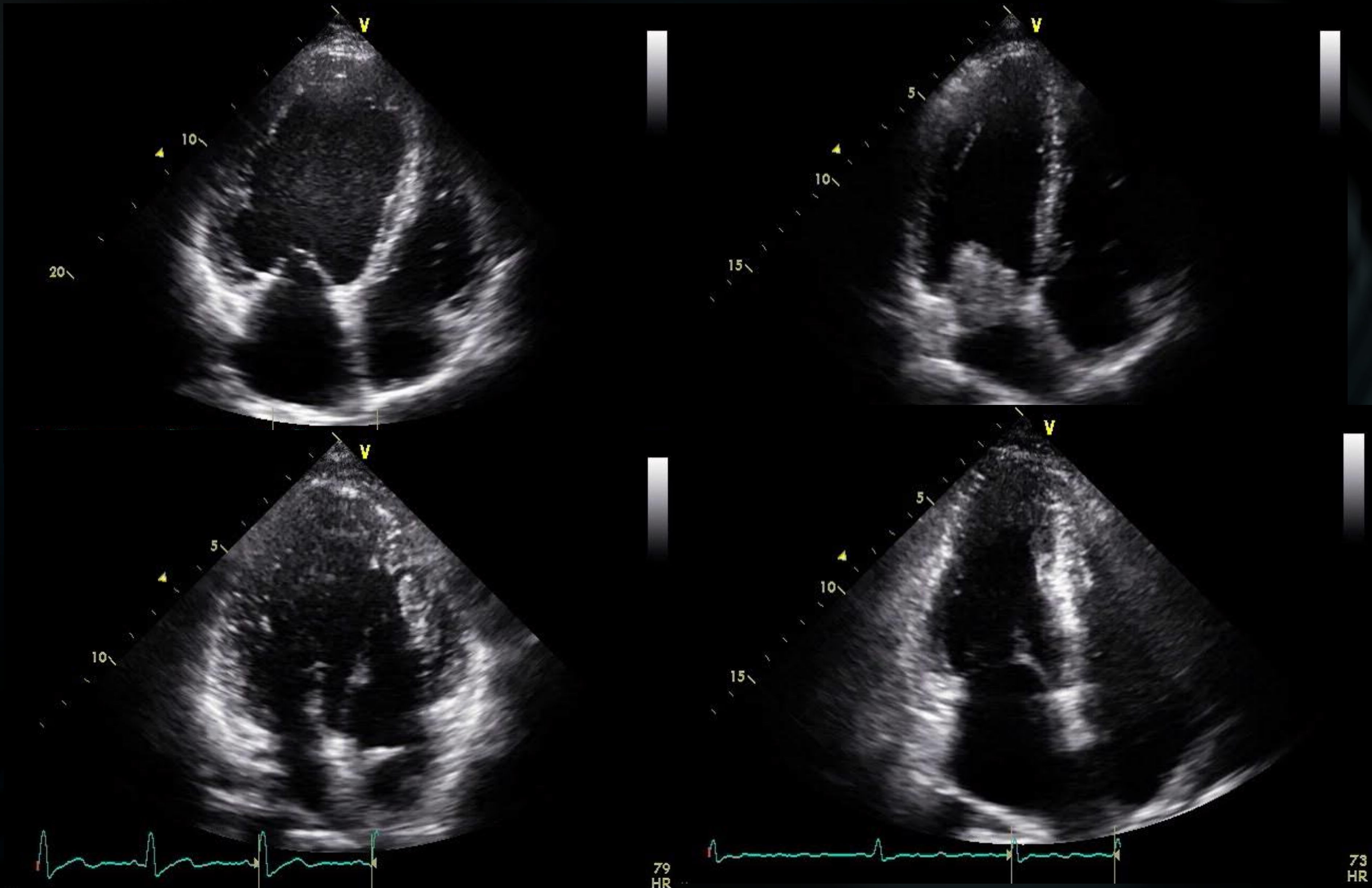
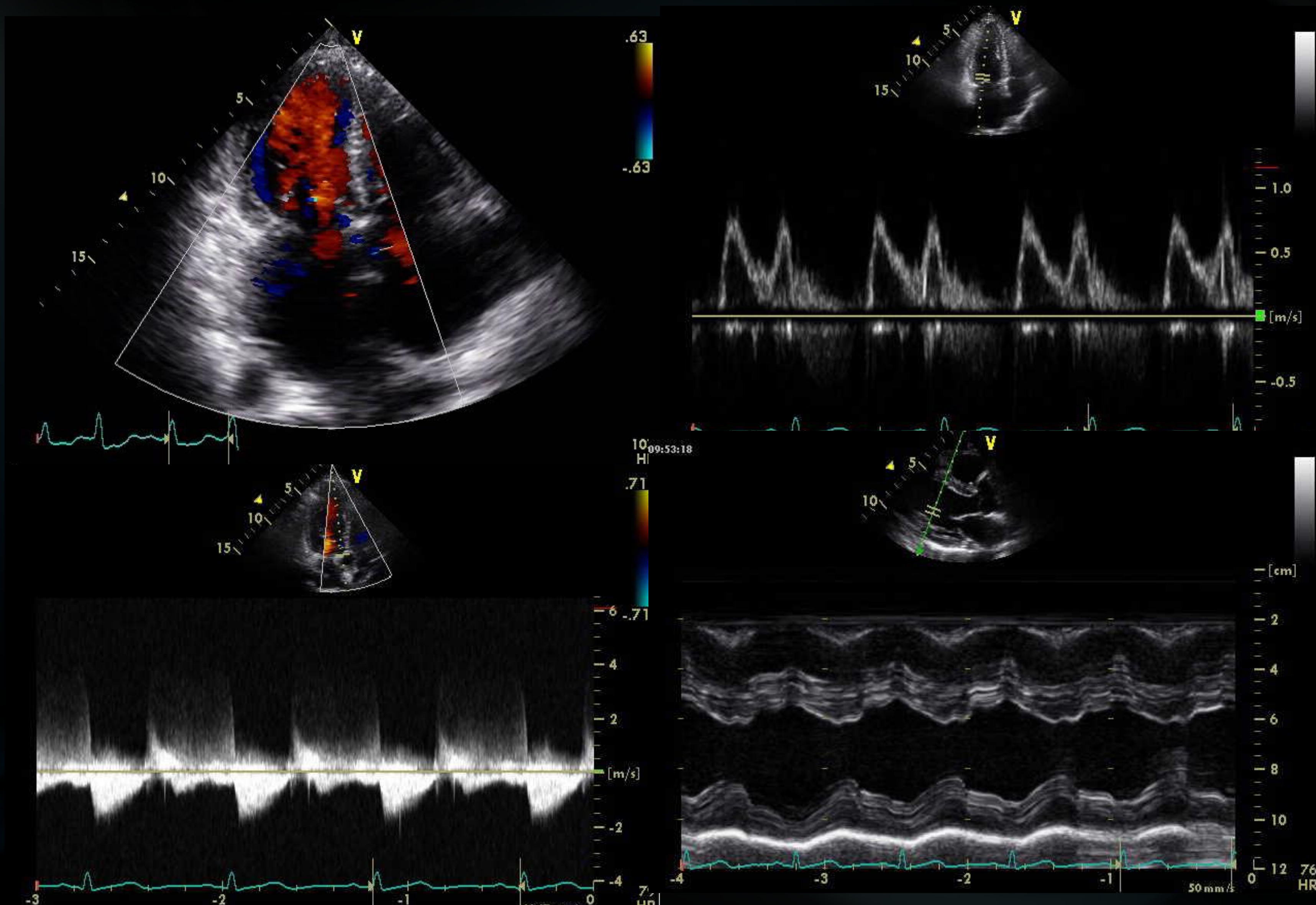
Echocardiography

Cardiovascular Center, KUMC

2D



Doppler, M-mode

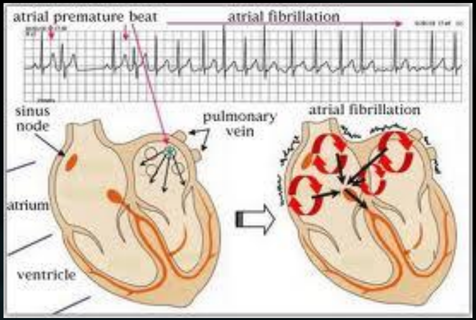


Summary of Talk

- The role of echo cardography in Atrial fibrillation
- The role of echo cardography in CRT

The role of echo cardography in Atrial fibrillation

Atrial Fibrillation

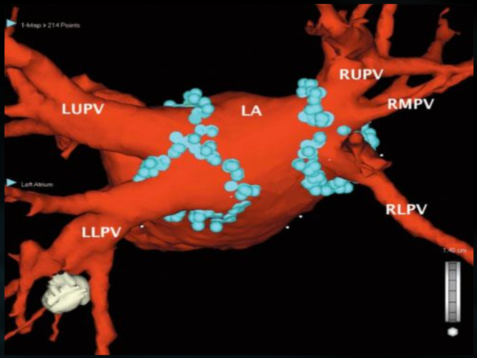


Common arrhythmia
  -Overall prevalence of 0.4% in the general population
Disease of the elderly
  -4% of the population over the age of 60
  -9% of the population over the age of 80

AF associated with the significant clinical problems of systemic thromboembolism and hemodynamic deterioration

Echocardiography has an important role in the evaluation of cardiac structure, function and risk stratification

Left Atrium



-normal dimesion is <4.0cm
-size of left atrium is important in helping to determine prognosis
-increased size decreases the probability of maintaining sinus rhythm
-increased LA size among the strongest predictors of development of new AF
-chronic AF, rheumatic MV dz, and severe LA enlargement (>6cm) have highest risk of recurrence
-LA size increases with progressive duration of AF
-suggests AF “promotes” LAE
-DCCV and maintenance of sinus rhythm are thought to possibly reverse LAE

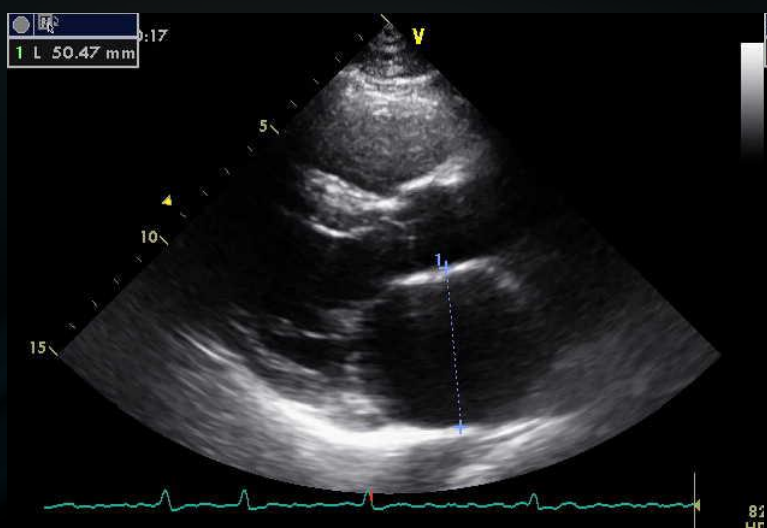
Role of TTE in atrial fibrillation

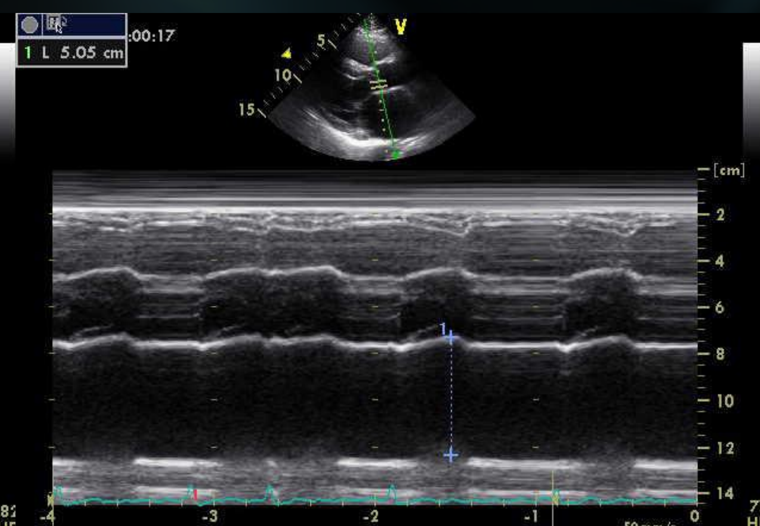
-Evaluation of LA size and function in AF

Anteroposterior dimension on M-mode or 2D

- Standard measurement of LA size
- This method has a tendensy to underestimate true LA size.
- In cardiovascular disease burden and outcome:

  LA volume >>> LA size

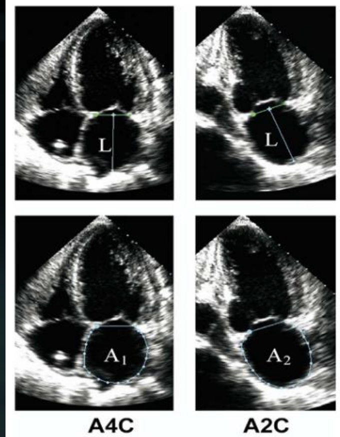




- Left atrial volume

Area-length method

Simpson's method



Left Atrial Volume = $8/3\pi[(A_1)(A_2)/(L)]$ *

* (L) is the shortest of either the A4C or A2C length

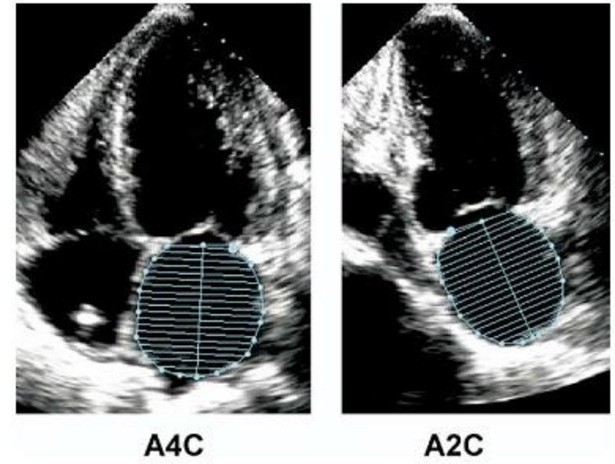


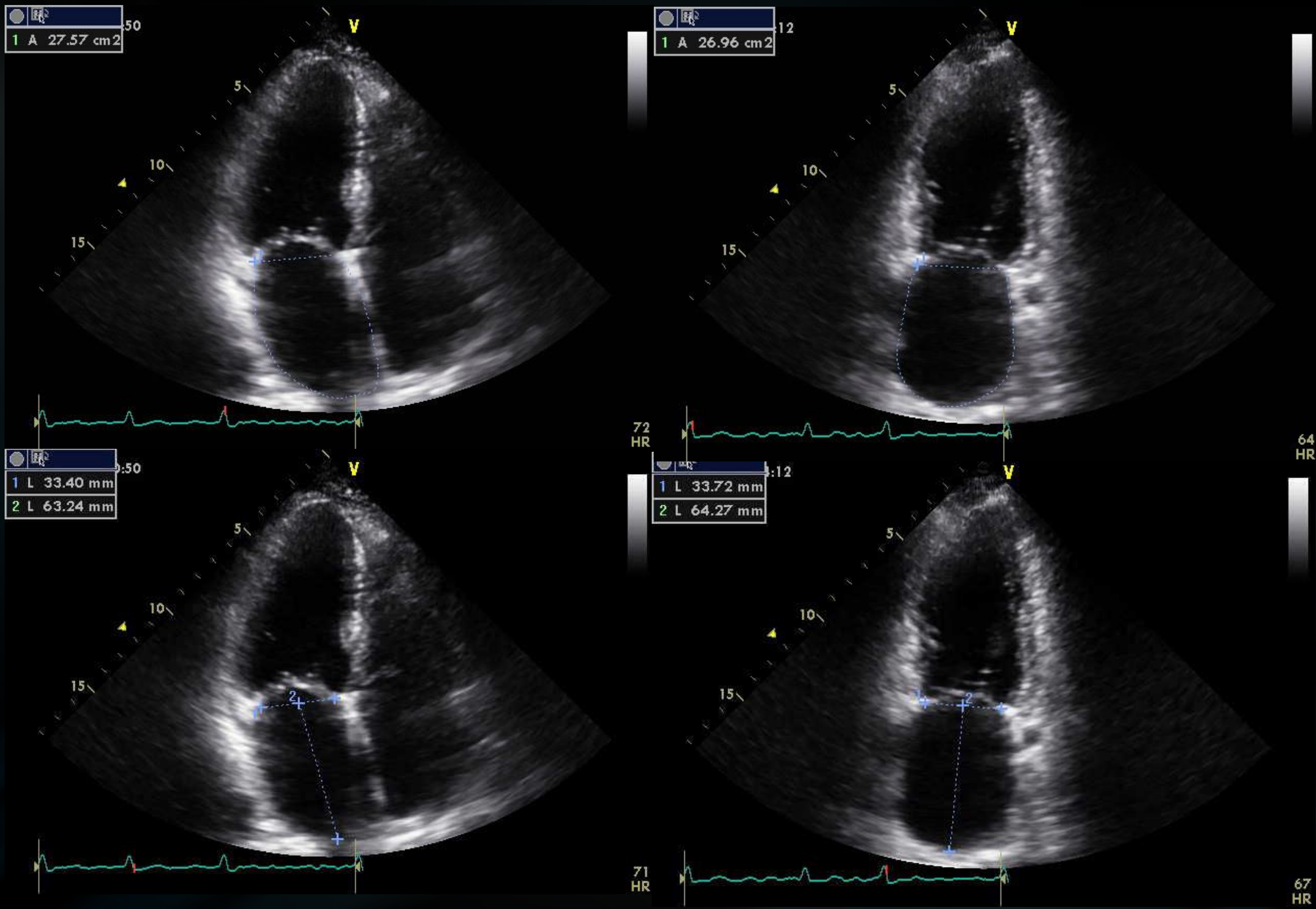
Figure 17 Measurement of left atrial (LA) volume from biplane method of disks (modified Simpson's rule) using apical 4-chamber (*A4C*) and apical 2-chamber (*A2C*) views at ventricular end systole (maximum LA size).

Table 9 Reference limits and partition values for left atrial dimensions/volumes

	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
Atrial dimensions								
LA diameter, cm	2.7–3.8	3.9–4.2	4.3–4.6	≥4.7	3.0–4.0	4.1–4.6	4.7–5.2	≥5.2
LA diameter/BSA, cm/m^2	1.5–2.3	2.4–2.6	2.7–2.9	≥3.0	1.5–2.3	2.4–2.6	2.7–2.9	≥3.0
RA minor-axis dimension, cm	2.9–4.5	4.6–4.9	5.0–5.4	≥5.5	2.9–4.5	4.6–4.9	5.0–5.4	≥5.5
RA minor-axis dimension/BSA, cm/m^2	1.7–2.5	2.6–2.8	2.9–3.1	≥3.2	1.7–2.5	2.6–2.8	2.9–3.1	≥3.2
Atrial area								
LA area, cm^2	≤20	20–30	30–40	>40	≤20	20–30	30–40	>40
Atrial volumes								
LA volume, mL	22–52	53–62	63–72	≥73	18–58	59–68	69–78	≥79
LA volume/BSA, mL/m^2	***22 ± 6***	***29–33***	***34–39***	***≥40***	***22 ± 6***	***29–33***	***34–39***	***≥40***

BSA, Body surface area; *LA*, left atrial; *RA*, right atrial.
Bold italic values: Recommended and best validated.

Area-length method



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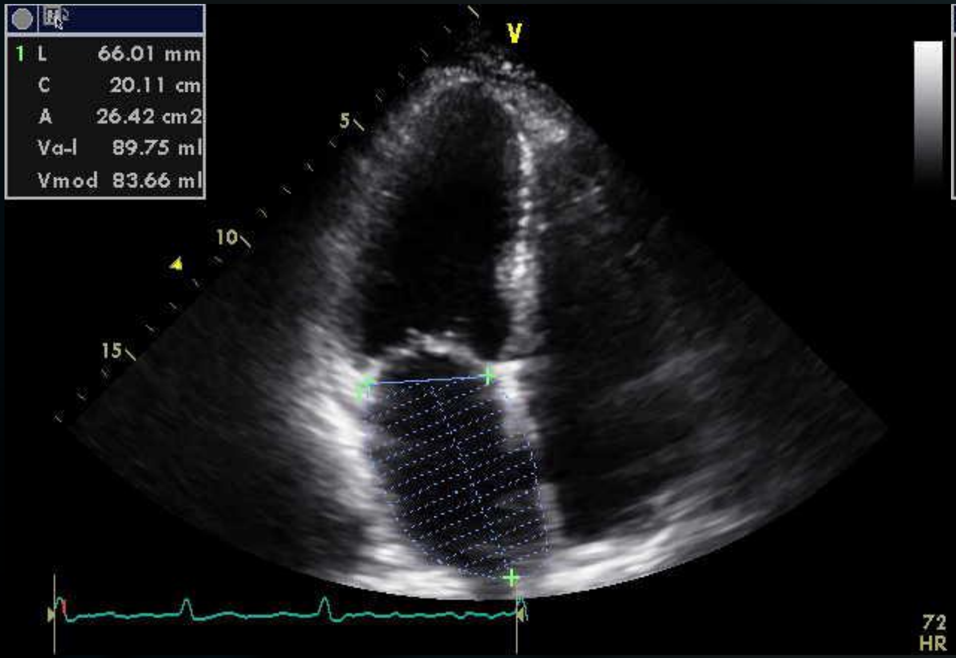
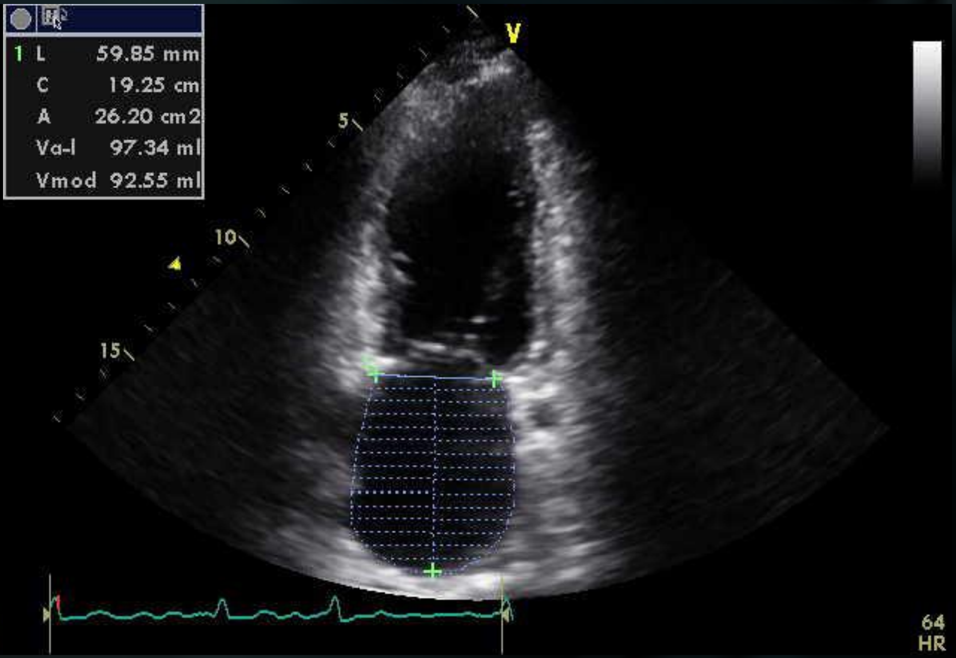
Simpson's method



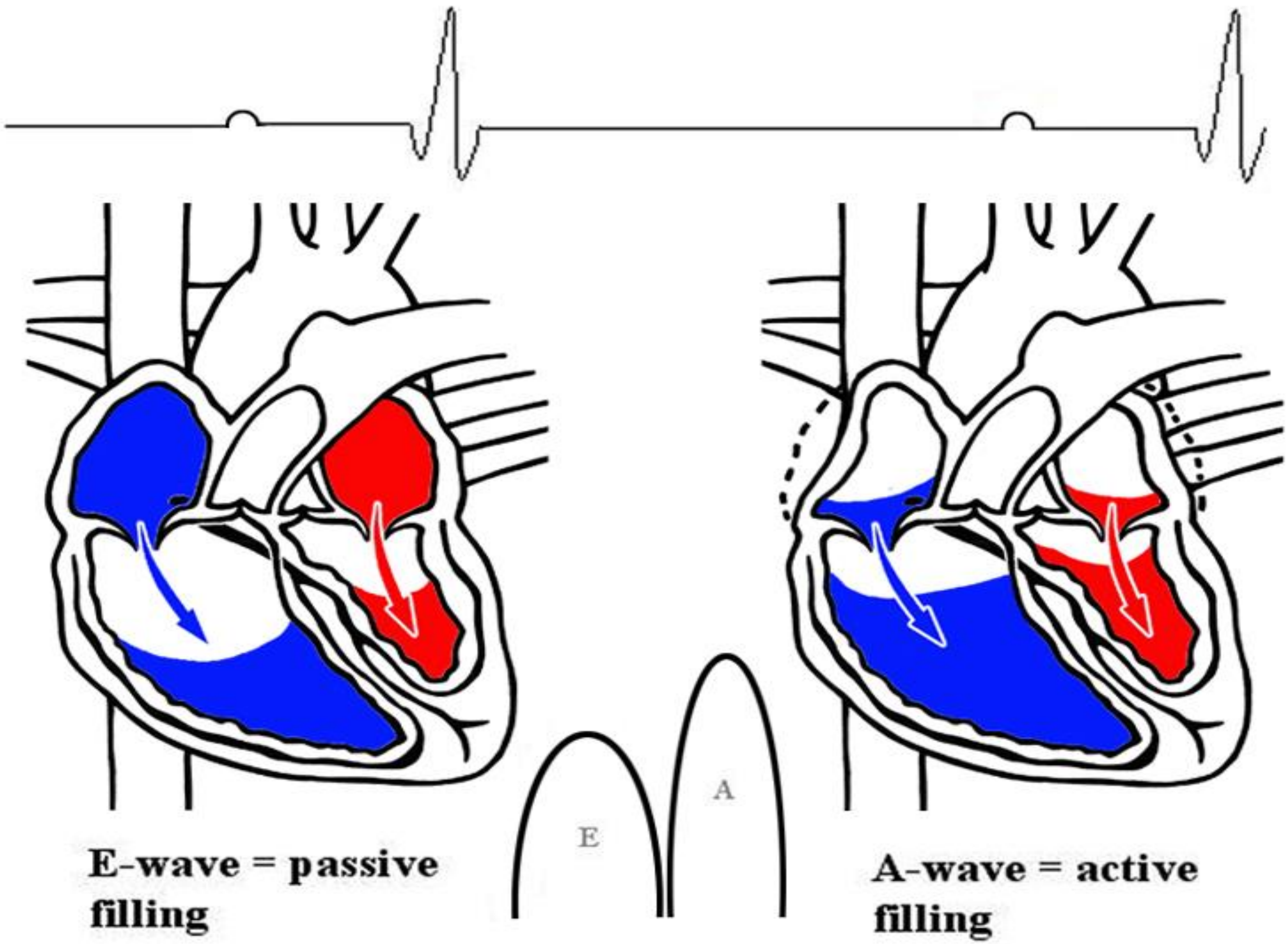


Functional assessement of LA

Transmitral inflow patterns by pulsed wave Doppler

Tissue Doppler image(TDI)

Transmitral inflow patten? What is E and A wave?



Transmitral inflow patterns by pulsed wave Doppler

- LA mechanical function

- Peak trans mitral inflow of the late diastolic filling wave(A) commonly used as a measure of LA mechanical function

- The peak A wave velocity has been used in the serial follow- up of LA function in patients with AF after cardioversion and RFCA

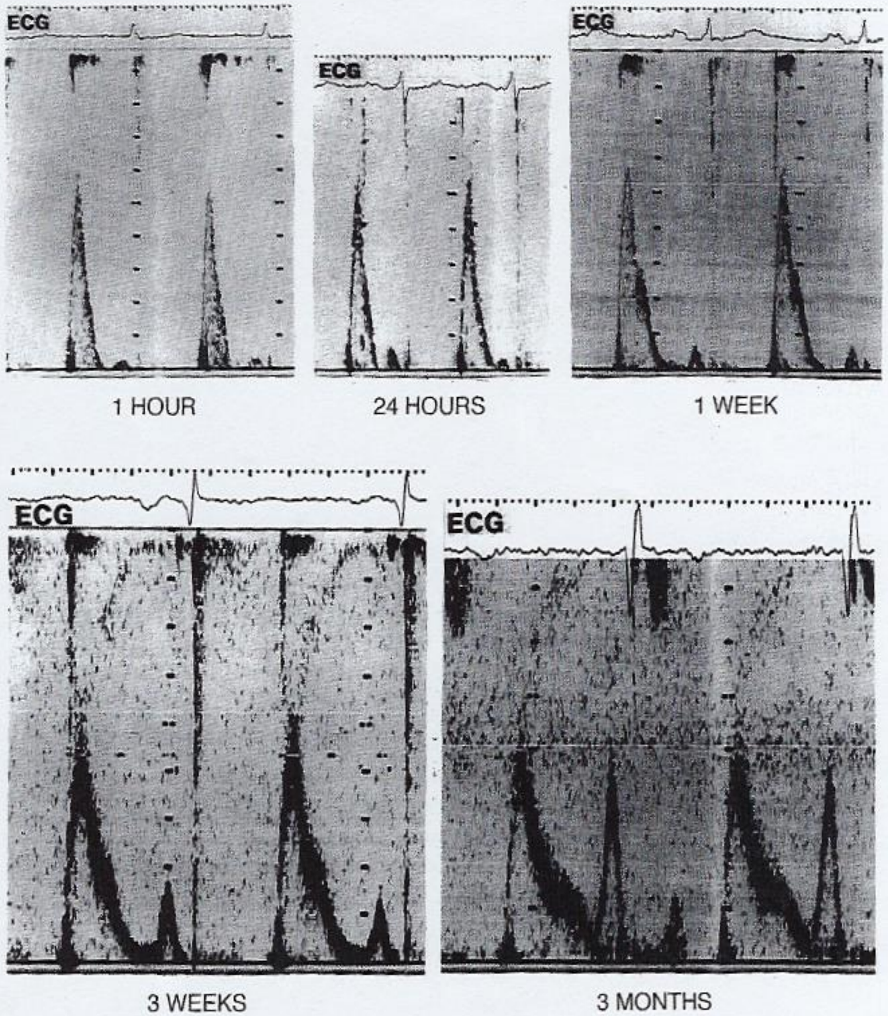


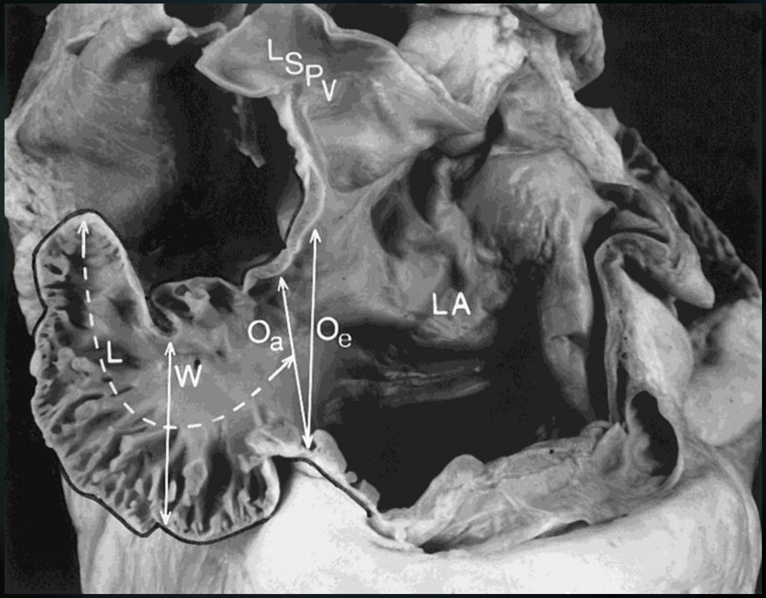
FIGURE 38–8. Serial transmitral pulsed Doppler inflow velocity profiles from an individual patient. Note the progressive increase in peak A wave velocity during the observation period. For each spectrum, the vertical calibration markings indicate 0.2 m per second flow velocity. (From Manning WJ, Leeman DE, Gotch PJ, Come PC: J Am Coll Cardiol 1989;13:620. Reprinted with permission from the American College of Cardiology.)

Role of TEE in atrial fibrillation

-Identification and risk stratification of LA/LAA thrombus

Left atrial appendage

- Tubular, long, narrow, wavy, hooked muscular structure in continuity with the LA
- Resembles a crescent
- Located anteriorly to the left superior pulmonary vein ,in the proximity of the free wall of the left ventricle



Left Atrial Appendage Function

- blood flow velocity is a quantifiable measure of stasis
- low velocity associated with higher risk of thrombus formation
- also associated with dense spontaneous echo contrast
- low blood flow velocity (<20cm/sec) associated with increased risk of CVA

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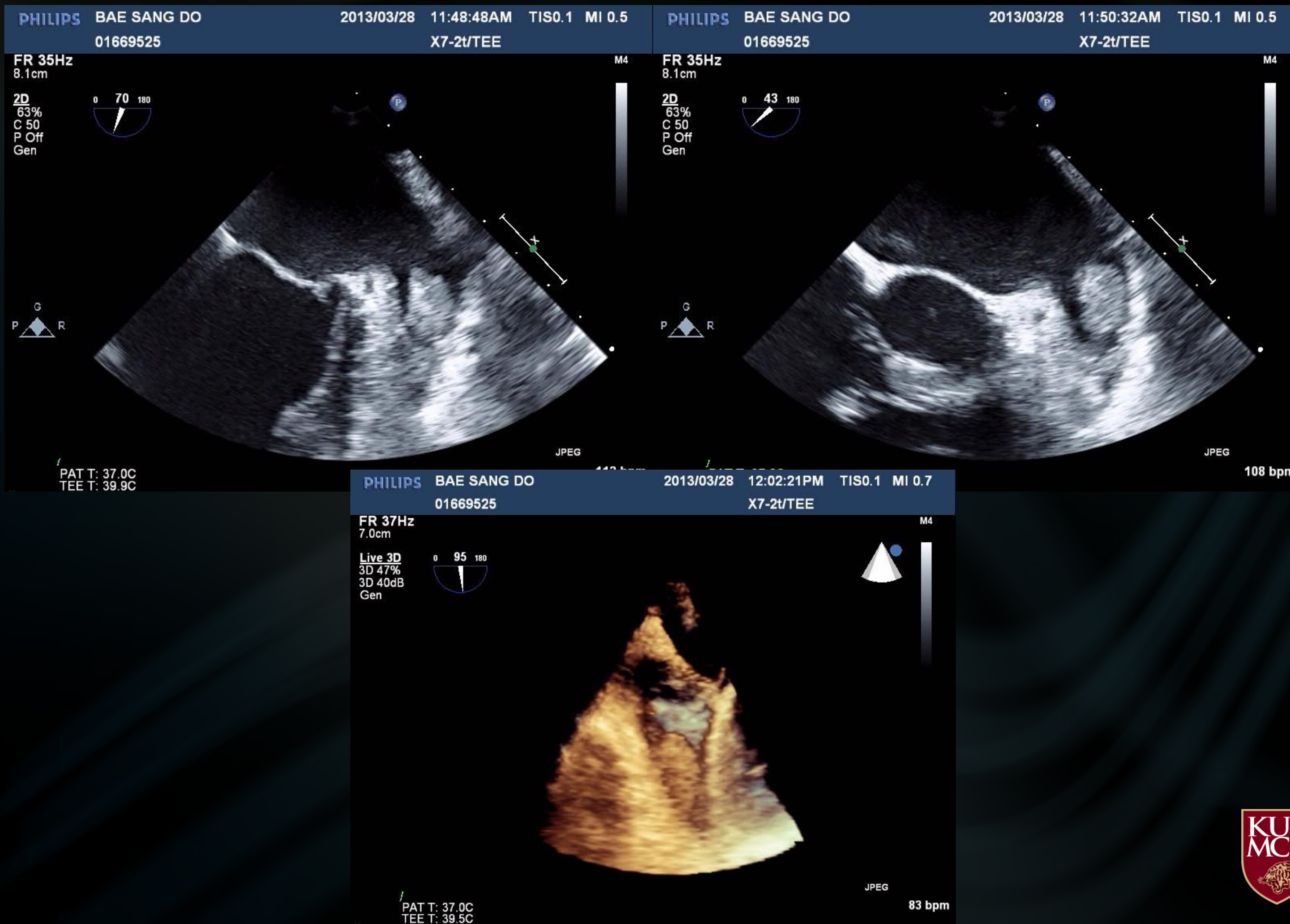


TEE – guided early cardioversion

- facilitated early cardioversion

- conventional care of patient with Af
  - oral anticoagulation (at least 7 week)

The role of echo cardography in CRT

What is Dysynchrony?

Electrial dyssynchrony

Mechanical dyssynchrony

Electrical dyssynchrony

- Abnormal ventricular depolarization, causing increased QRSd generates early and delayed ventricular contraction
- QRSd directly associated with EF
- BBB present in 20% of HF patients and 35% of patients with severely impaired EF
- BBB is an independent predictor of mortality especially QRSd > 120 ms

Mechanical dyssynchrony

- Intraventricular- refers to delayed activation of one LV region to another
- Interventricular- refers to delayed activation of LV relative to RV
- CRT aims to correct both

Identifying Dyssynchrony with Echocardiography

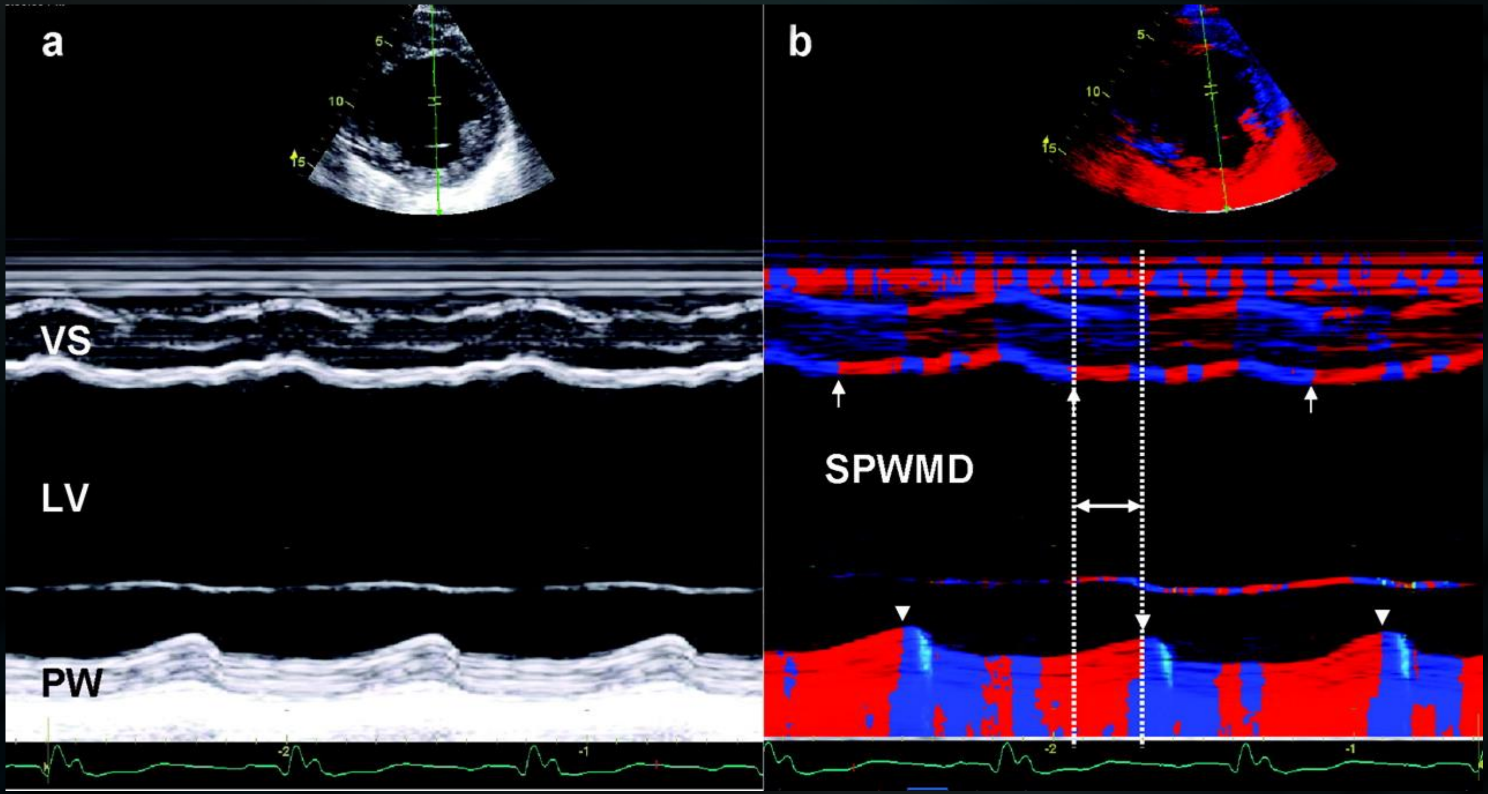
Methods of Dyssynchrony Evaluation

- Intraventricular Mechanical Delay /M-Mode (Septal-Posterior Wall)
- Interventricular Mechanical Delay/ Aortic and Pulmonic Pre-Ejection Interval
- Tissue Doppler Imaging
- Tissue Tracking and Delayed Longitudinal Contraction
- Strain Rate Imaging

Intraventruclar Mechanical Delay, M-Mode

- Septal to posterior wall delay
- Measures time between maximal displacement of septum and posterior wall (SPWMD)
- ≥ 120 ms considered significant
- Easy to perform
- No specific equipment needed

M-mode echocardiography with color-coded tissue velocity. a, Timing of ventricular septal (VS) wall motion is difficult to define because of its severe hypokinesis and the lack of distinct peaks. b, Color coding of tissue velocity helps to identify the exact wall motion timing as transition point of blue to red color for septal wall (arrows) and red to blue color for posterior wall (arrowheads) (right)



Normal < 120ms

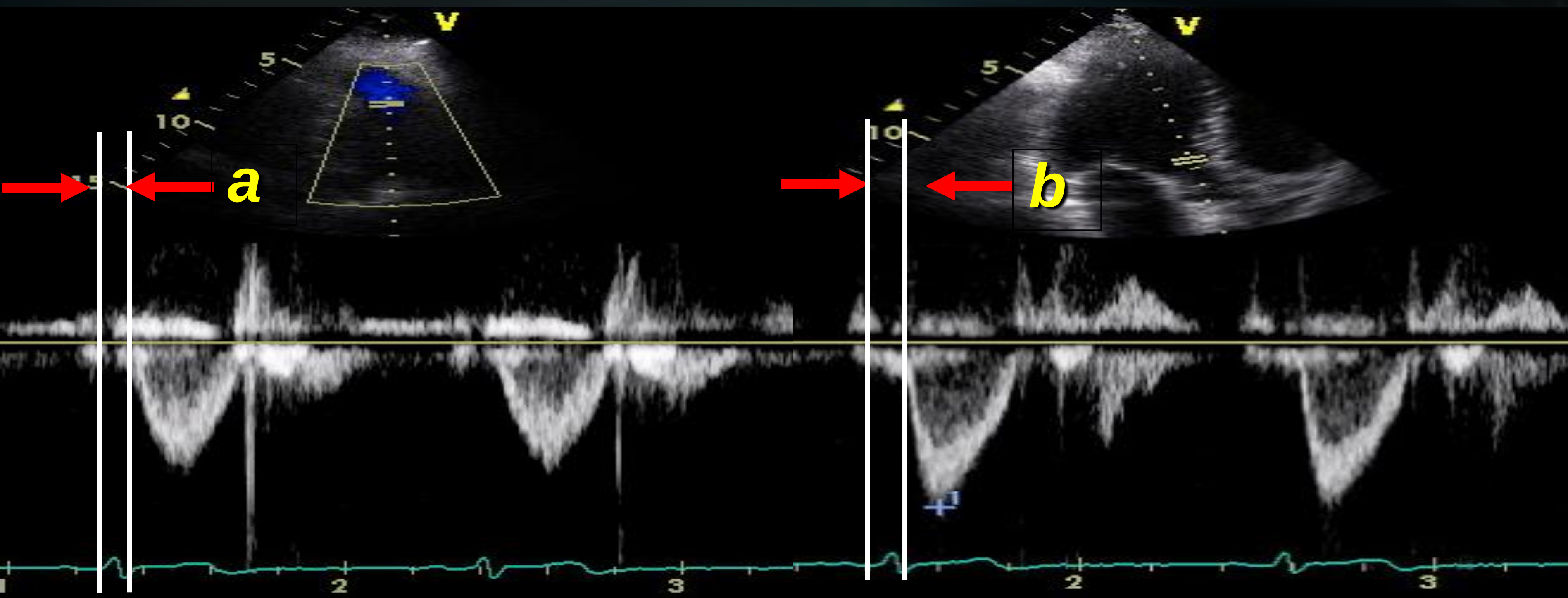
Interventricular Mechanical Delay

- PW-Doppler recorded from the LV and RV outflow tracts proximal to the semi-lunar valves
- IVMD is calculated as the difference between forward flow in the RV and LV outflow tracts
- IVMD is used as an indicator of synchrony between A-V-V contraction

Interventricular Mechanical Delay

RVOT

LVOT



Normal : b – a < 38ms

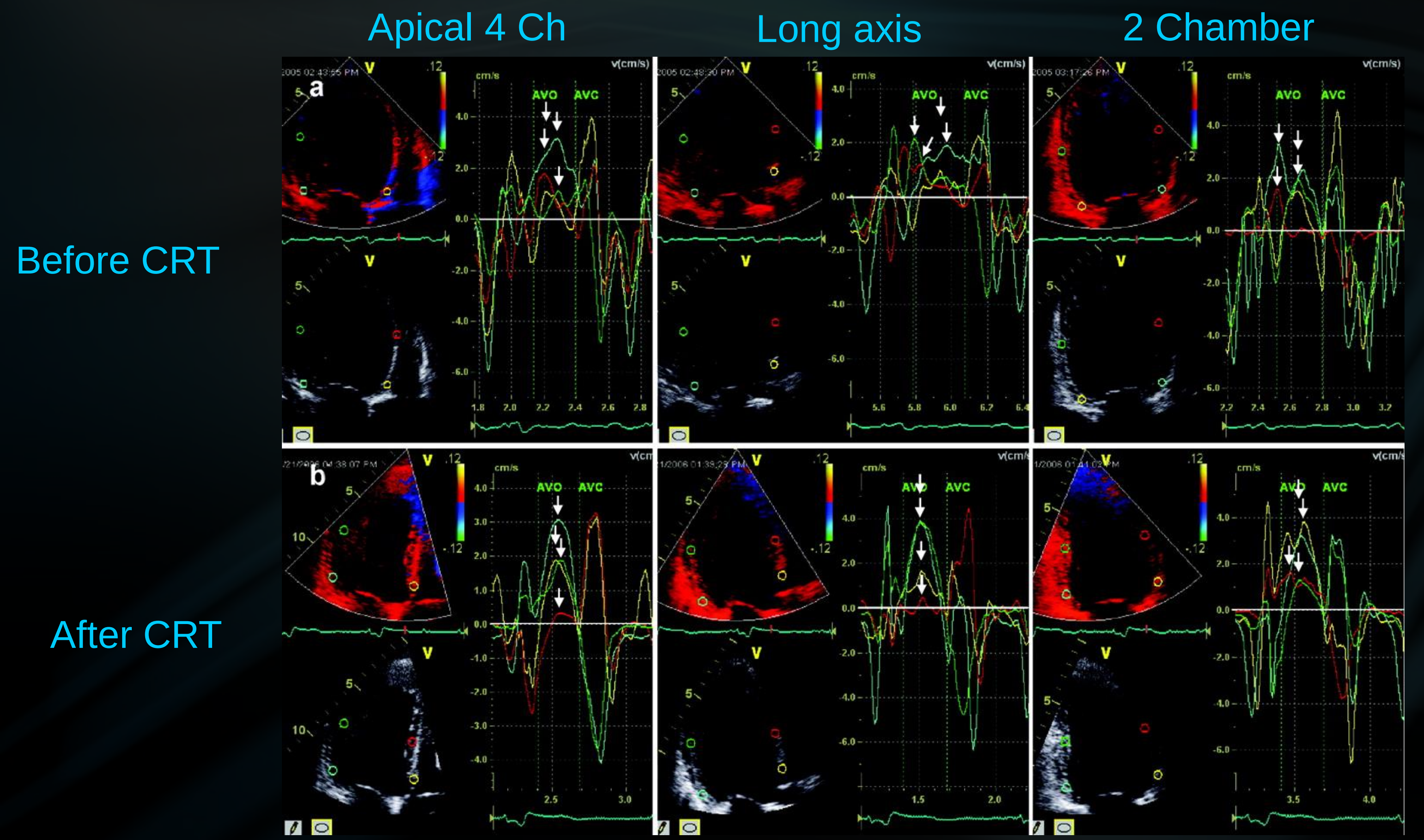
Tissue Doppler Imaging

- Same basic technology is used as with Doppler for blood flow velocity
- Filters out high velocity blood flow signal, leaving only the wall signal
- Can measure velocity, timing, velocity gradients, and LV strain
- Provides new quantitative information regarding LV mechanics
- Measurement of either longitudinal tissue velocity or deformation (strain)

  - Opposing wall peak delay of > 60-65 ms[1-2]

  - Yu index: global 12 segment Asynchrony Index ≥ 33 ms[3]

Color-coded tissue velocity recordings from 12 LV segments before (a) and after (b) CRT in 65-year-old patient with nonischemic cardiomyopathy whose LVEF improved by 17% at 6 months after CRT



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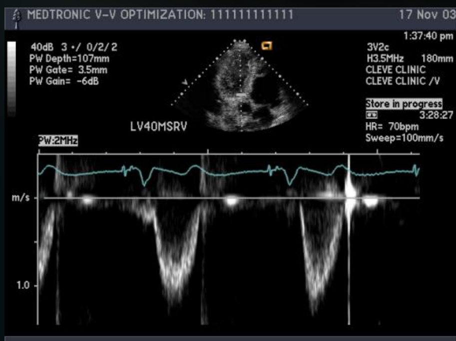
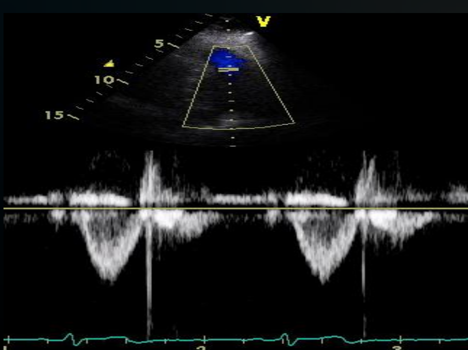
Dyssynchrony seen with echo



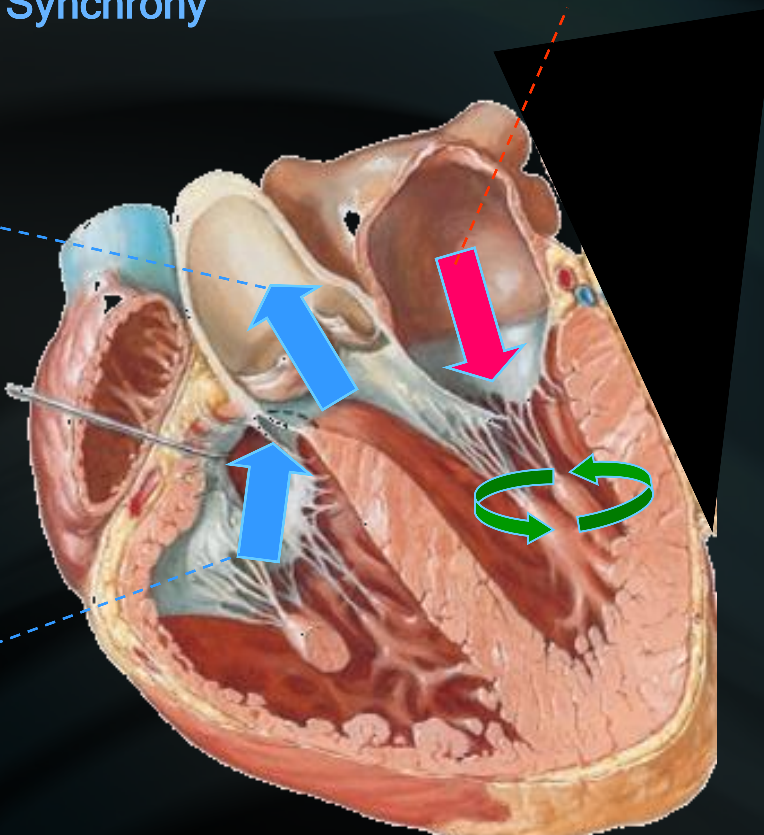
Aortic VTI (Pulsed Doppler Echo)

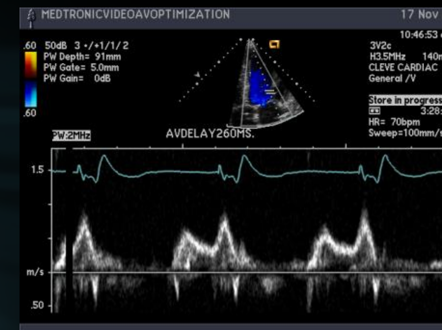


Pulmonic VTI (Pulsed Doppler Echo)

Inter-Ventricular Synchrony

Atrio-Ventricular Trans-mitral Flow

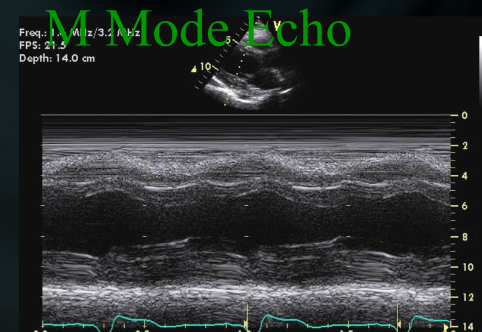




Pulsed Doppler Echo at Mitral valve

Intra-Ventricular Synchrony

M-Mode Echo

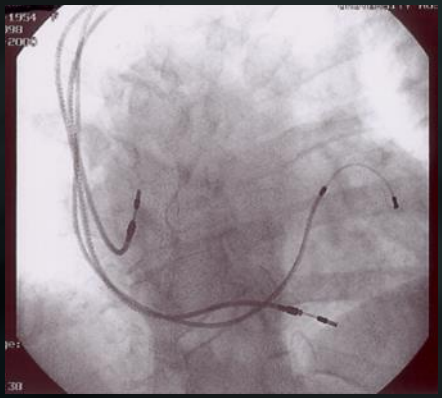


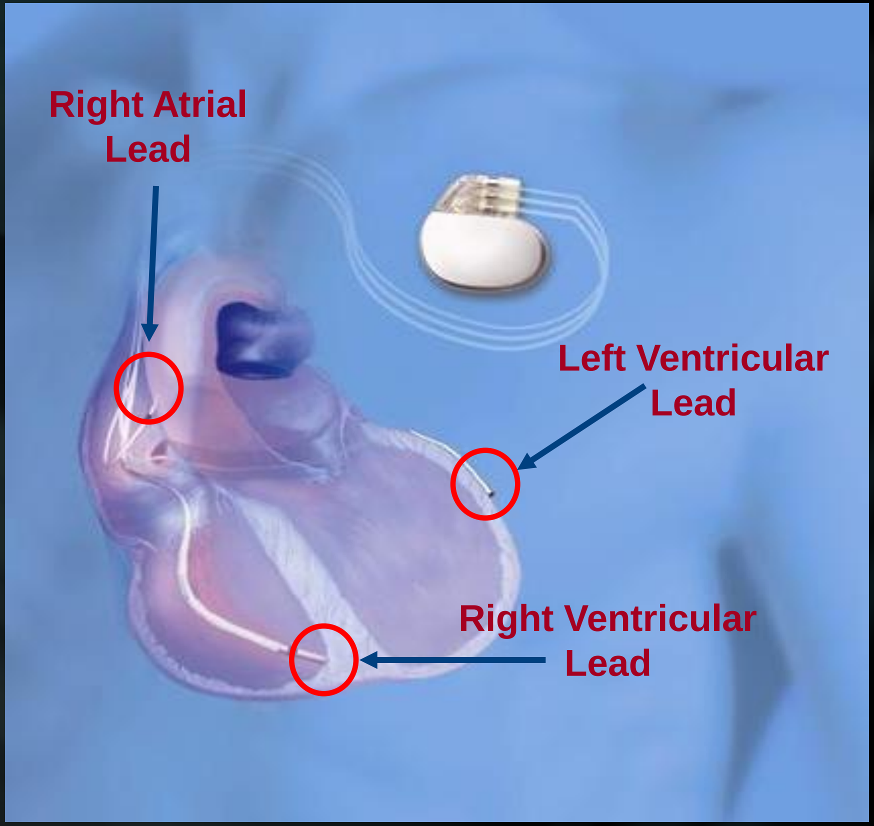
Achieving Cardiac Resynchronization

Goal: Atrial synchronous biventricular pacing

Transvenous approach for left ventricular lead via coronary sinus

Back-up epicardial approach





What is Optimization and Why Optimize CRT Devices?

Optimization

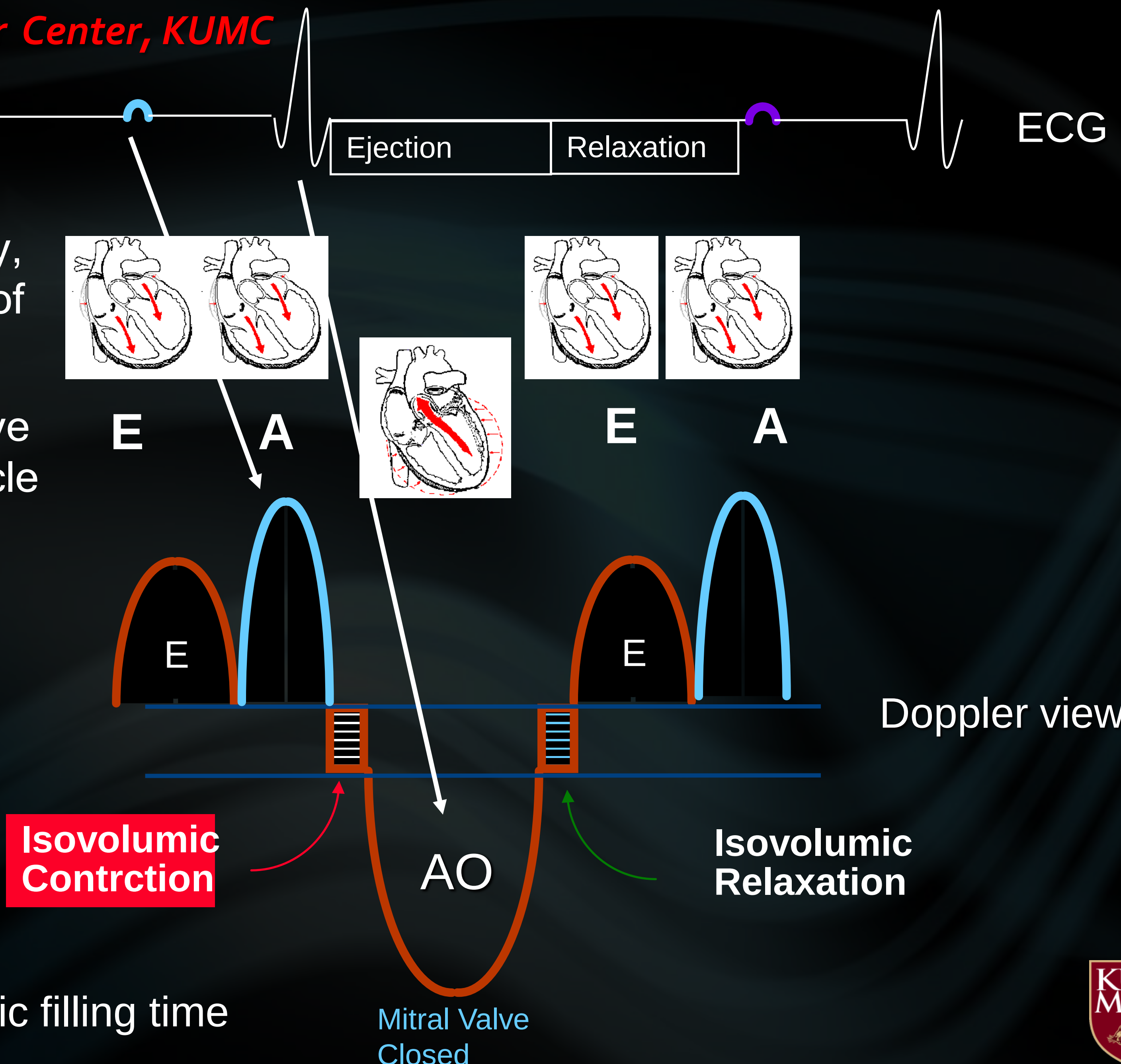
Refers to the programming of the A-V and V-V intervals of a CRT device. The goals of optimization relate to augmenting ventricular filling, decreasing Mitral regurgitation, and synchronizing the contraction of the ventricles to accentuate forward flow

An Optimal A-V Delay

- Allows complete filling of the left ventricle and causes ventricular contraction to occur immediately following the atrial contraction
- Promotes completion of ventricular filling and closure of the mitral valve before systole
- Is the shortest possible AV delay that allows complete ventricular filling without interfering with atrial contribution.

E-wave = Early, passive filling of ventricle

A-wave = Active filling of ventricle



E + A = diastolic filling time

2 AV-Opt methods (both require Echo)

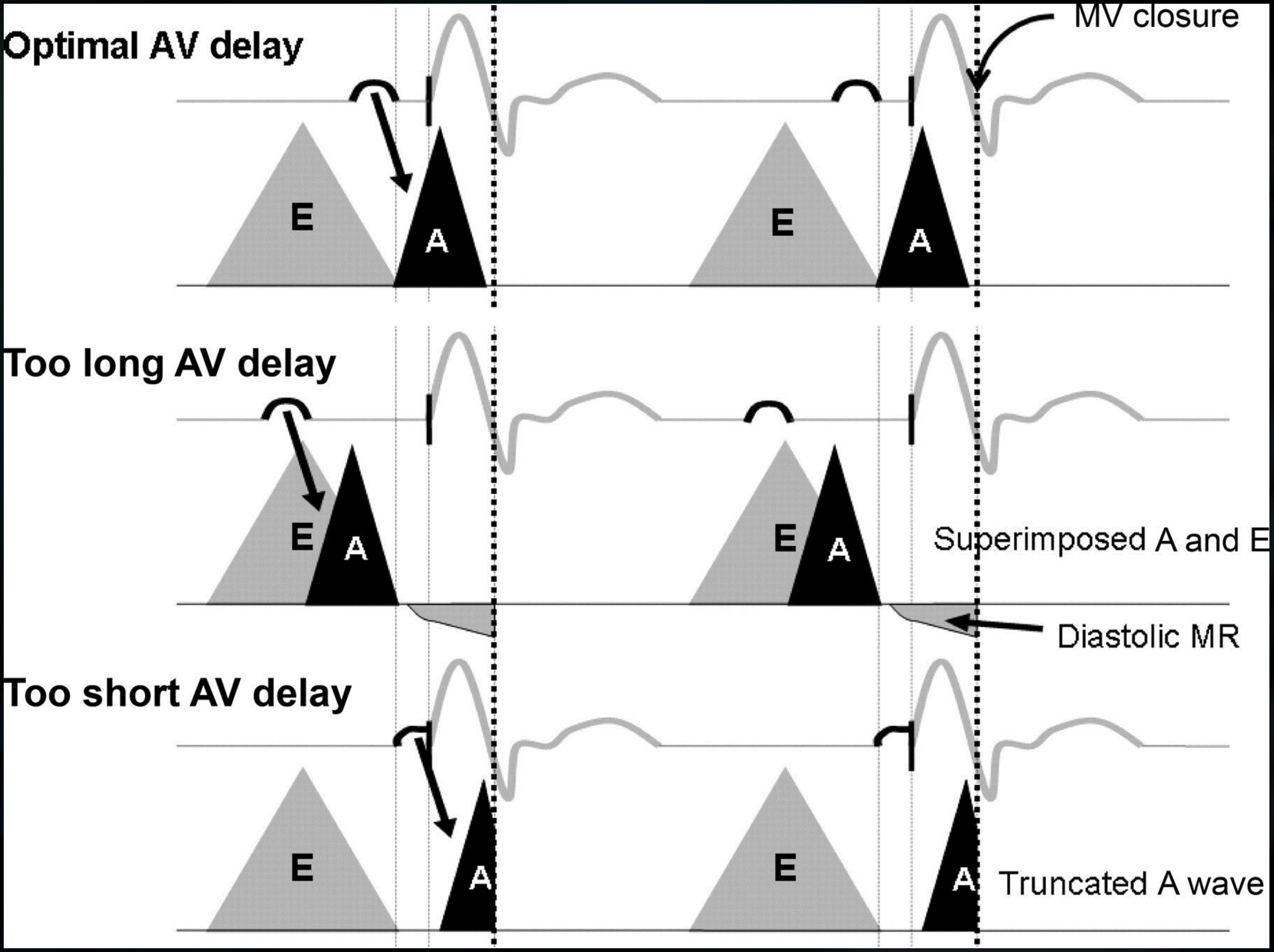
- **Iterative Method**
- Easy to perform
- Accurate
- Integrates art and science

- **Ritter Method**
- Confusing
- Limited accuracy for Bi-V devices
- Often times iterative method must be employed to get the "best" setting

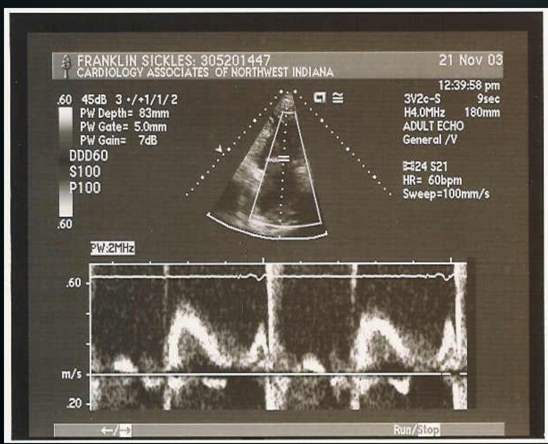
Iterative Steps

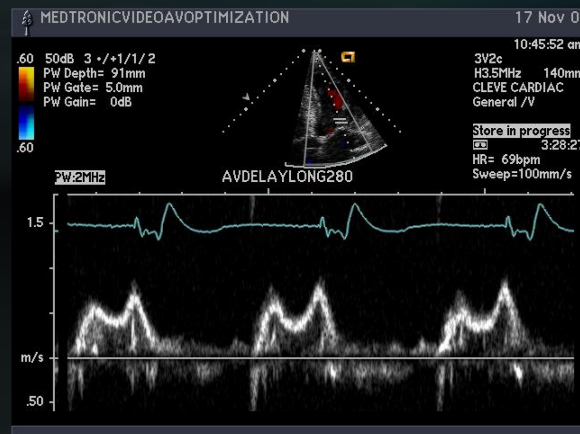
- Measure Intrinisc P-R Interval
- Program AV Delay to less than Intrinisic P-R
- Shorten AV in 20ms steps until you see A Wave truncation
- Lengthen AV Delay in 10ms steps until you see no A wave truncation
- GOAL: No A wave truncation, with minimal E and A wave fusion

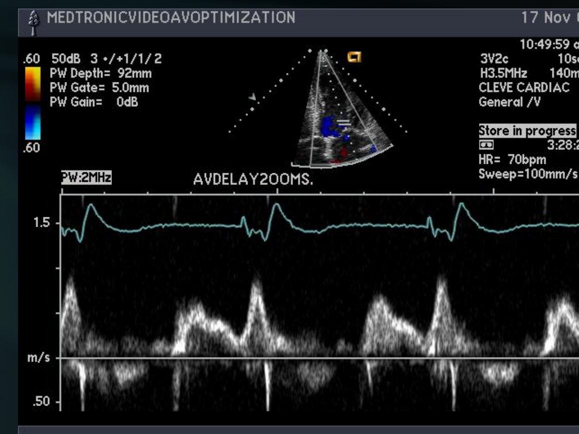
Schematic diagram showing the effect of atrioventricular delay duration on Doppler echocardiographic recordings of transmitral



Effect of AV Delay on LV Diastolic Filling Pattern







Short AV Delay
50 ms

- A-wave truncated
- Less time for filling
- Atrial contraction against a closed Mitral valve

Long AV Delay
280 ms

- Fused A and E wave
- Less time for filling
- Pre-systolic Mitral re gurgitation

Optimized AV Delay
200 ms

- Max diastolic filling time
- Mitral closure occurs at end of A-wave

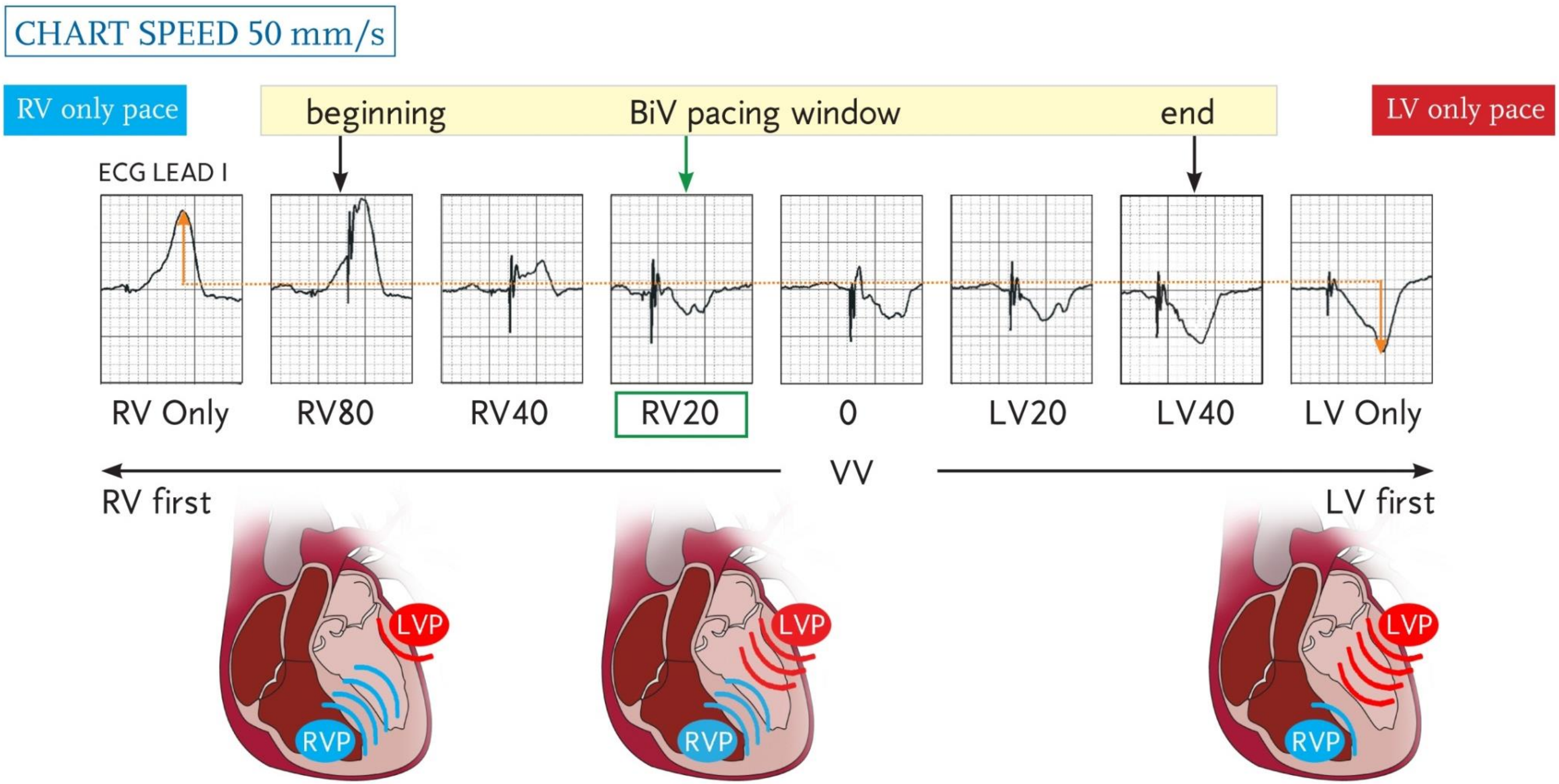
What is an Optimal V-V Interval

- It is believed the optimal V-V interval is the one demonstrating the largest stroke volume or as new techniques evolve to quantify dyssynchrony, the one delivering the highest level of inter or intraventricular synchrony
- Sequential RV and LV stimulation has shown promise to further enhance hemodynamics with CRT
- Remember the goal of CRT is to increase the effectiveness of the contraction sequence which will ultimately accentuate forward flow

VV Delay Adjustment

VV DELAY PROGRAMMING CONSIDERATIONS

Program the VV delay to the middle of the biventricular pacing window determined by transition of the QRS from a primarily left-sided paced (RBBB type) to primarily right-sided paced (LBBB type) morphology.

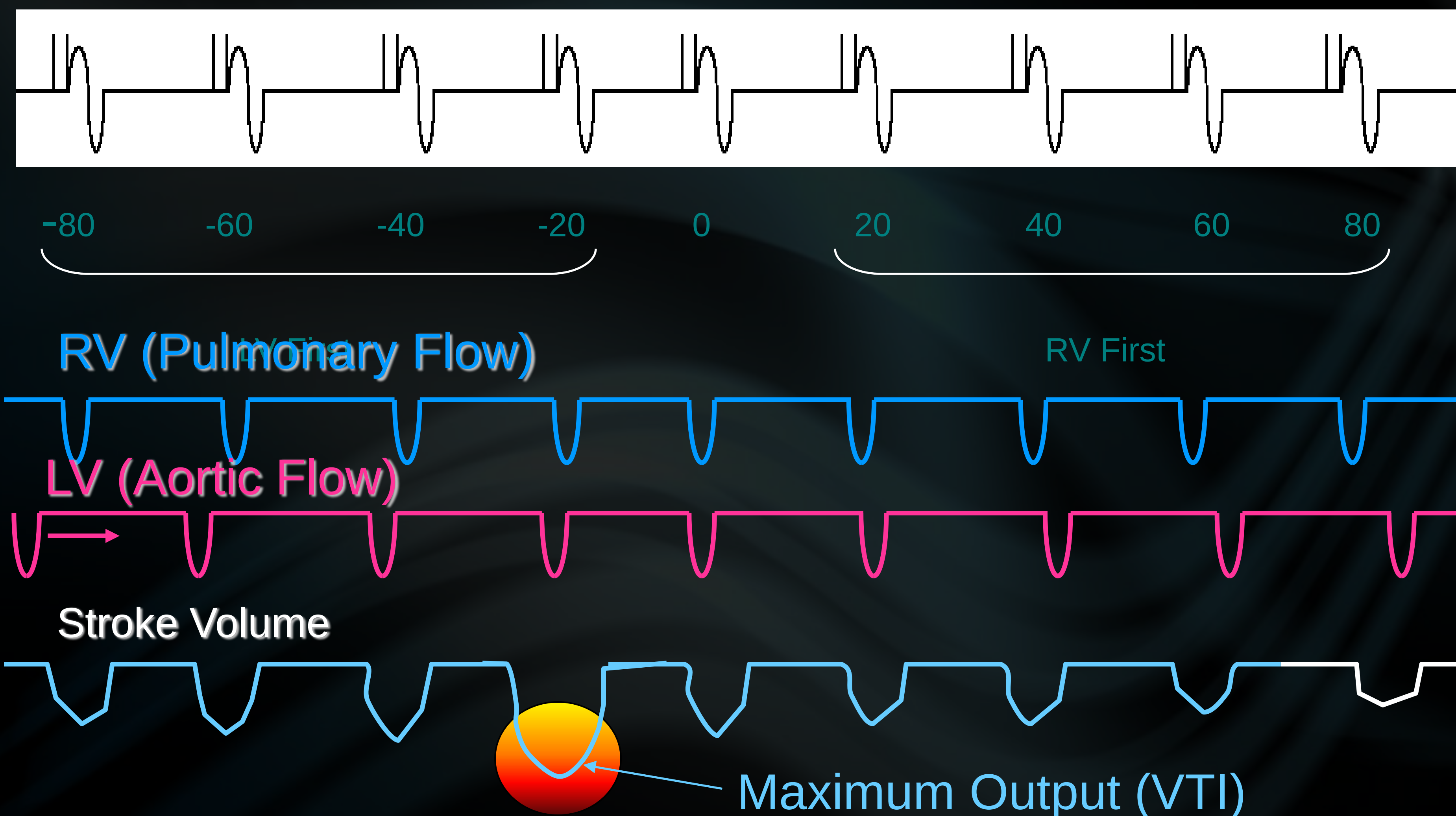


Predominant RV-pace QRS with early RV

Adjusted VV

Predominant LV-pace QRS with early LV

Recognizing the Best VTI



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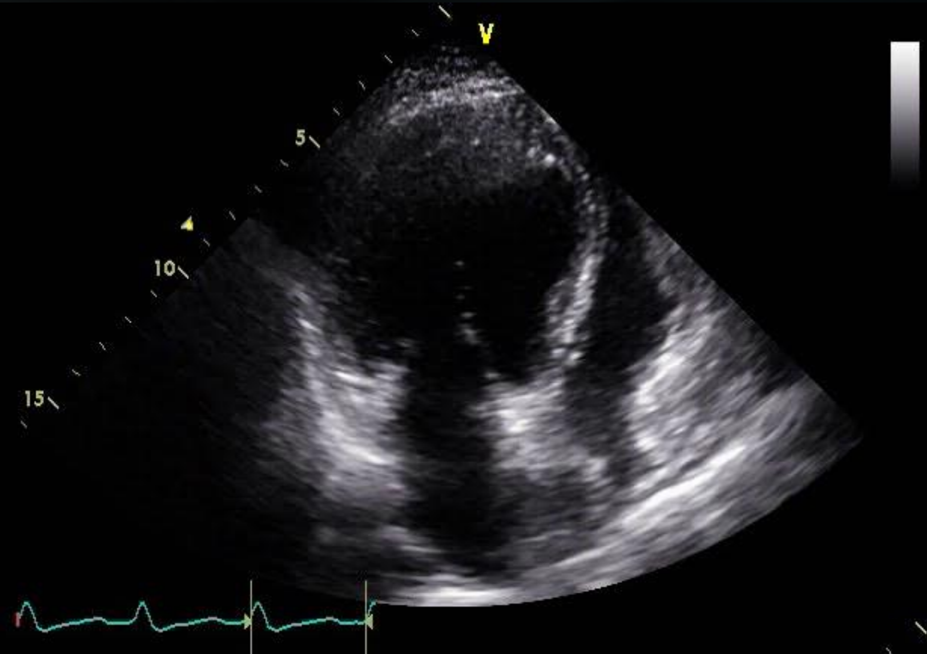

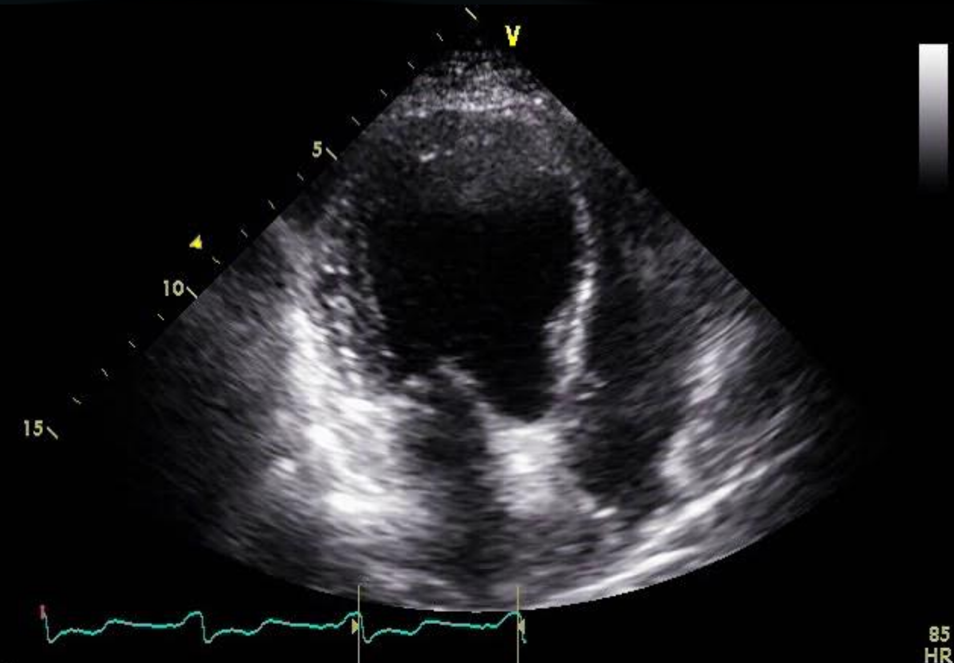

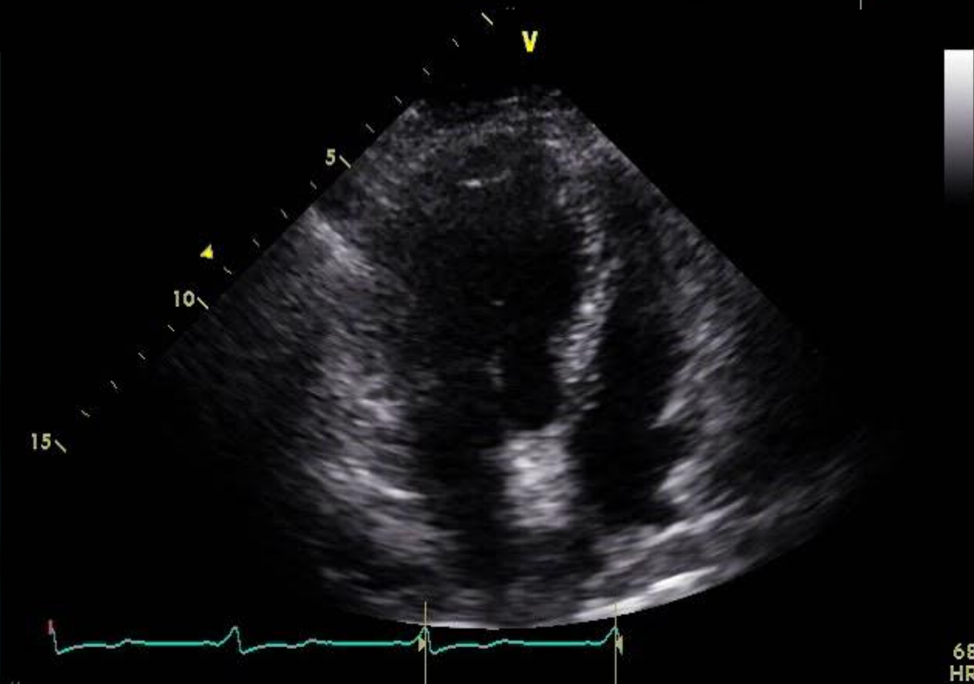

summary

AF

- TTE - LA size, volume, structure, function
- TEE – LA, LAA Thrombus

CRT

- Dyssynchrony
- Optimization

For the EP…..