CV Training Session

Oct. 2013

Clinical Product Specialist Team,

International Sales Dept.

ALPINION
MEDICAL SYSTEMS

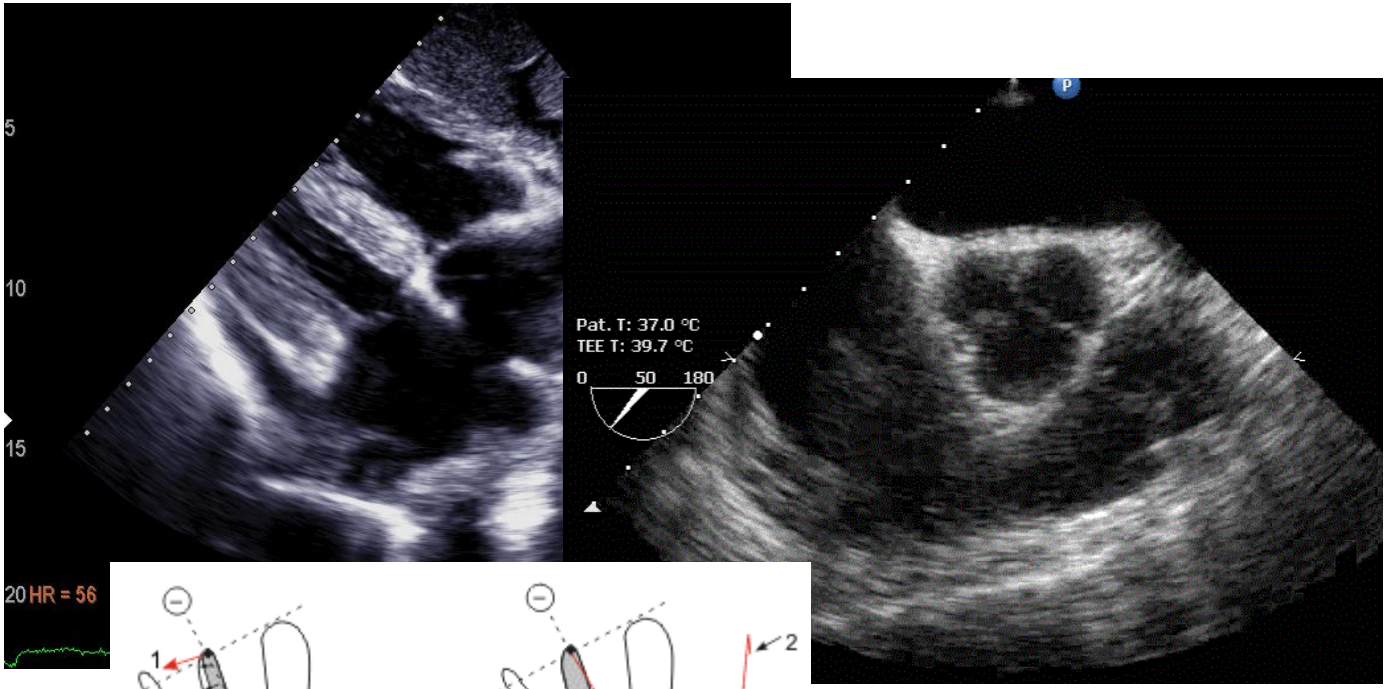
Table of Contents

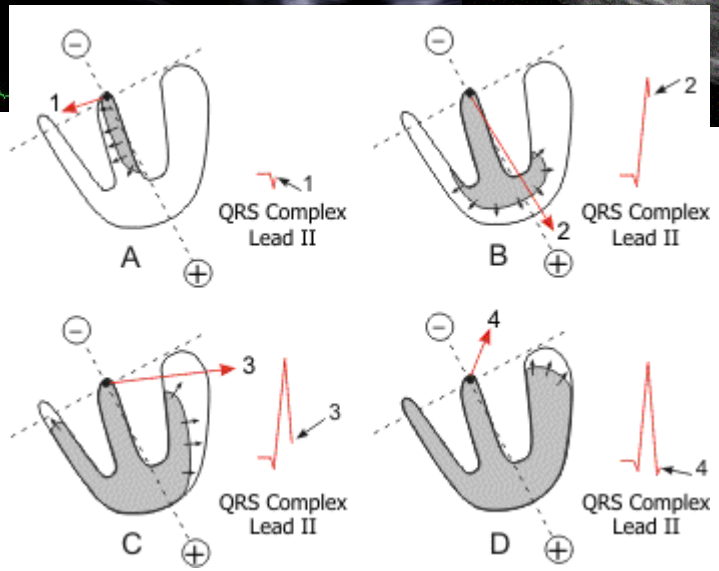
Echocardiography

- Method : transthoracic , transesophageal, (transvenous) intra-cardiac
- 2D, Real-time 3D
- Structure; size , shape, location, abnormal structure
- Function ; Systole, Diastole,

  Conduction system

Echocardiography

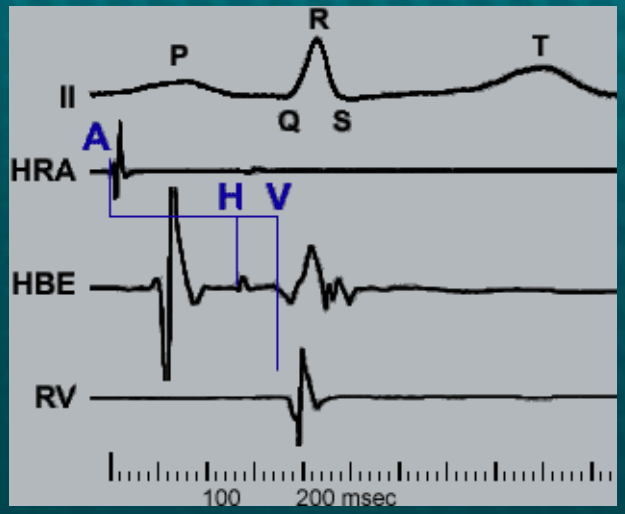




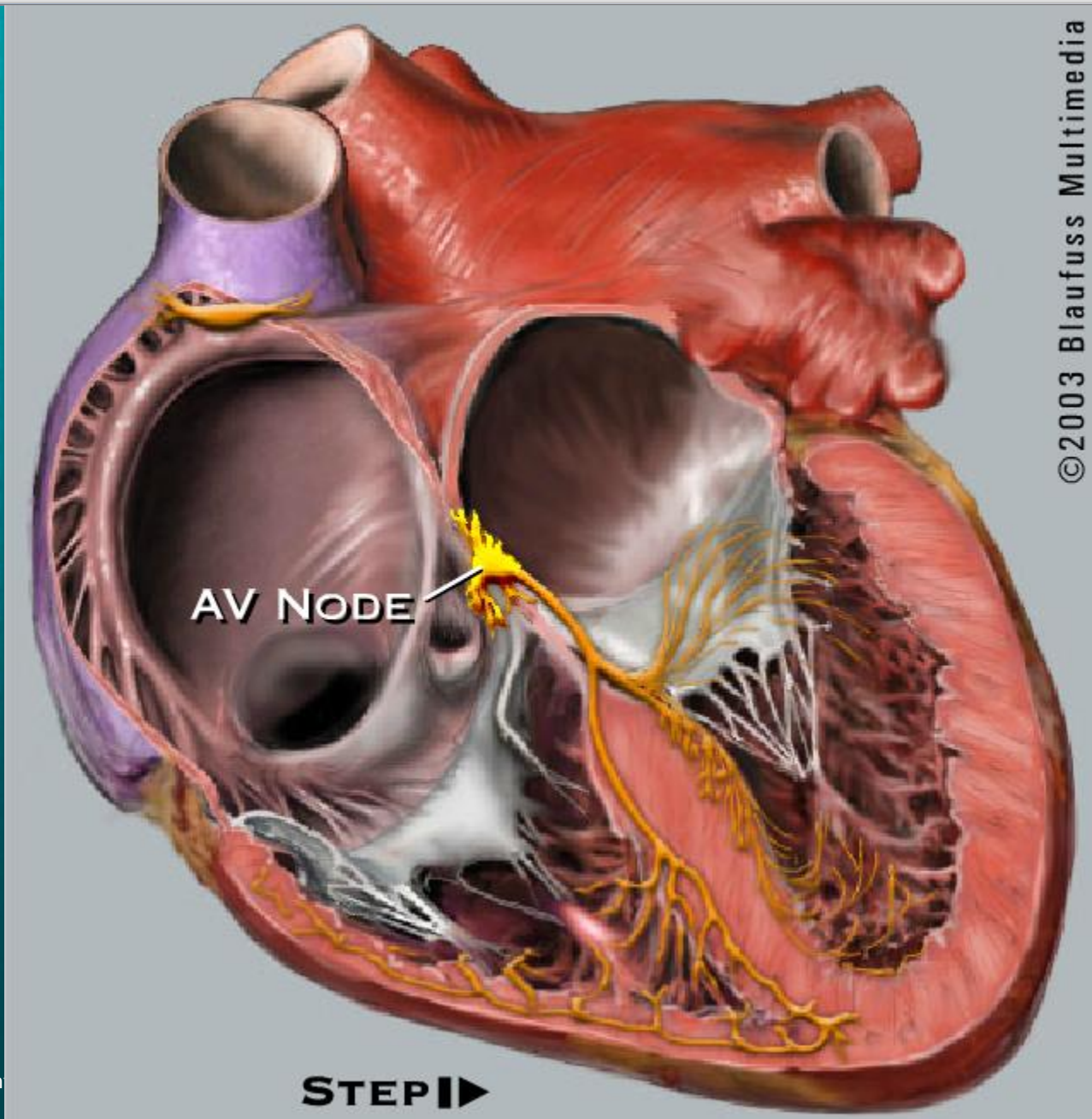
Normal sinus rhythm

Intracardiac tracings show the normal intervals between

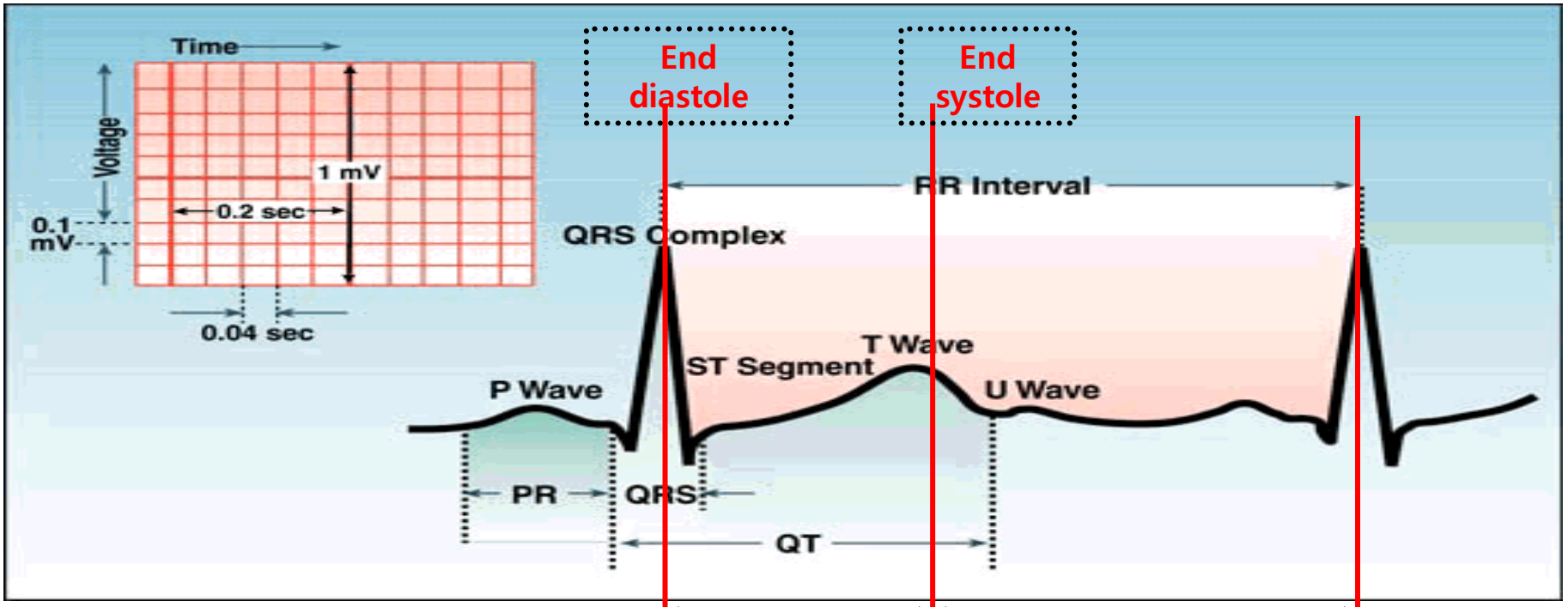
- initiation of atrial depolarization A
- His bundle activation H
- ventricular depolarization V
- AH + HV = PR interval



All information in the presentation are highly confiden



EKG and Hemodynamic Change



If color turbulence is found at each phase.

Systolic phase

Diastolic phase

Mitral valve = Tricuspid V.

Closed

Open

Aortic valve = Pulm. valve

Open

Closed

Premium Transducers for Echocardiography

SP 1-5X

Extreme Phased Array for EC-15
FOV : 90 °
Application : Adult Echo, Transcranial etc.

SP 1-5

Single Crystal Phased Array for EC-9DIA
FOV : 90 °
Application : Adult Echo, Transcranial etc.

SP 3-8

Single Crystal Phased Array for EC-15 & EC-9DIA series
Application : Pediatric Echo, Pediatric abd.

CW2.0

Pencil type probe for EC-15
Application **:** Adult & Pediatric Echo
Doppler-based display

CW5.0

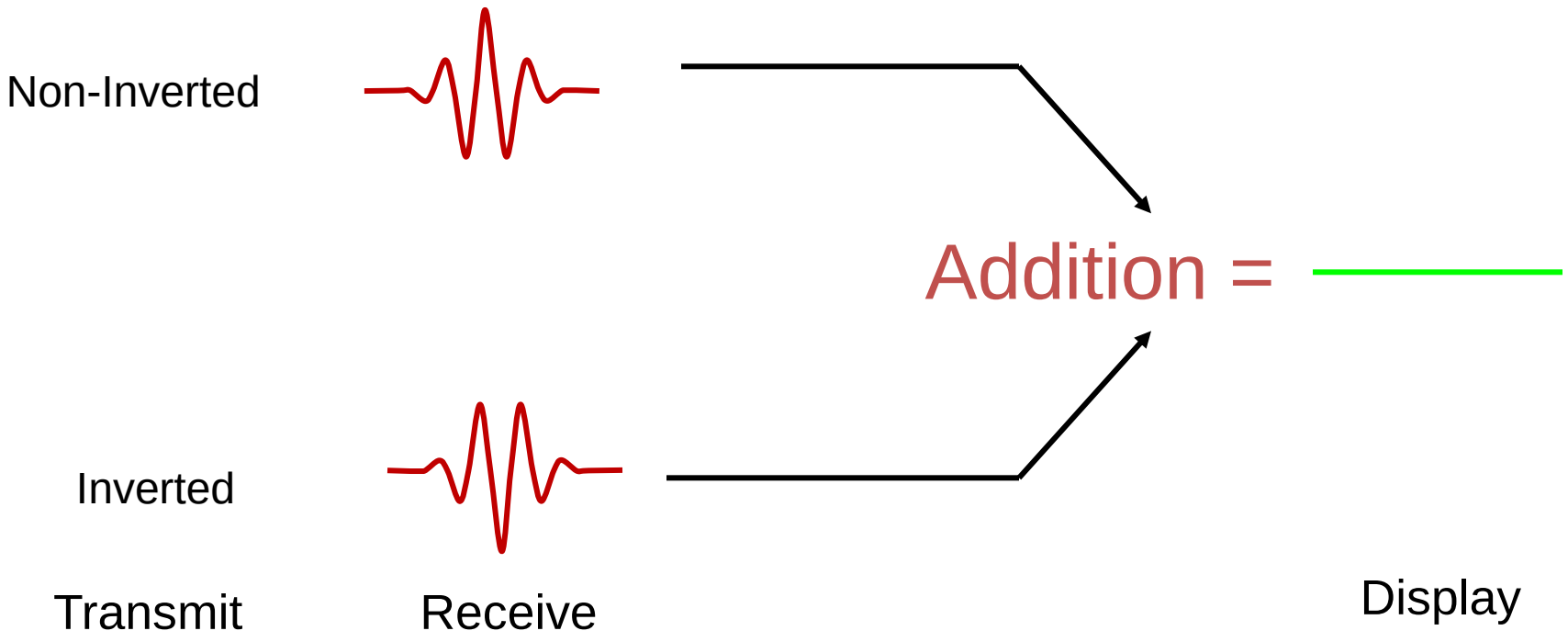
Pencil type Probe for EC-15
Application **: Deep venous & artery**
Doppler-based display

Harmonic Imaging Technology :

Filtered Tissue Harmonic Imaging(FTHI) & Pulsed Inversion THI

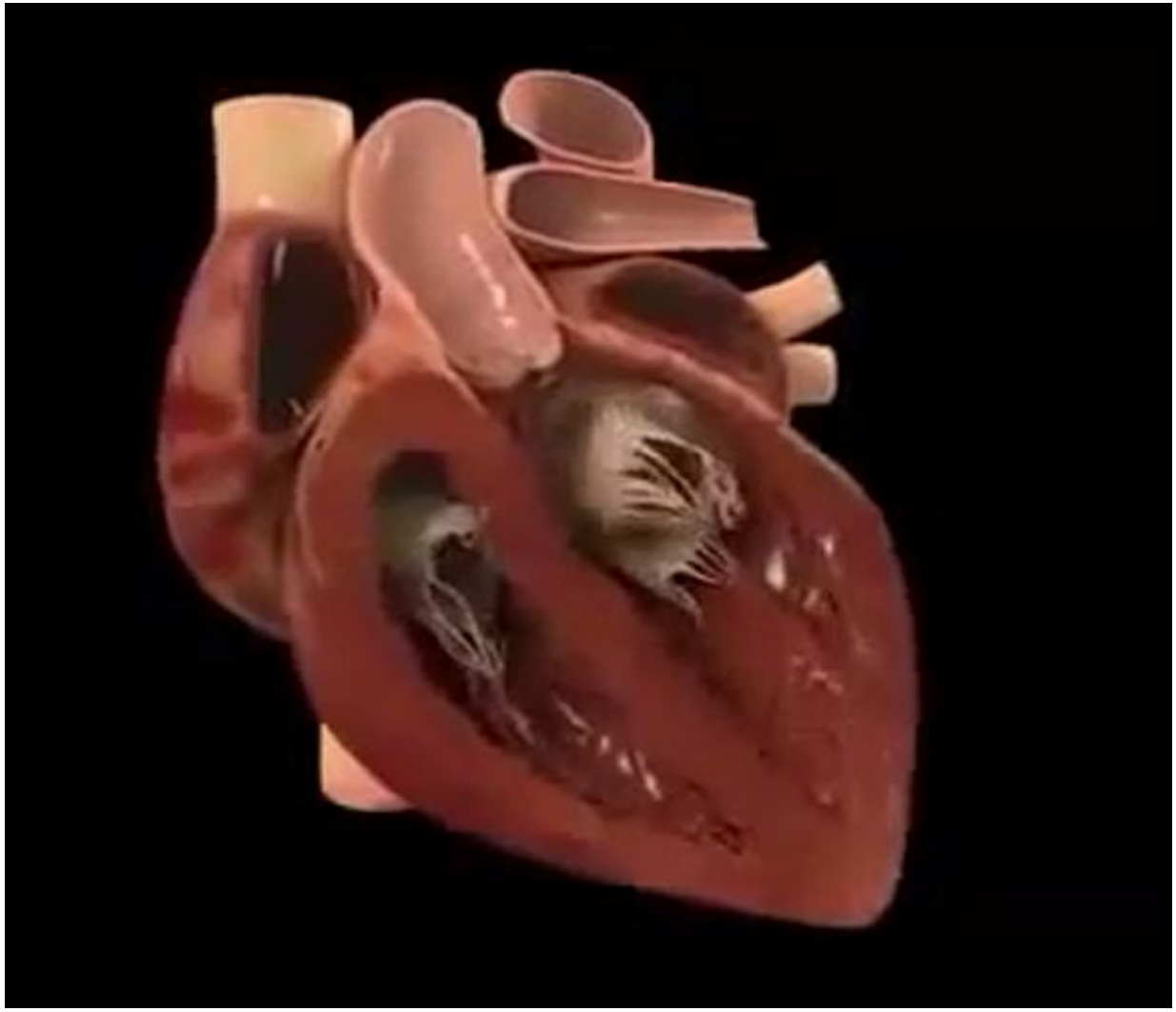
Pulse Inversion

Tissue (Linear Reflector)



Echo Protocol

The Heart



Basic Echocardiographic Views

1. Parasternal

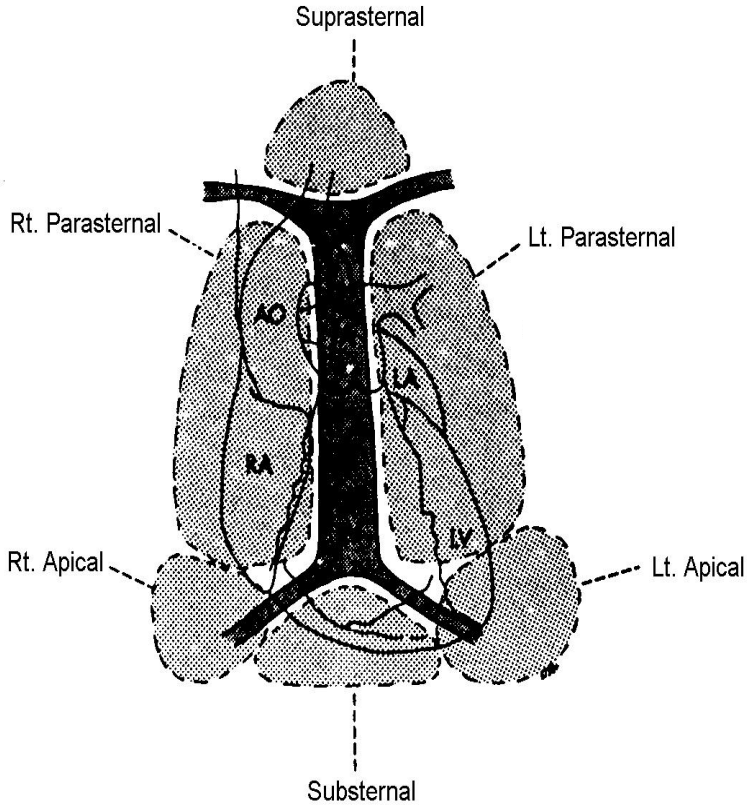
- Long Axis View
- Short Axis View

2. Apical

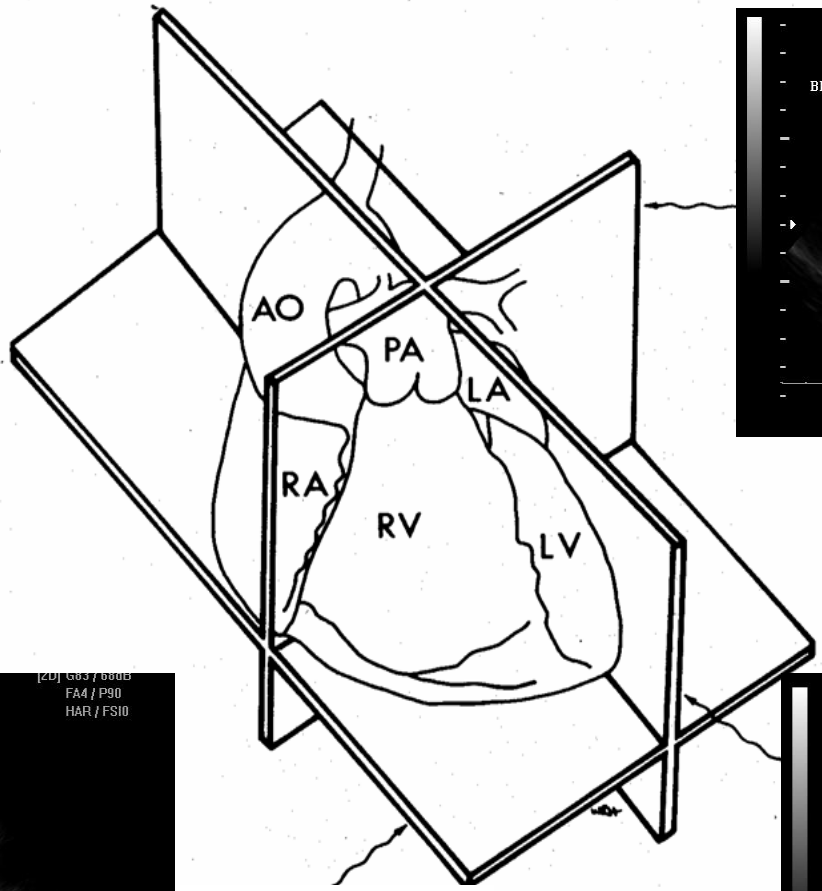
- Four Chamber View
- Five Chamber View
- Three Chamber View
- Two Chamber View

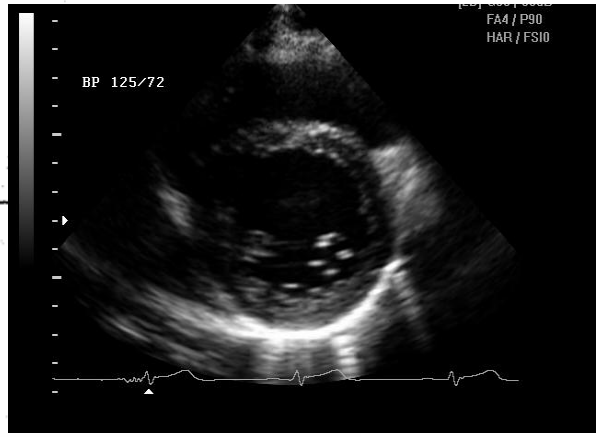
3. Subxiphoid or subcostal

4. Suprasternal



Basic Views

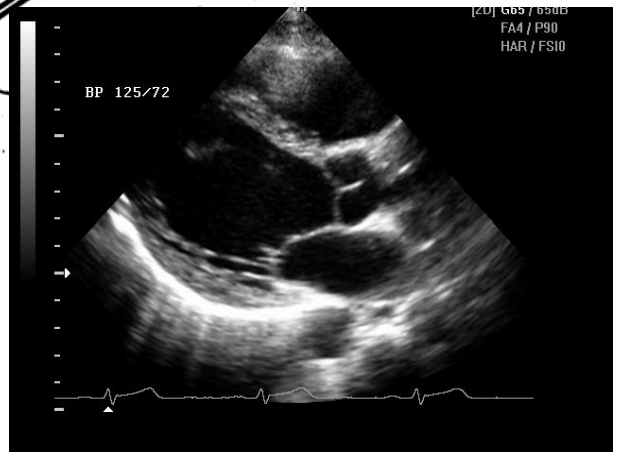




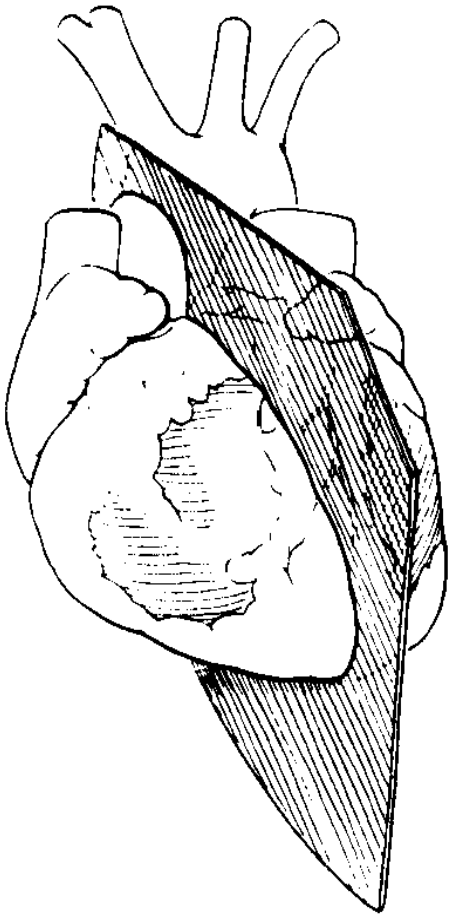
Short Axis Plane

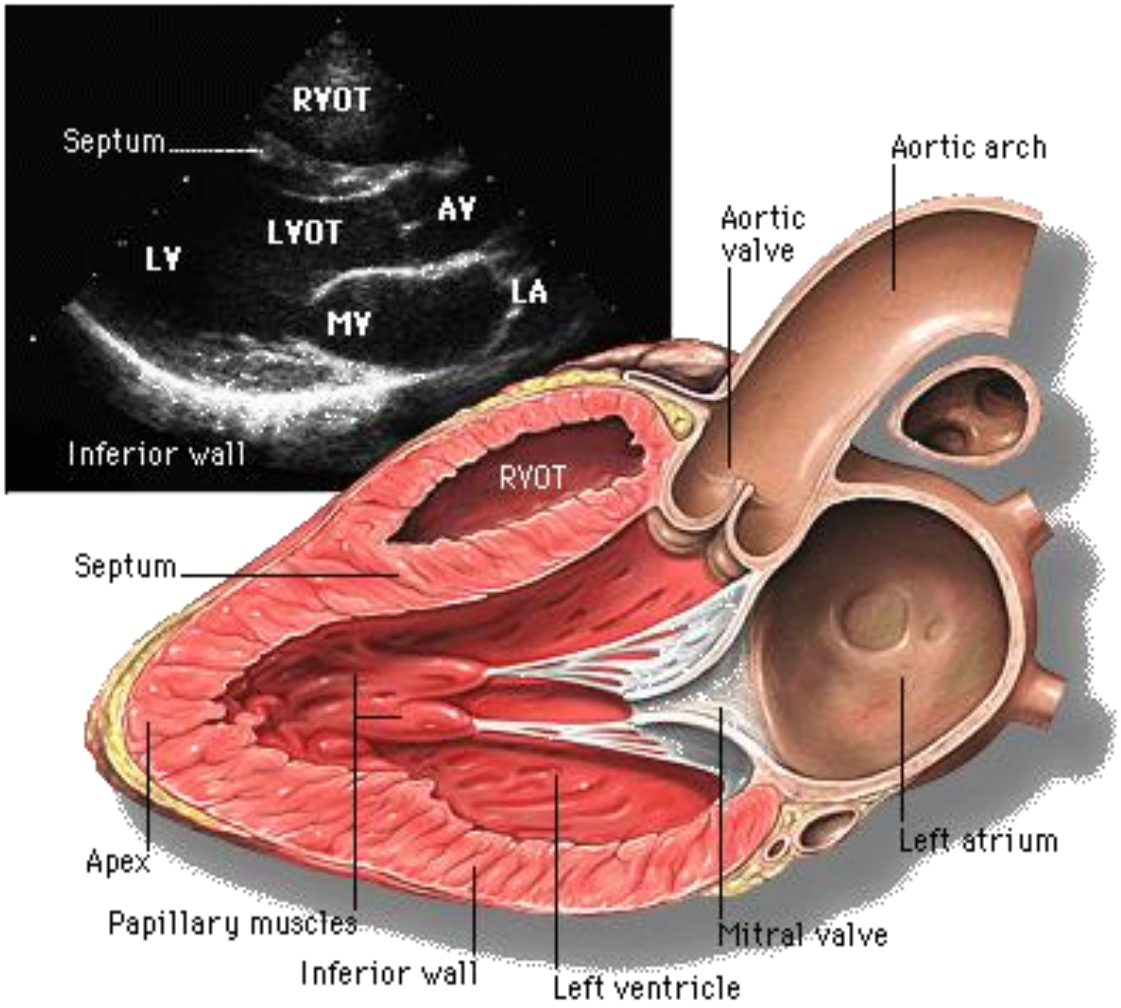
Long Axis Plane

Apical Plane



Parasternal Long Axis View (PLAX)





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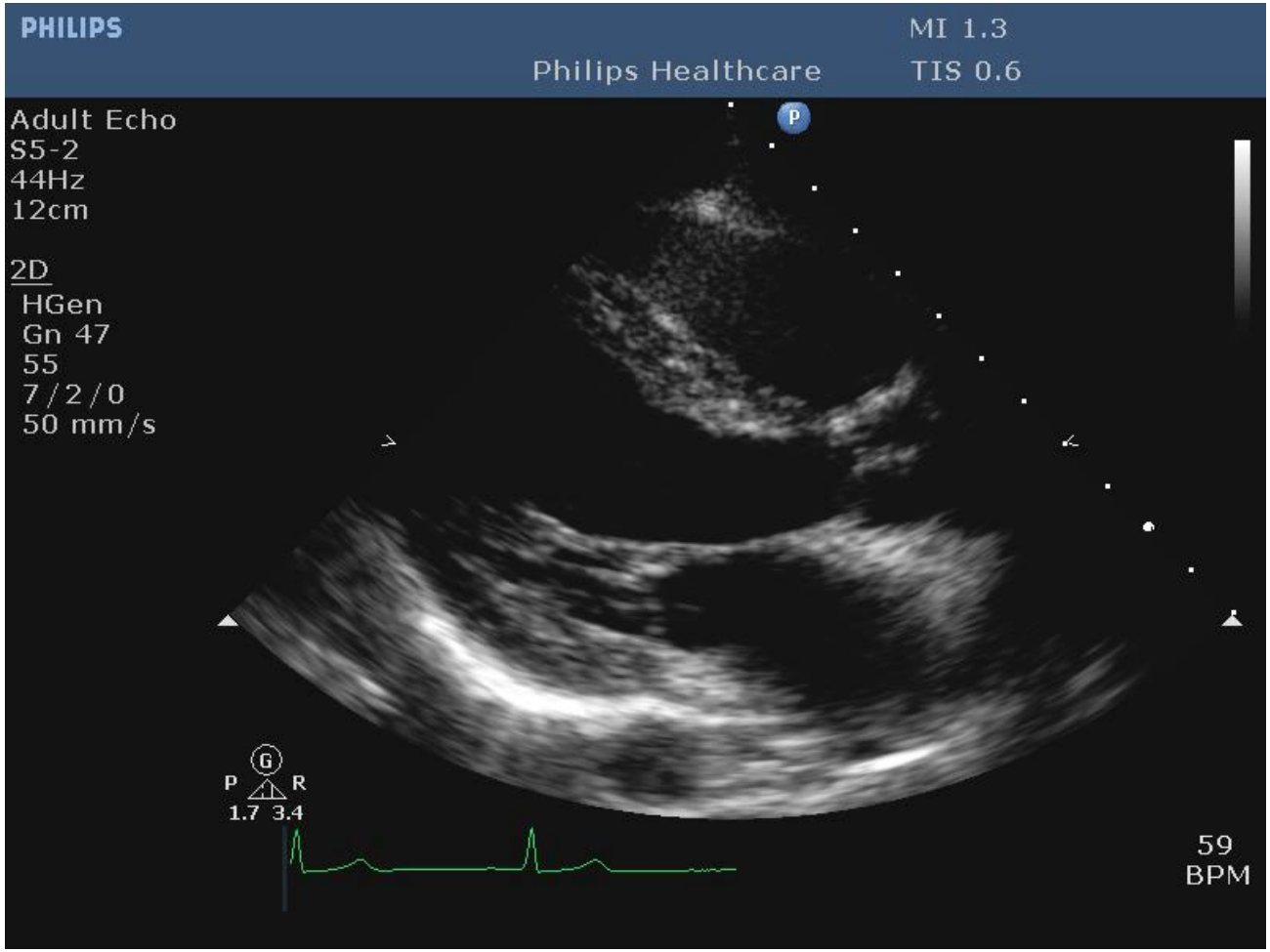
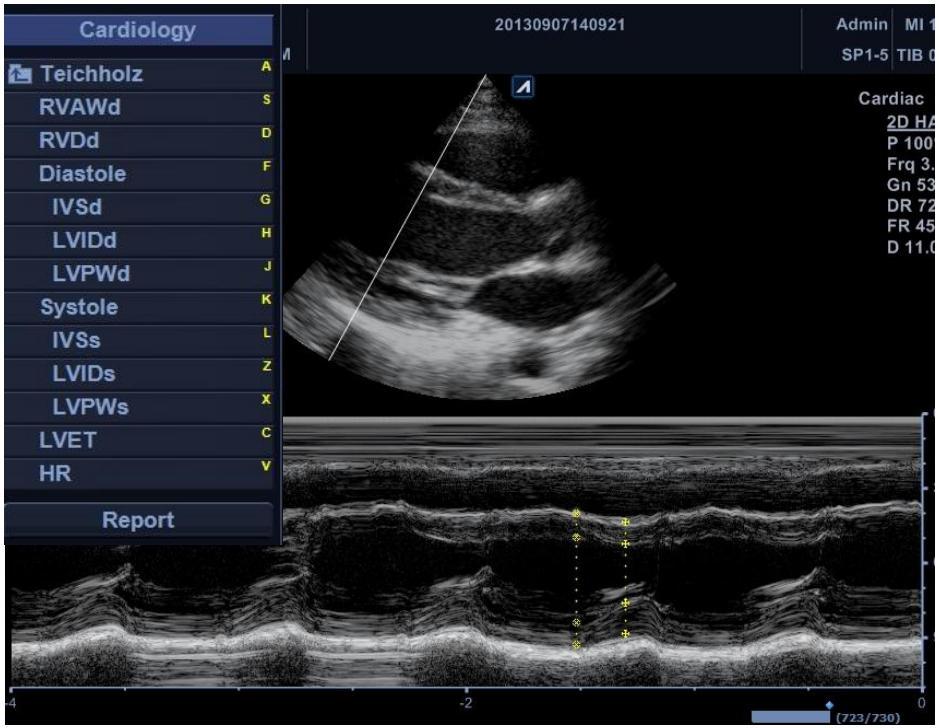
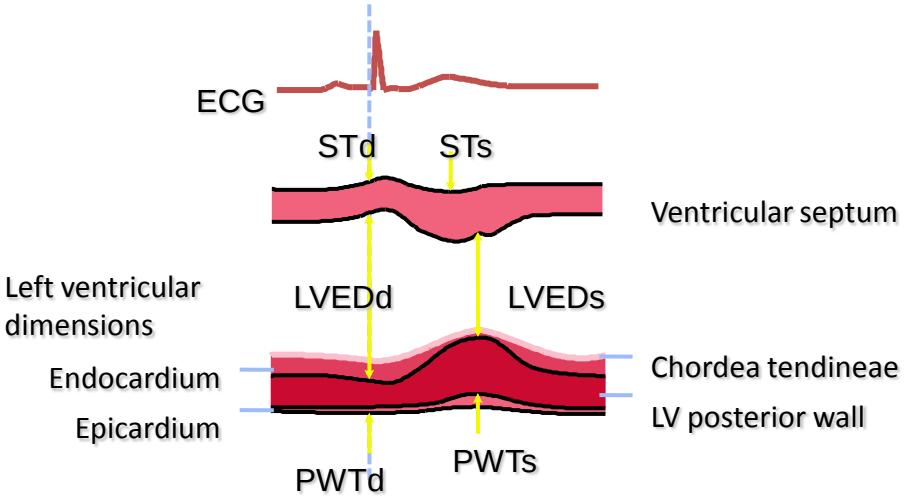


Parasternal Long Axis View (PLAX)





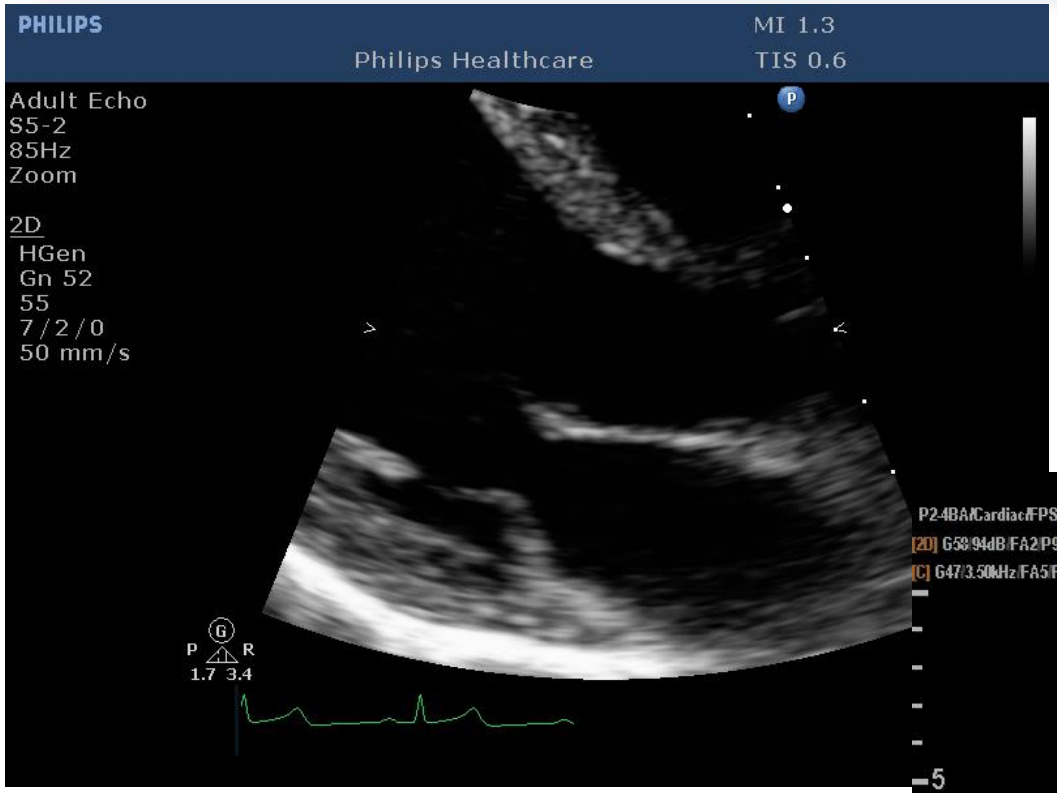
Basic Measurements

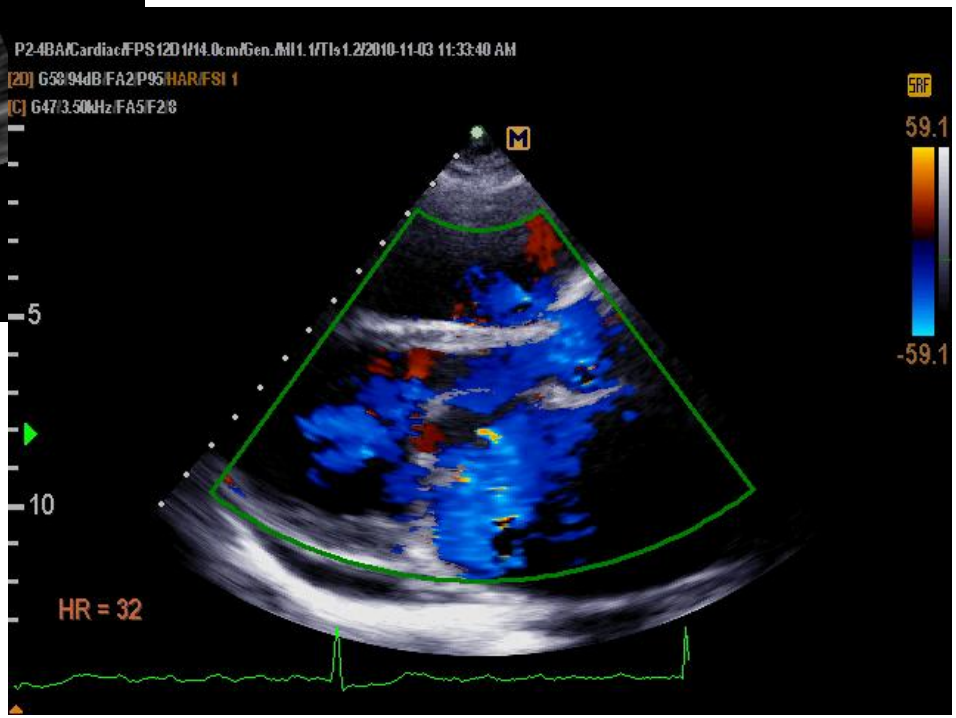
Systolic Function

- Systolic Function = Ejection Fraction
- Evaluated by M-mode and Simpson's Method
- Assessment of left ventricle systolic function is an important clinical variable with respect to diagnosis, prognosis and treatment

$$\frac{EDV - ESV}{EDV} \times 100 \Rightarrow EF$$

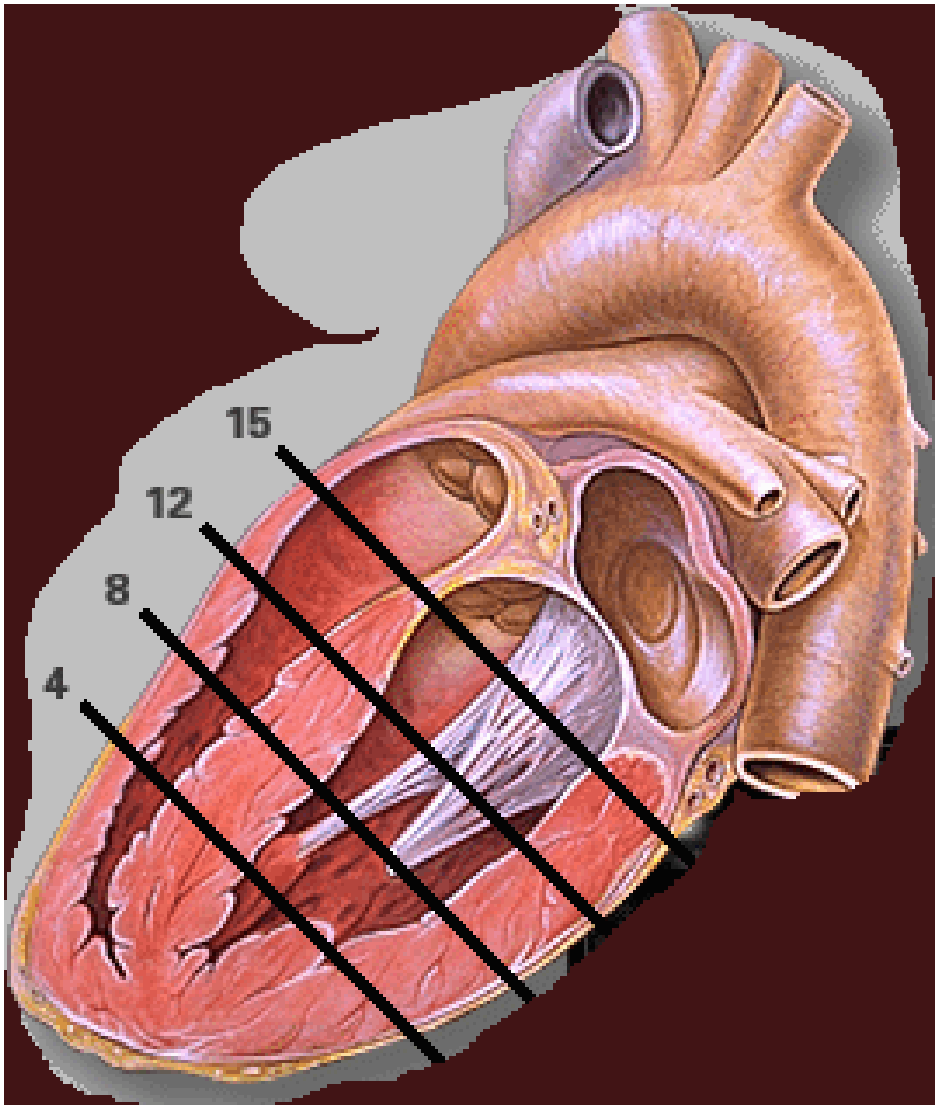
Parasternal Long Axis View (PLAX)





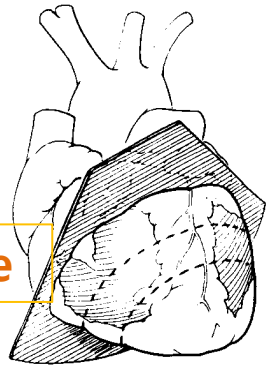
- LVOT Diameter
- LVOT stroke volume
  $=0.785*D^2*LVOT_{TVI}$
- Left Atrium Diameter
- Ascending Ao

Parasternal Short Axis Scan

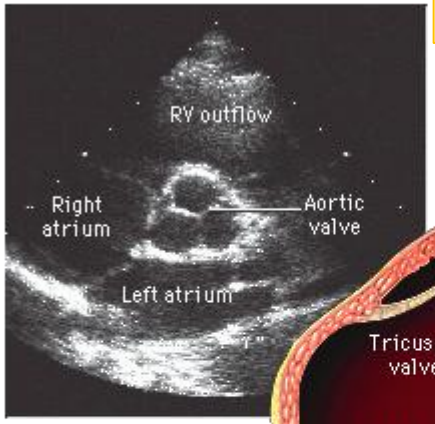


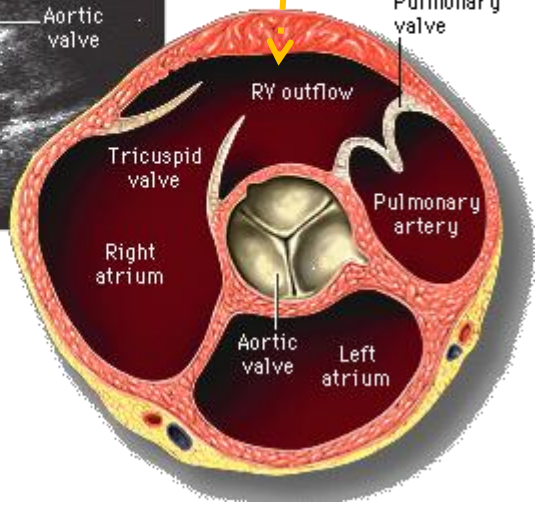
Parasternal Short Axis View

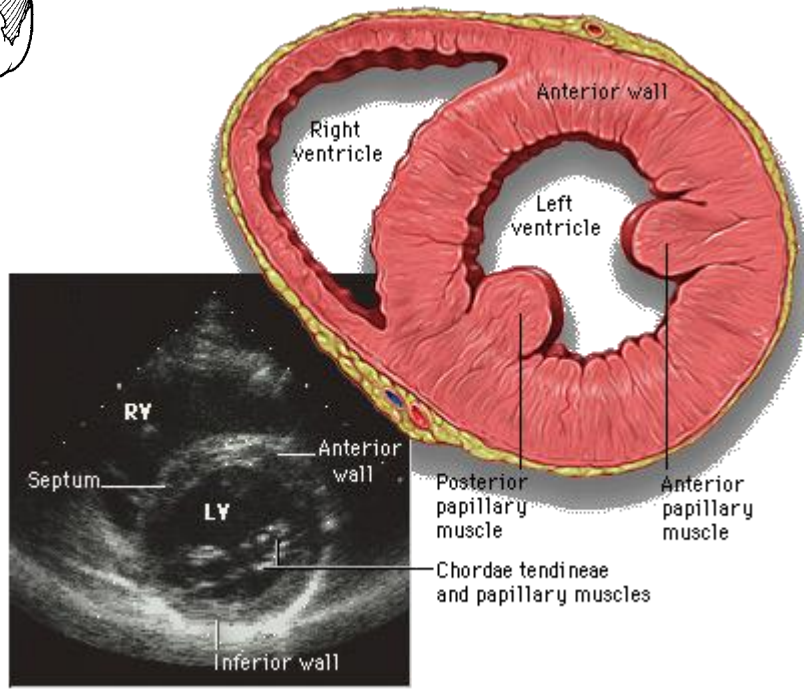
- Aortic Valve cusp
- Regurgitation
- Left Ventricle shape, width
- pressure overload
- RV size



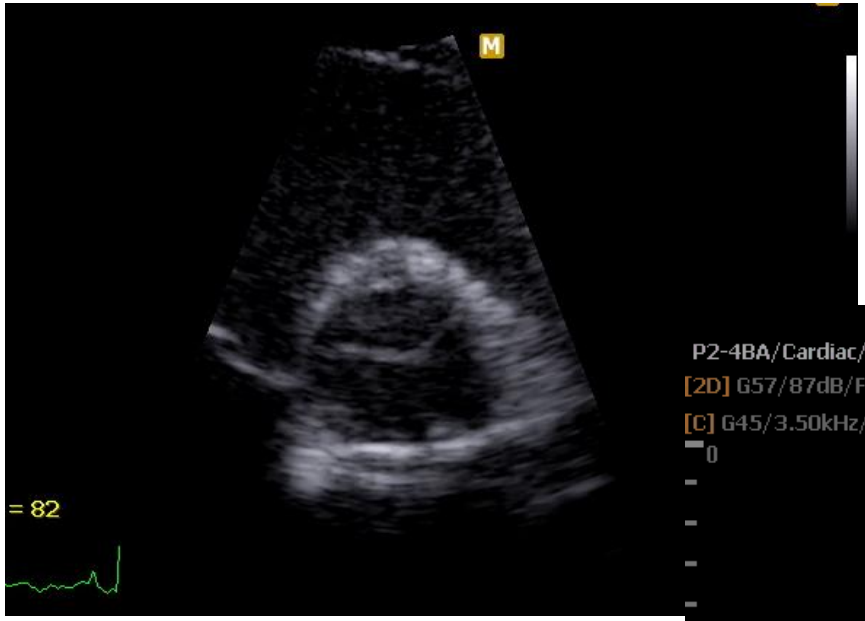
Aortic Valve



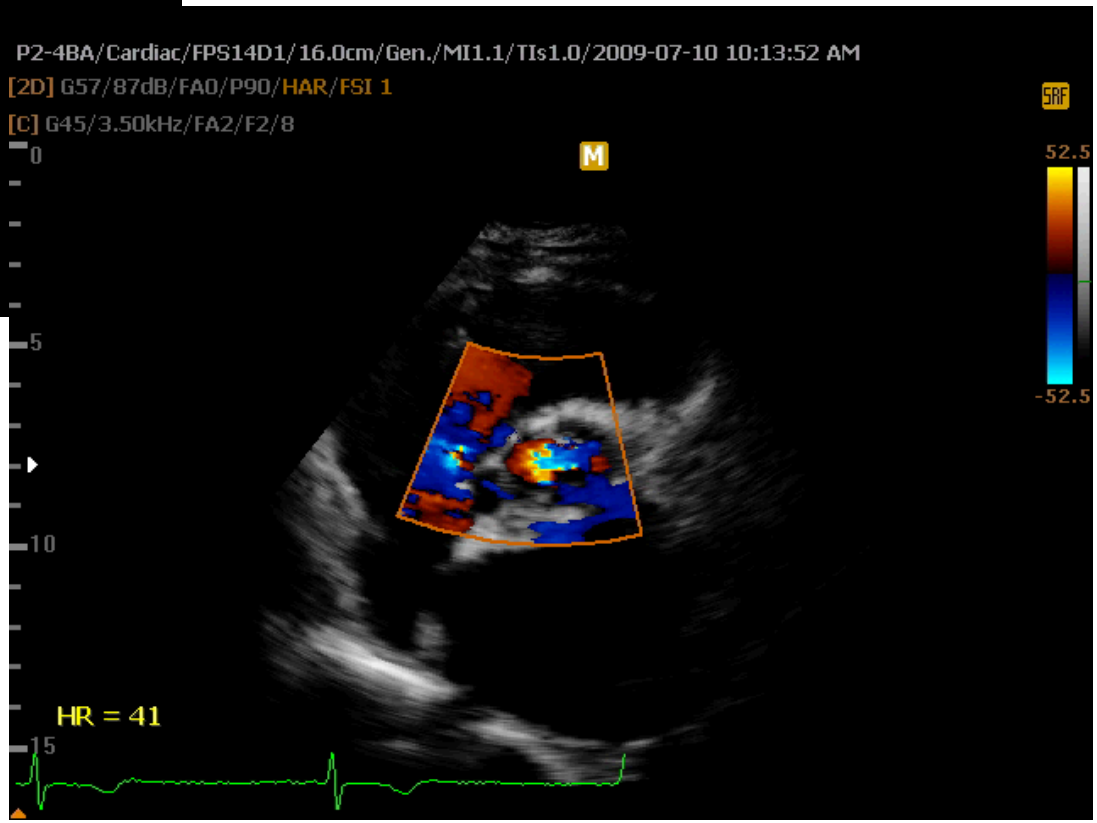




Parasternal Short Axis Scan

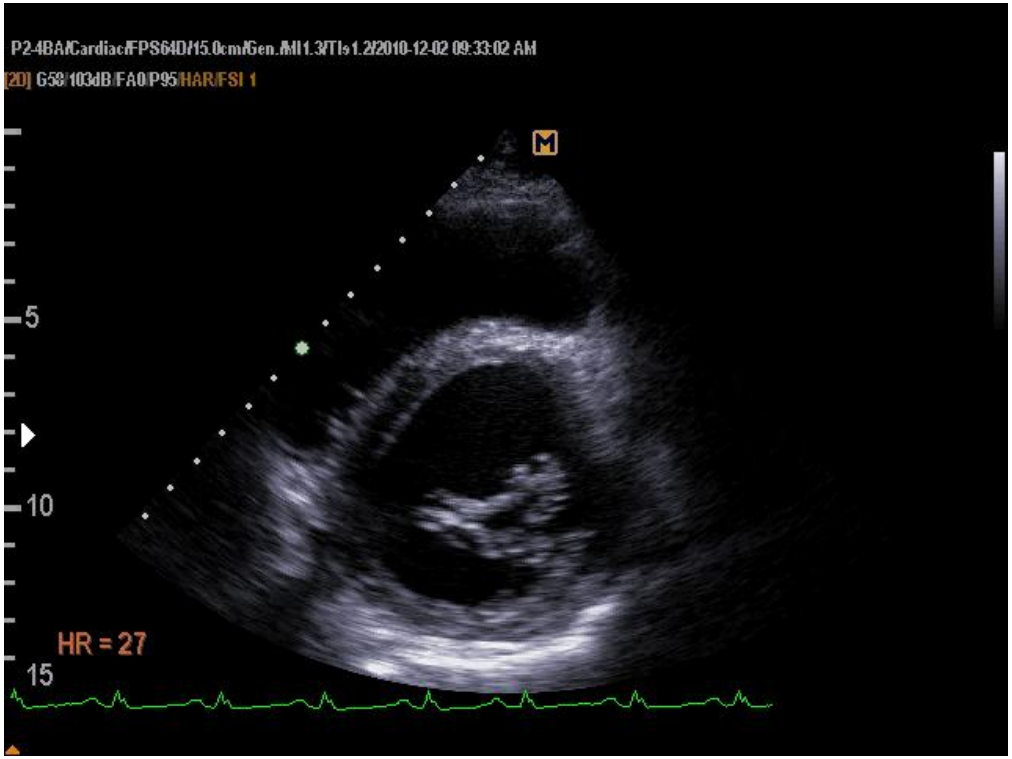


- Aortic Valve cusp
- Regurgitation

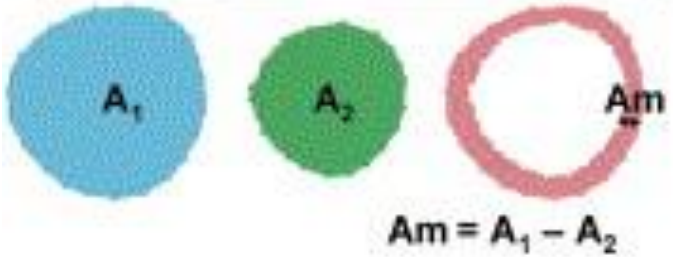


Parasternal Short Axis scan

- Regurgitation
- Mitral Valve & chordae, calcification
- pressure overload
- Apex movement



Left Ventriclular Mass



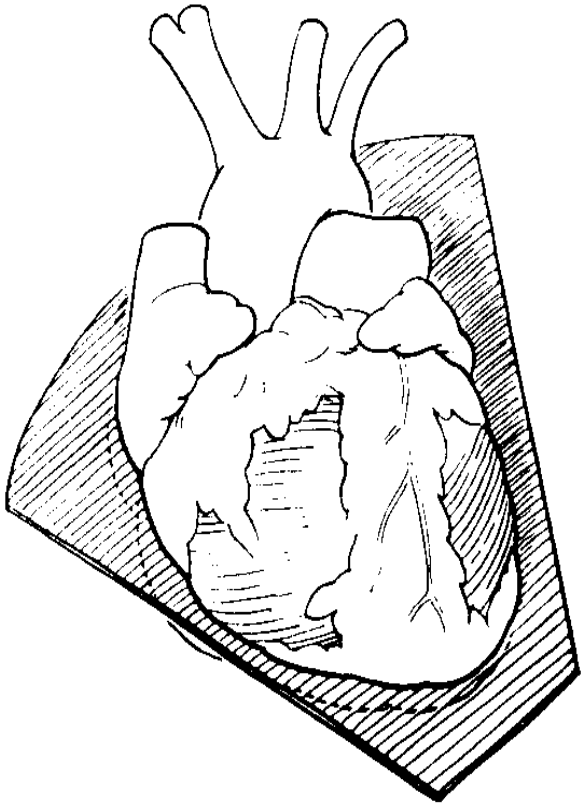
$$b = \sqrt{\frac{A_2}{\pi}} \qquad t = \sqrt{\frac{A_1}{\pi}} - b$$

$$Am = A_1 - A_2$$

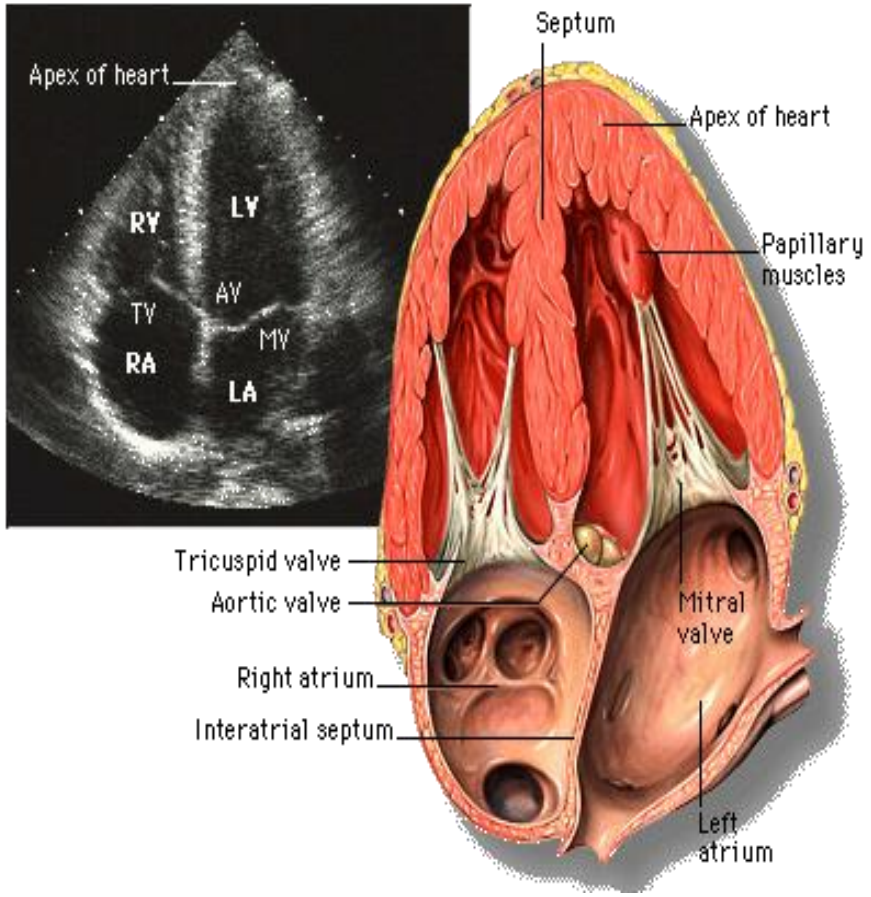
$$\text{LV Mass (AL)} = 1.05 \left\{ \left[\tfrac{5}{6} A_1 (a+d+t) \right] - \left[\tfrac{5}{6} A_2 (a+d) \right] \right\}$$

$$\text{LV Mass (TE)} = 1.05 \times \left\{ (b+t)^2 \left[\tfrac{2}{3} (a+1) + d - \frac{d^3}{3(a+t)^2} \right] - b^2 \left[\tfrac{2}{3} a + d - \frac{d^3}{3a^2} \right] \right\}$$

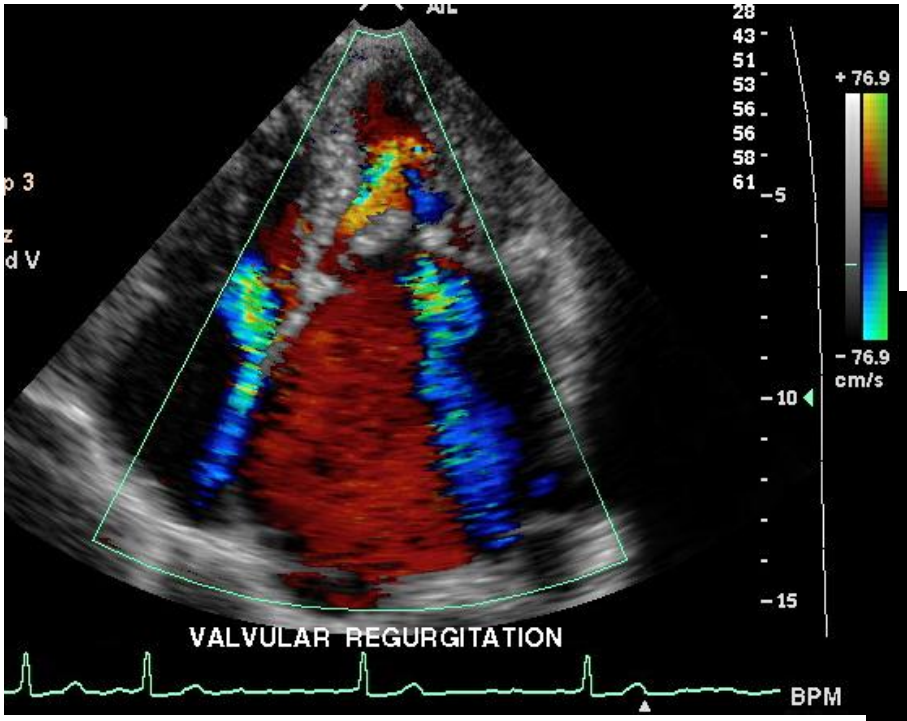
Apical 4 chamber View



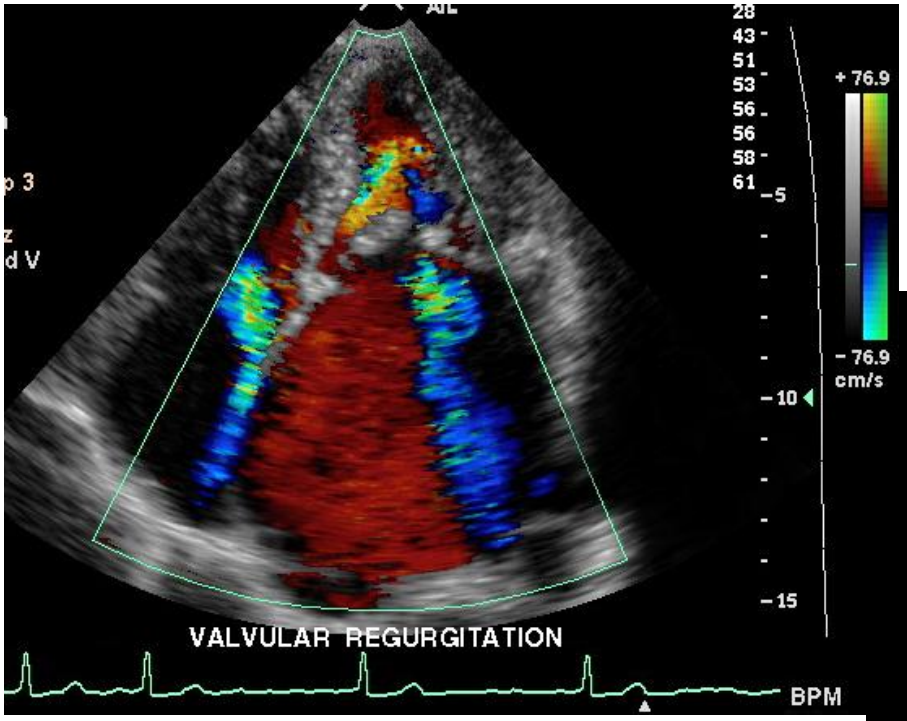
- Mitral V, Tricuspid V's shape
- Each Chamber's size, measure EF,
- Apical thrombosis



Apical 4 chamber- measurements



Apical 4 chamber- regurgitation flow



Apical 4 chamber- systolic Function

Biplane Simpson's method (Modified Simpson's method)

- LV volumes is measured form annulus to annulus tracing along the endocardial border of the LV
- Single 4chamber EF or bi-plane EF (4ch.+ 2ch)

[Pitfalls]

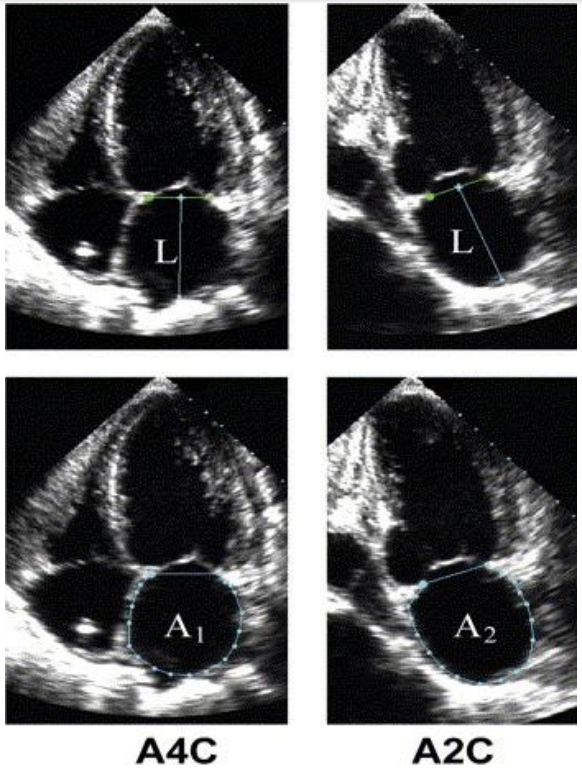
- *Not foreshortening of LV*
- *The diastolic and systolic volume are measured in the same cardiac cycle.*

Apical 4 chamber- diastolic Function

LA volume

- LA volumes is measured form annulus to annulus tracing along the endocardial border of the Left atrium(4ch+ 2ch)
- LA diameter "L"

[Pitfalls]
- *Systole phase : measure at the largest LA*
- *Sympson method, or ASE standard*



A4C A2C

Left Atrial Volume =

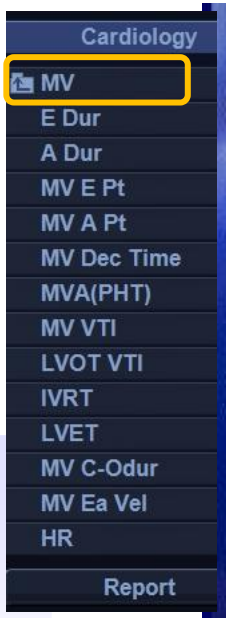
$$8/3\pi[(A_1)(A_2)/(L)]^*$$

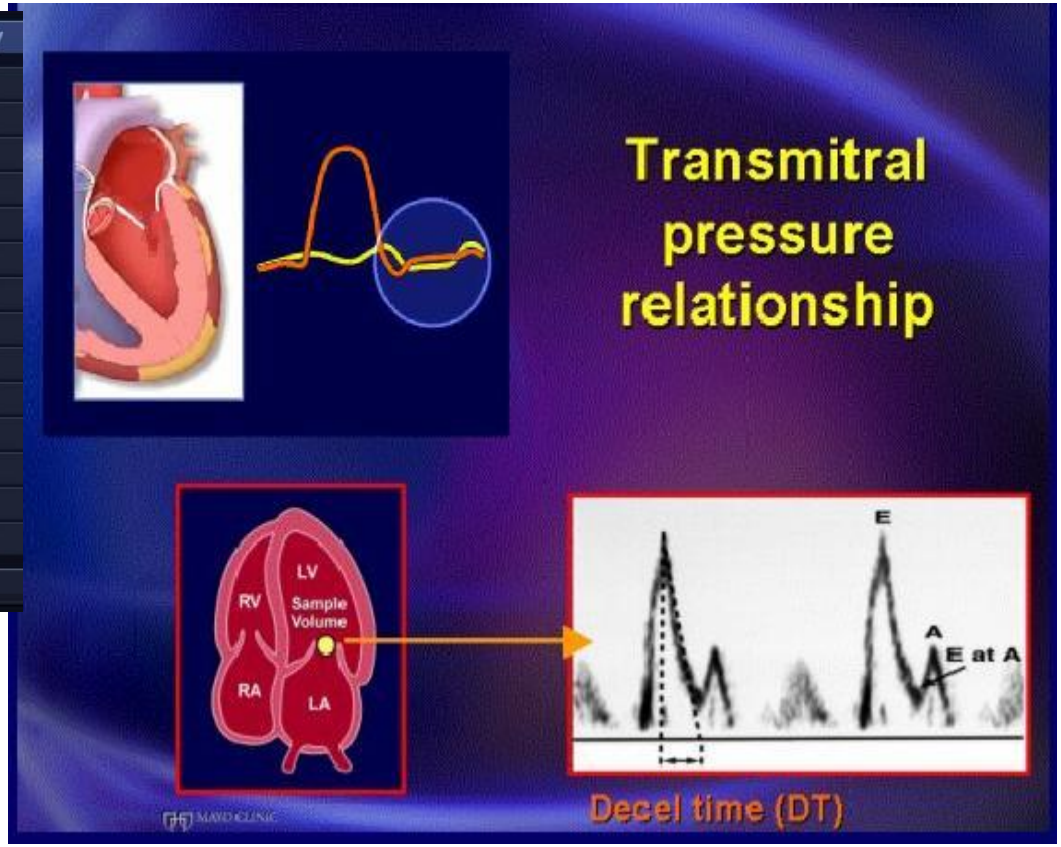
* (L) is the shortest of either the A4C or A2C length

Apical 4 chamber- diastolic Function

Mitral Inflow and Septal Tissue doppler , and pulmonary vein doppler

- Mitral Inflow ; Peak E vel., Deccelleration Time, Peak A vel., IVRT
- Septal TDI ; systole s`, diastole e` and a`





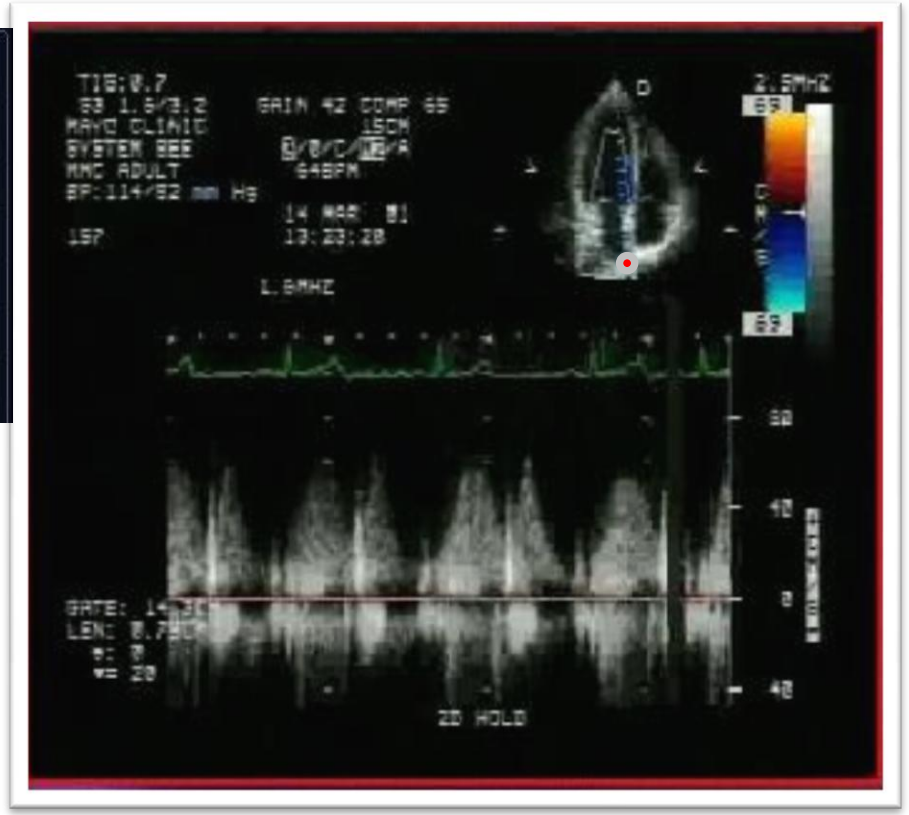
[Pitfalls]

- *Location of PW gate differ from Mitral inflow*
- *Septal TDI*

Apical 4 chamber- diastolic Function

Mitral Inflow and Septal Tissue doppler , and pulmonary vein doppler

- Pul.Vein : Systole, Diastole , A reversal



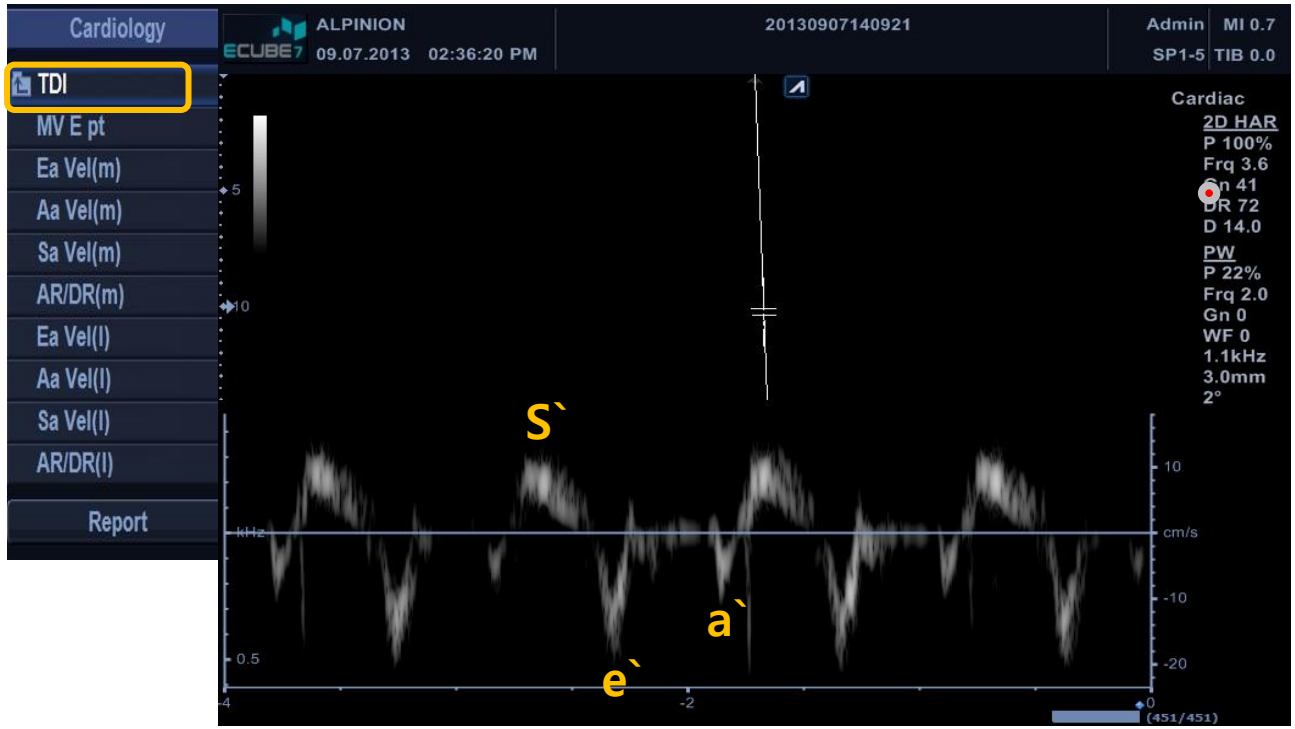
[Pitfalls]

- *PW gate location*
- *0.5~1cm below to the Pul.vein*

Apical 4 chamber- diastolic Function

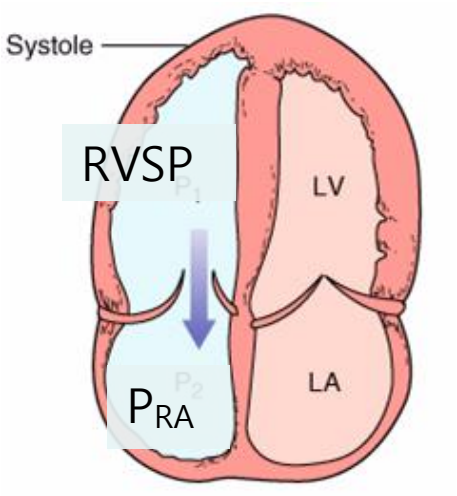
Diastolic function

- Requirements :
  -. TDI : Ea Vel or MV Ea Vel.
  >> E/E' value : 8 normal 15> abnormal



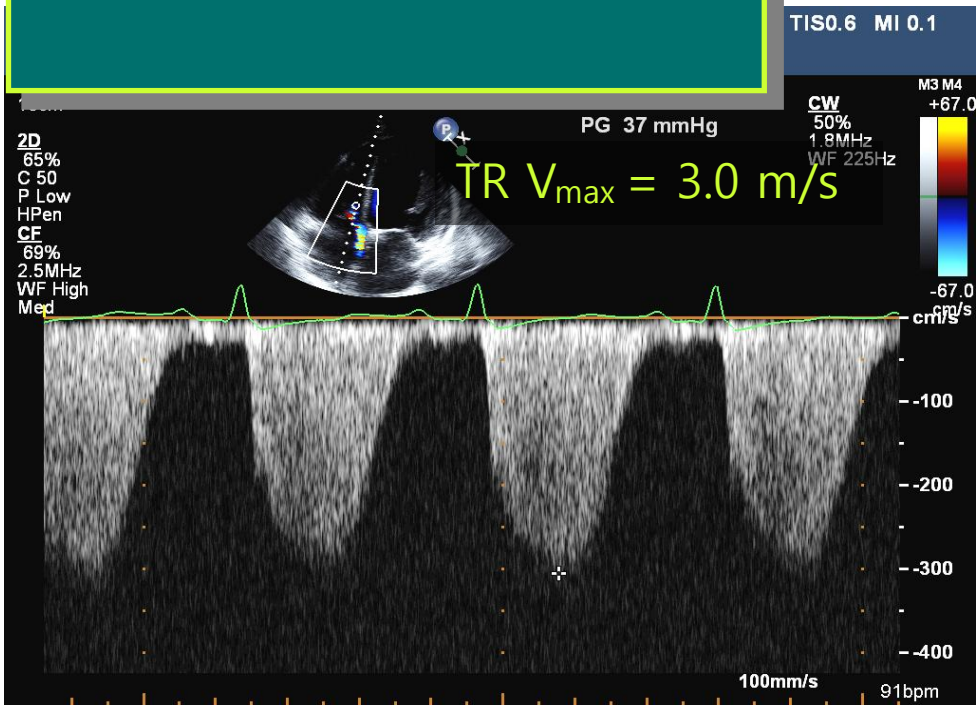
Apical 4 chamber- Tricuspid Regurgitation

- Right Ventricle Systolic Pressure



$$RVSP - P_{RA} = 4V^2$$

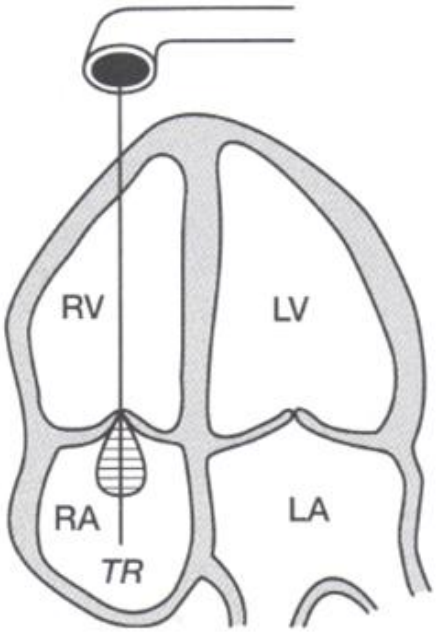
$$RVSP = 4V^2 + P_{RA}$$



Apical 4 chamber- Tricuspid Regurgitation

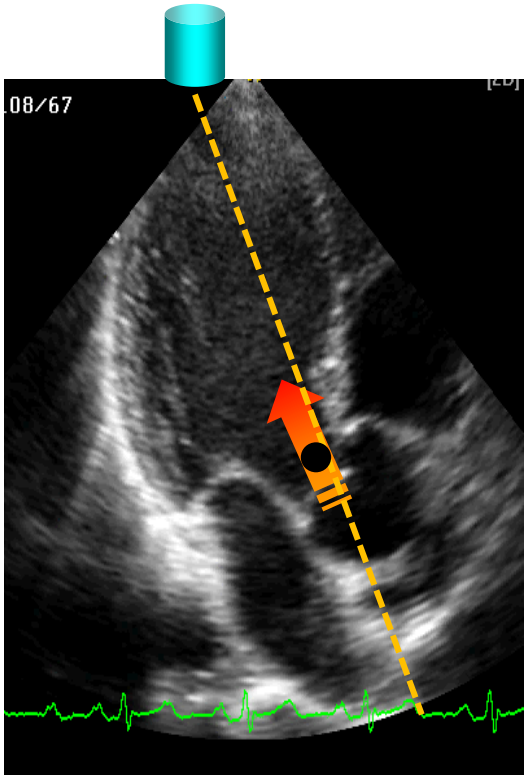
- Pulmonary Artery Systolic Pressure

Without PV stenosis, PASP = RVSP

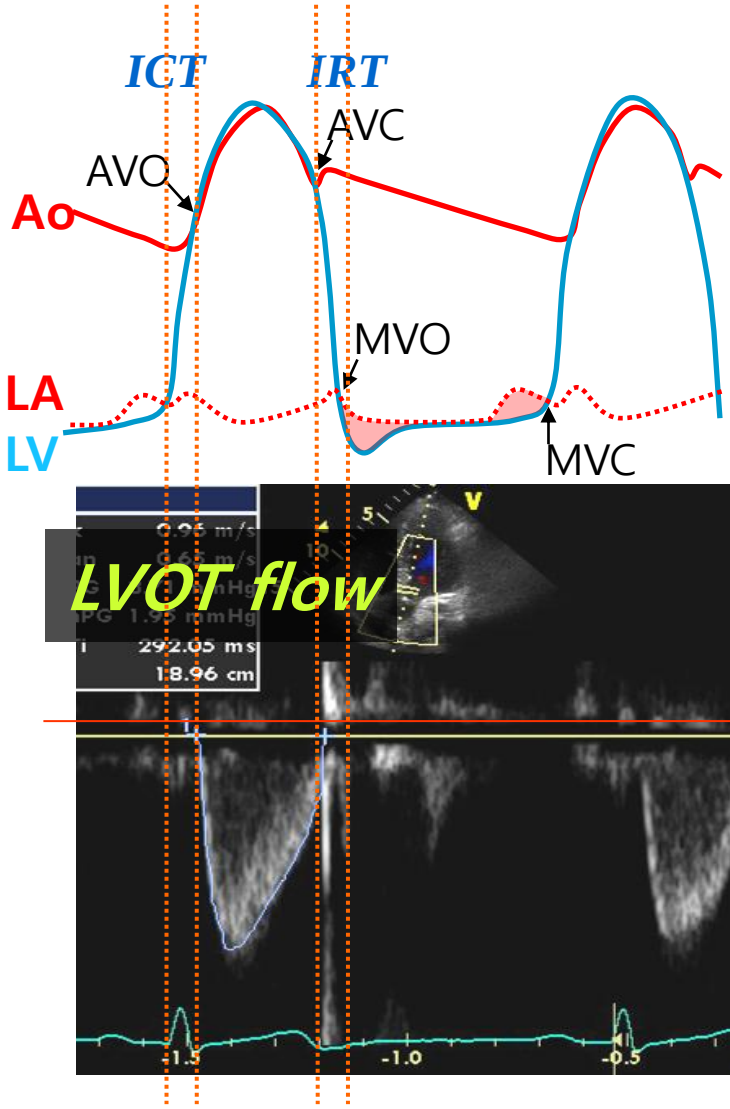


$$RVSP = 4\,(V_{TR})^2 + RAP$$

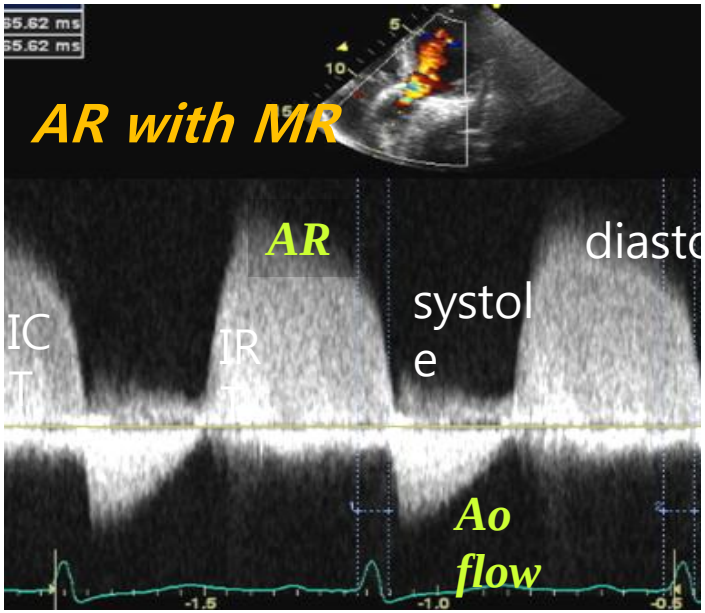
Apical 5 chamber View

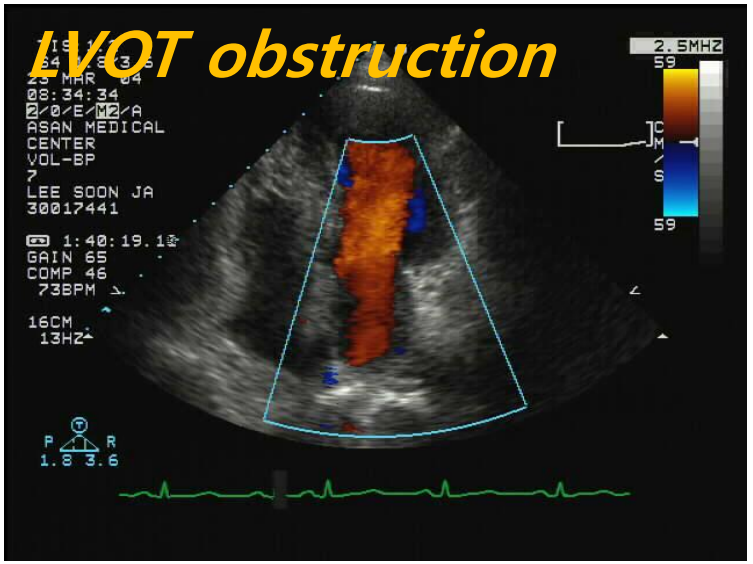


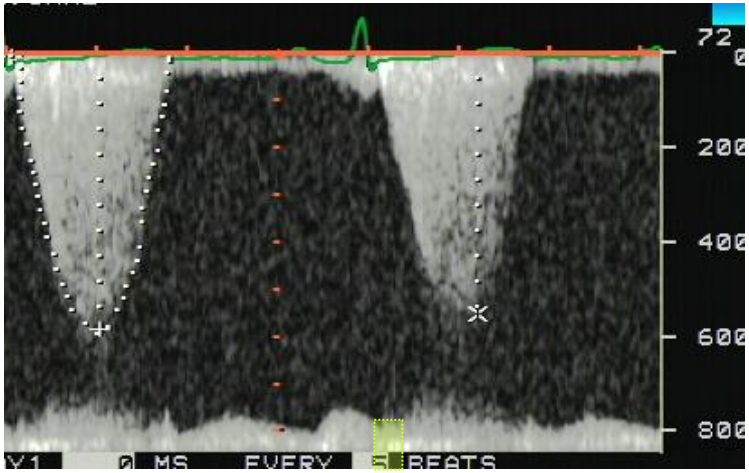
Apical 5 chamber



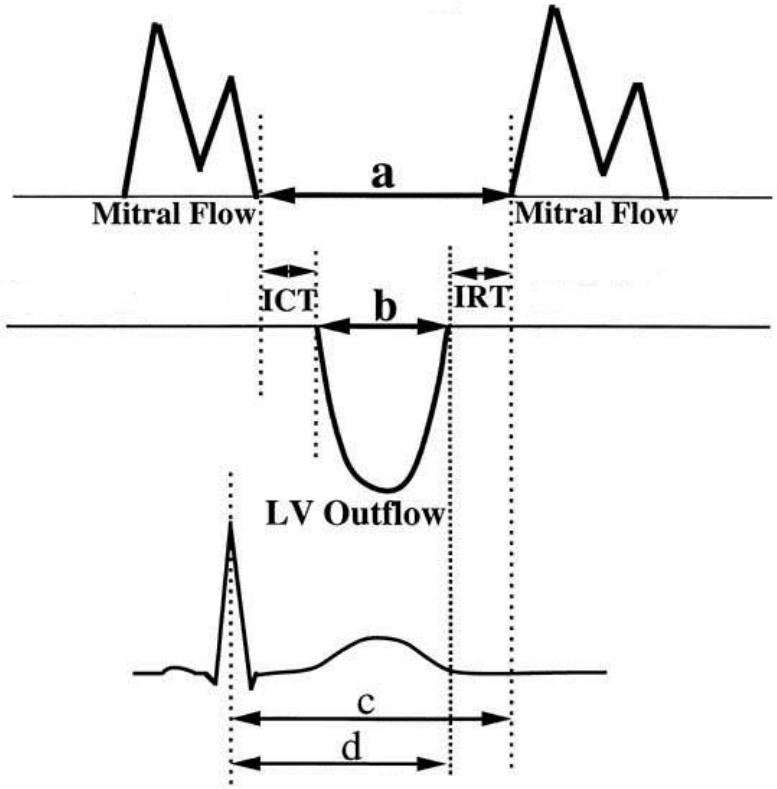
Apical 5 chamber View



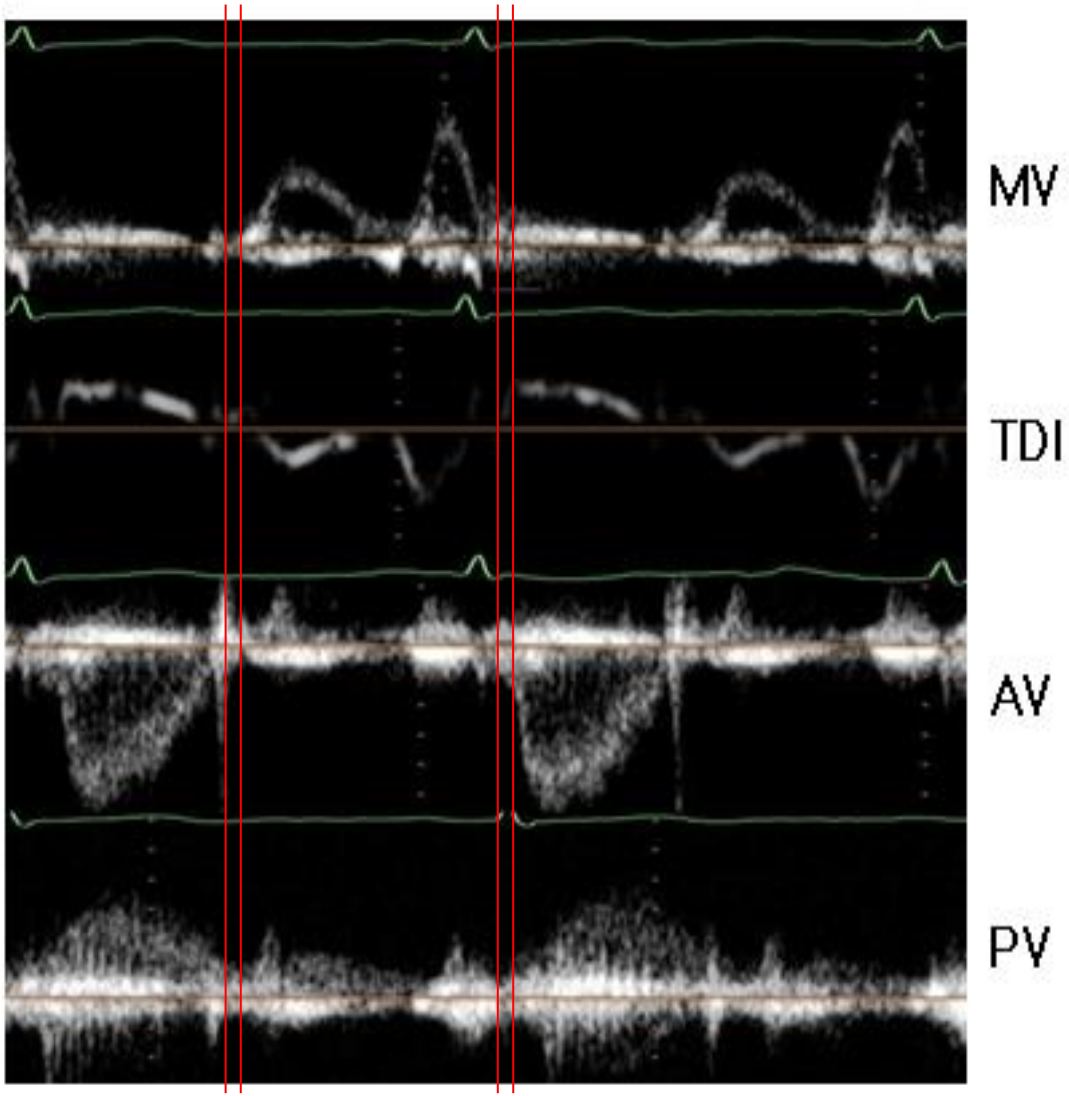




Myocardial Performance Index



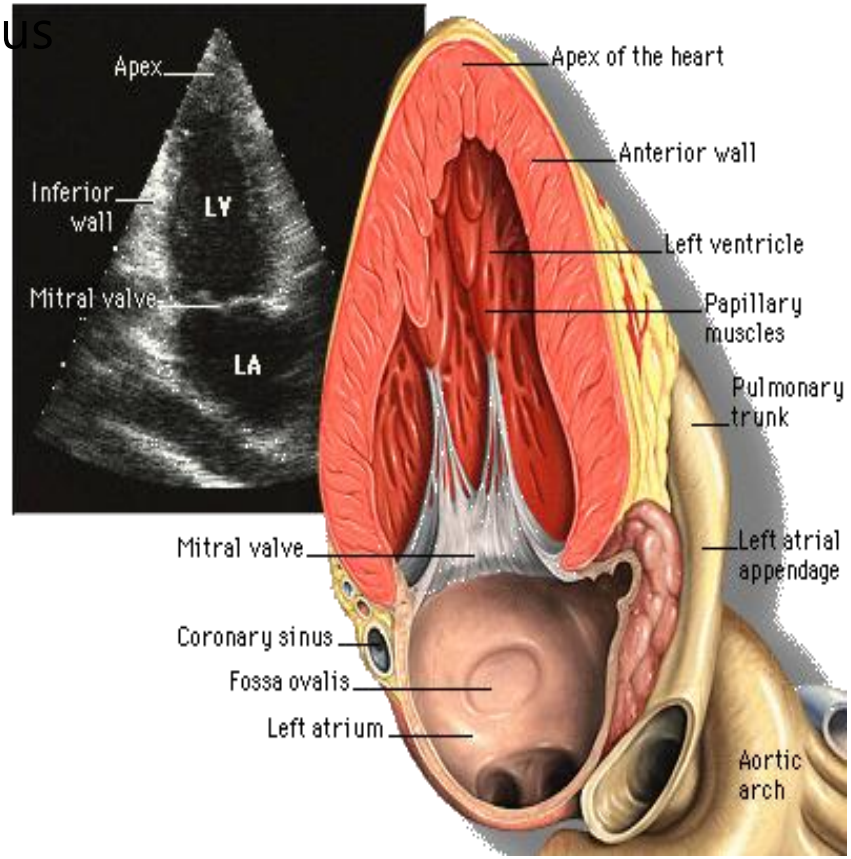
doppler alignment by ECG gating



Apical 2 chamber View

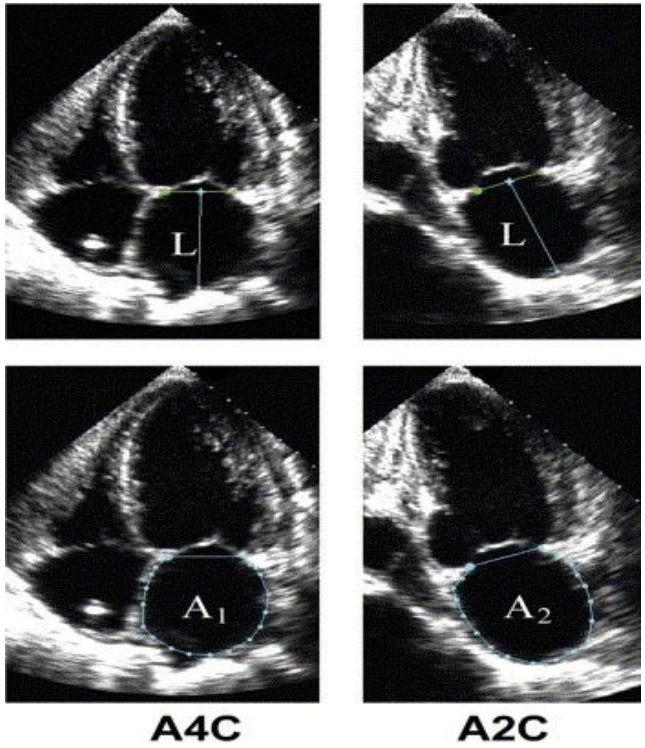
LA volume or MV, LV wall motion

- LA volumes is measured form annulus to annulus tracing along the endocardial border of the Left atrium(4ch+ 2ch)
- Wall motion
- Wall thickness
- Valvular & annular morphology
- Mitral regurgitation jet



Apical 2 chamber

Apical 2 chamber –LA volume



Left Atrial Volume =

$$8/3\pi[(A_1)(A_2)/(L)]\ *$$

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

- **LA Vol.ml**

	ref. range	mild abn.	mod. abn.	sev. abn
women	22–52	53–62	63–72	≥73
men	18–58	59–68	69–78	≥79

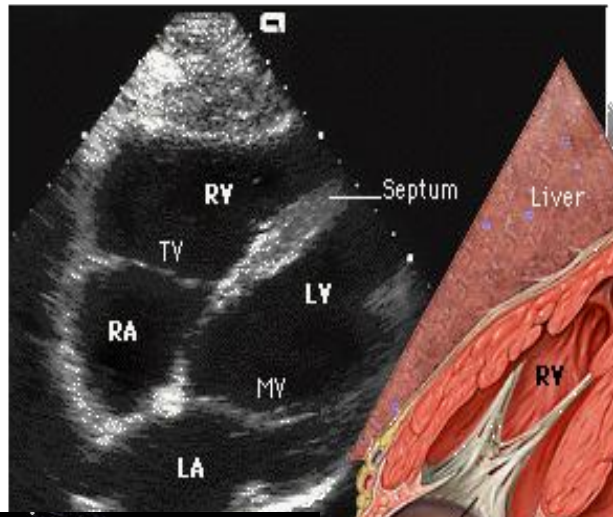
- **LA vol/BSA, ml/m²**

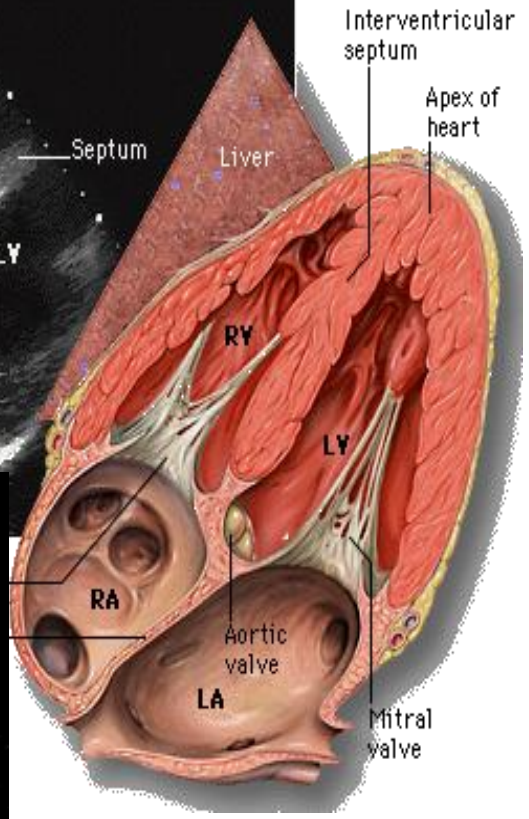
	ref. range	mild abn.	mod. abn.	sev. abn
women	22±6	29–33	34–39	≥40
men	22±6	29–33	34–39	≥40

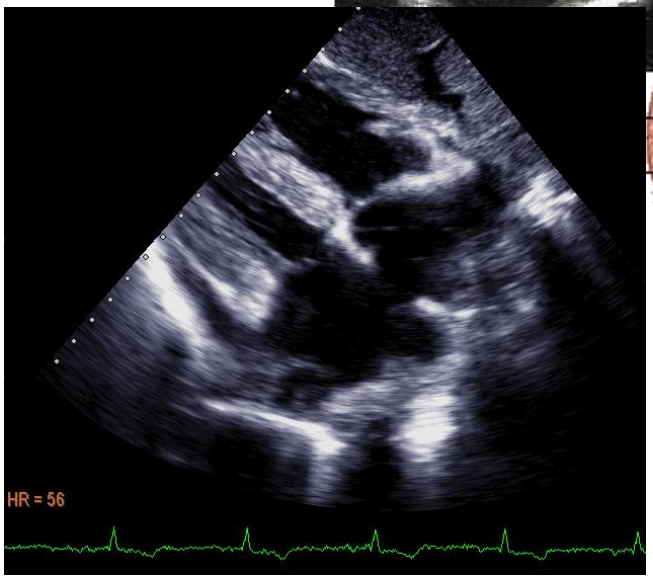
Subcostal View

Atrial septal defect, IVC and abdominal Aorta

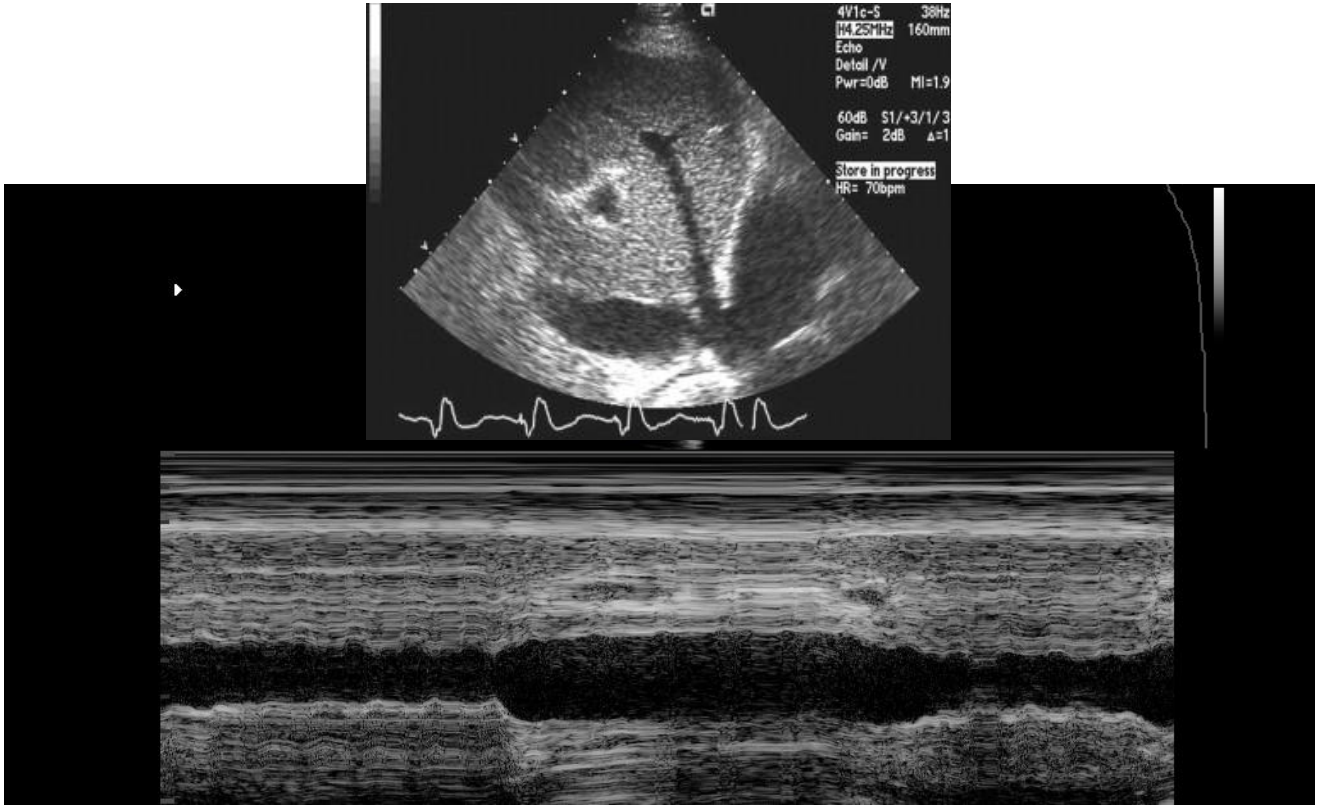
- Show entire atrial septum
- Tricuspid regurgitation
- abdominal aorta (flap, artheroma)
- Change IVC diameter according to respiration
- Hepatic vein flow

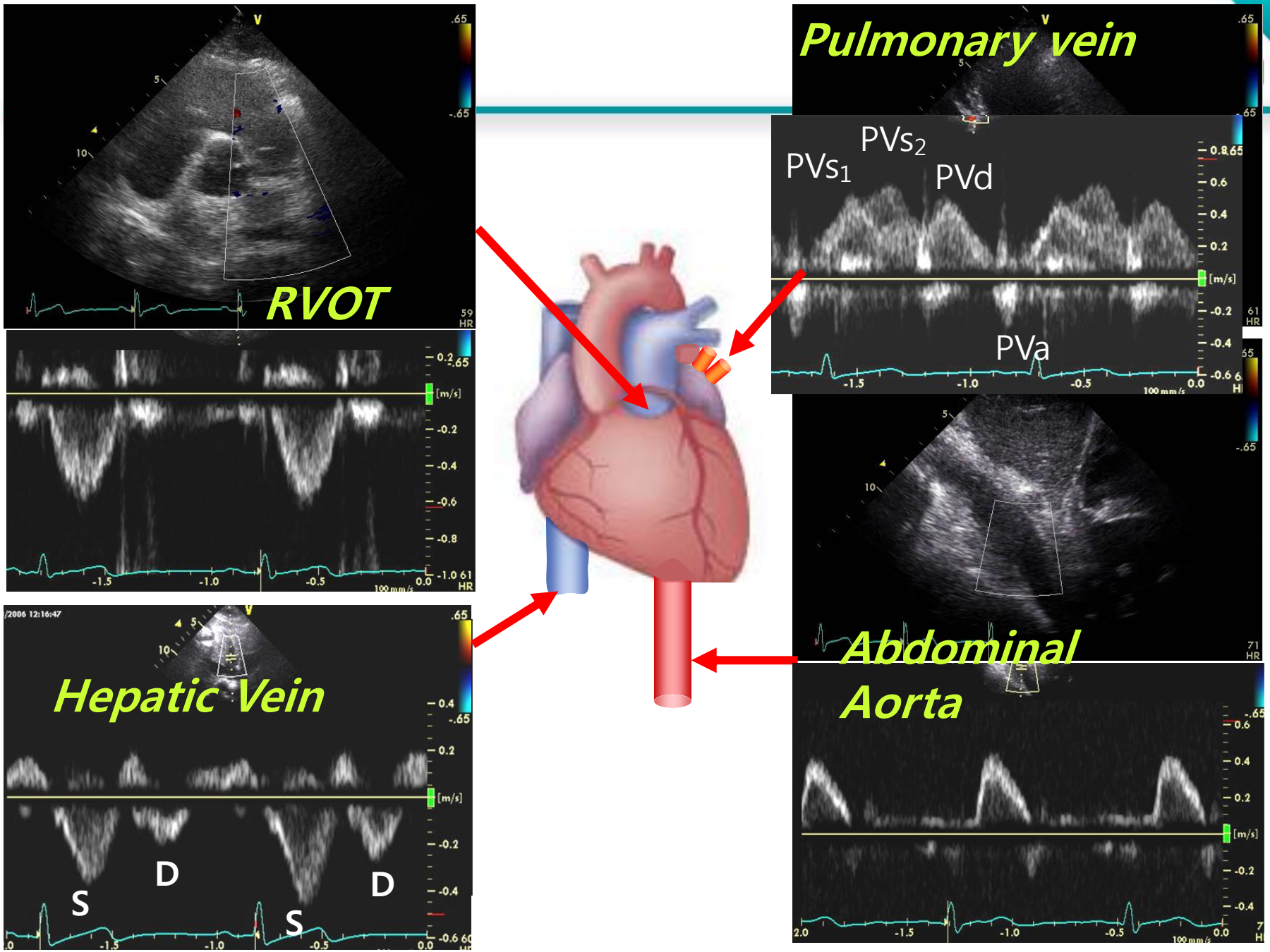




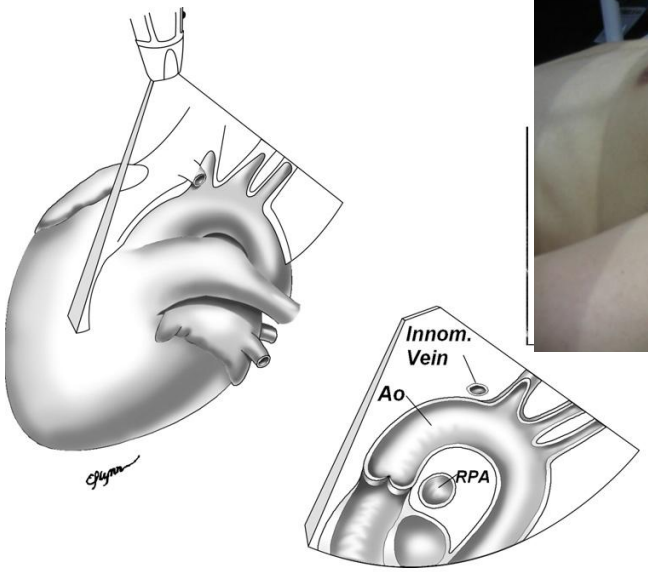


Subcostal View- M-mode

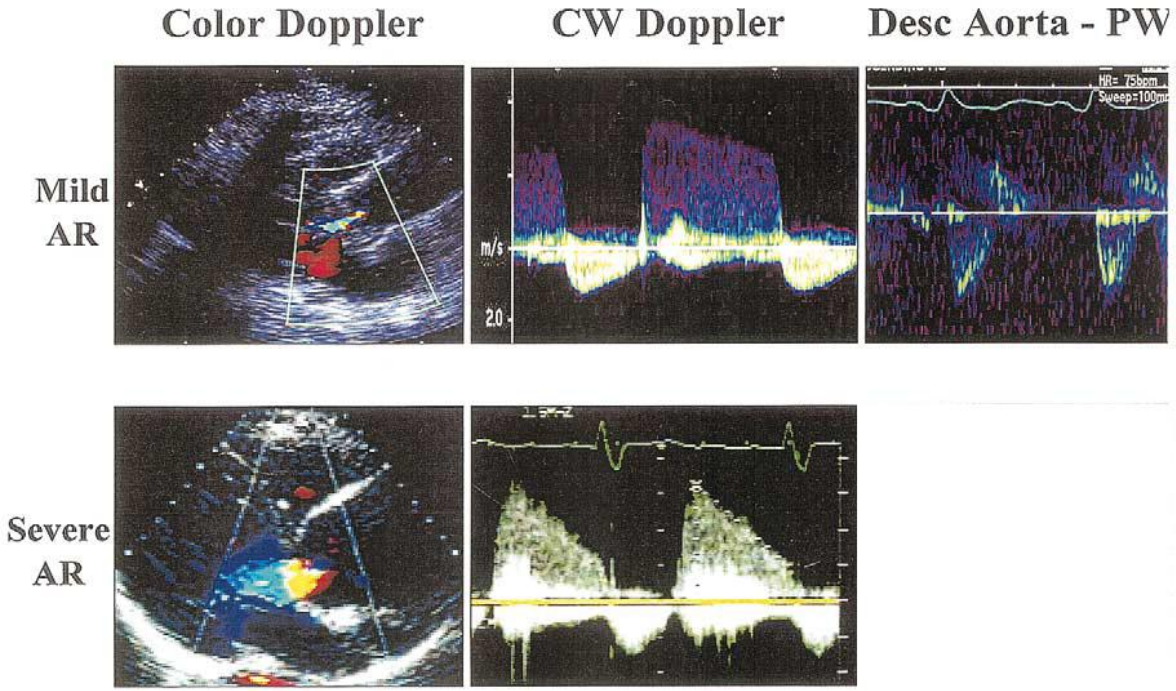



Pulmonary vein
PVs1
PVs2
PVd
PVa
RVOT
Abdominal Aorta
Hepatic Vein
S
D
S
D

Suprasternal View

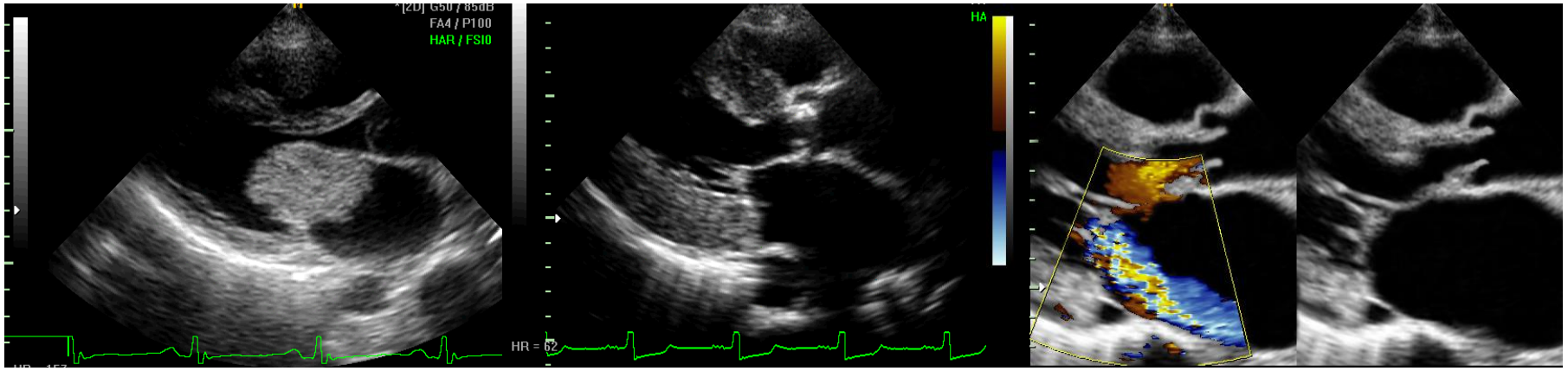


Suprasternal View- Descending Ao doppler



Basic & Advanced Measurements

Measurements and Calculation



Basic Measurements

-. Systolic function

-. Diastolic function

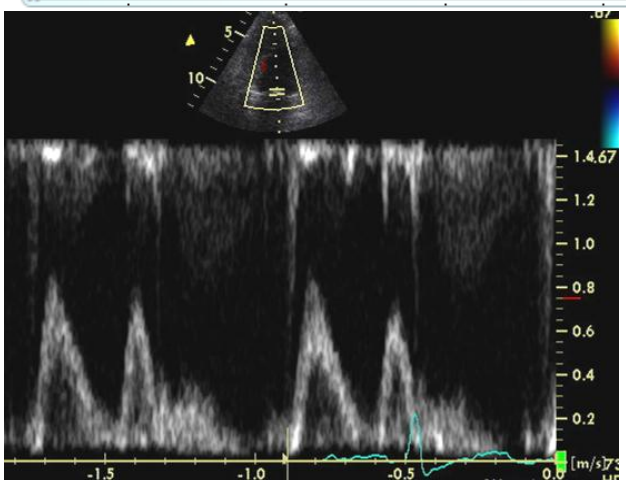
Advanced Measurements

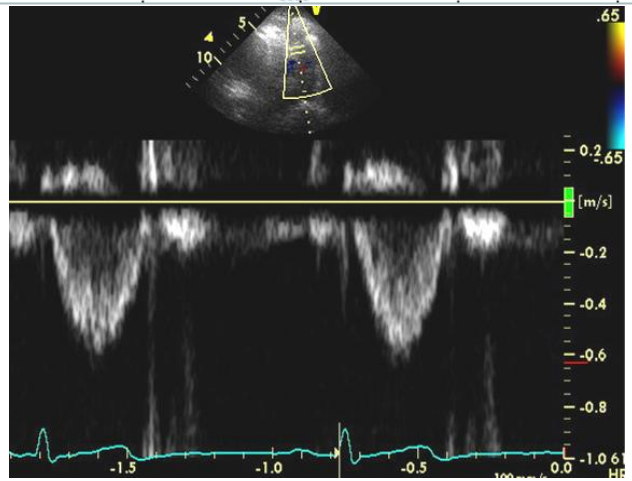
-. Valvular Function Evaluation
(PISA, Continuity Equation)

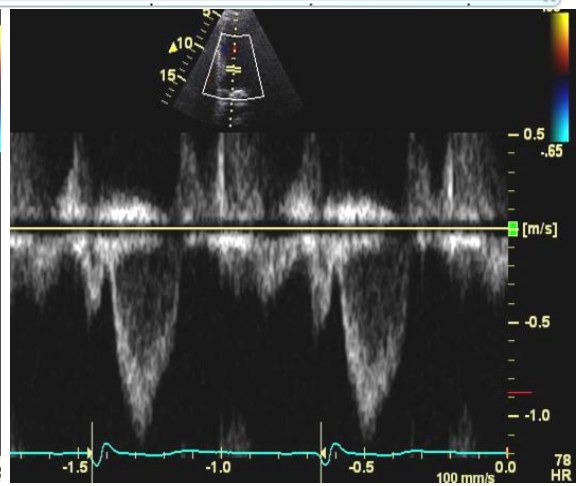
-. Shunt Study

Normal Values of Max. Blood Flow Velocities

	Mean	Range
Mitral inflow	0.90 m/s	0.6-1.3 m/s
Tricuspid inflow	0.50 m/s	0.3-0.7 m/s
RVOT flow	0.75 m/s	0.6-0.9 m/s
LVOT flow	0.90 m/s	0.7-1.1 m/s
AV flow	1.35 m/s	1.0-1.7 m/s







Measurements and Calculation

Basic Calculation

-. Bernoulli equation

Pressure Gradient= $4V^2$

Advanced Measurements

-. Continuity Equation

-. Valve area, Shunt Study

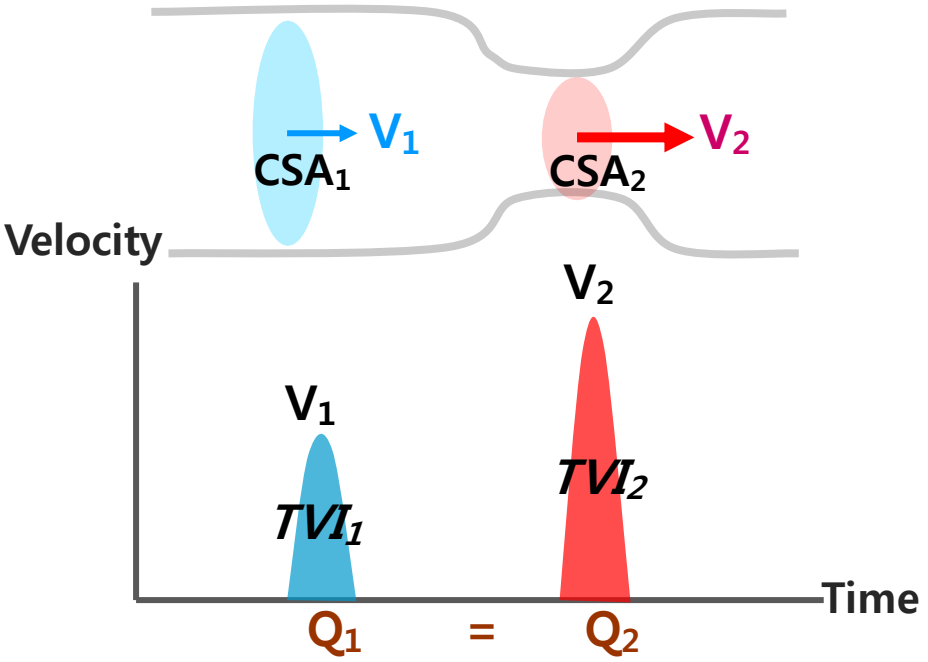
-. PISA method

Doppler Equation

$$\pm\Delta f = f_r - f_0$$

$$\Delta f = \frac{2 f_0 V \cos\theta}{C}$$

$$V = \frac{C \Delta f}{2 f_0 \cos\theta}$$



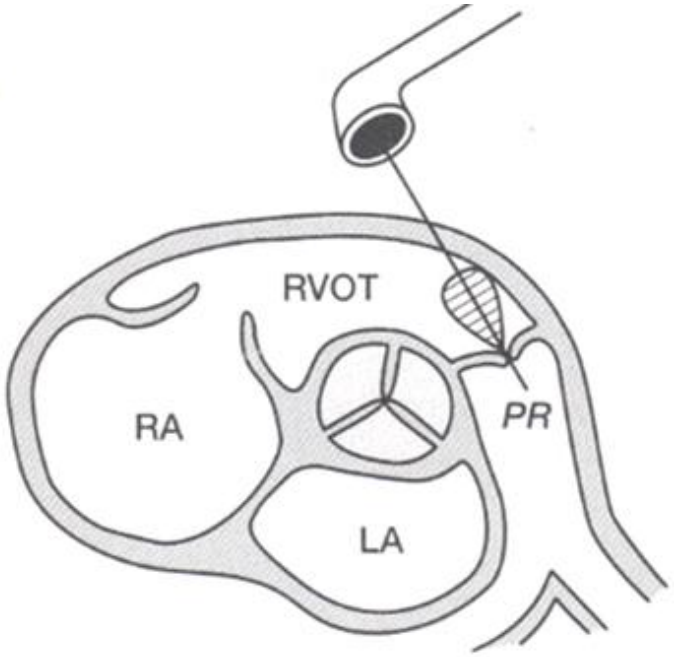
$CSA_1 \times TVI_1 = CSA_2 \times TVI_2$

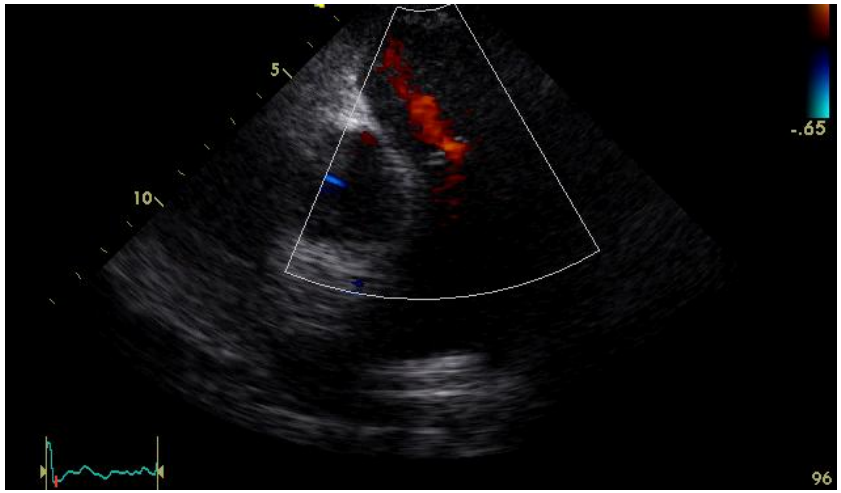
Pulmonary Artery Diastolic Pressure

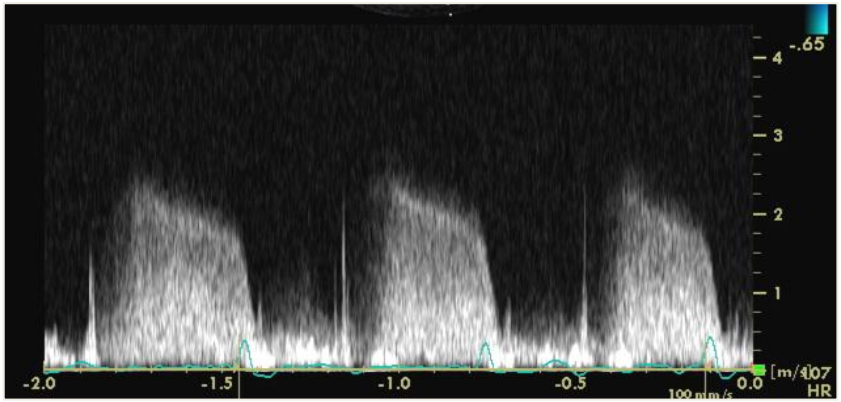
- **Mean PA pr= 4** $(V_{peak})^2$
- **PA end-diastolic pr**

  = 4 $(V_{ED})^2$ + RVEDP

  = 4 $(V_{ED})^2$ + RA pressure





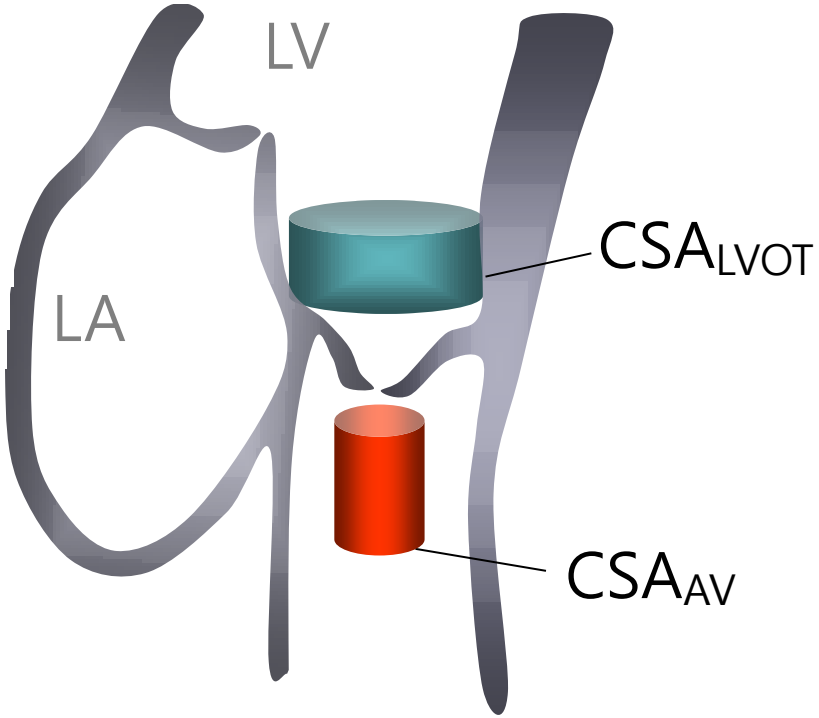


AVA by Continuity Equation

Continuity Equation

$$AV\ flow = LVOT\ flow$$

$$CSA_{AV} \times TVI_{AV} = CSA_{LVOT} \times TVI_{LVOT}$$

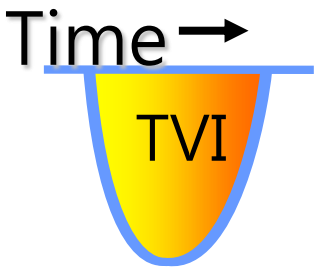


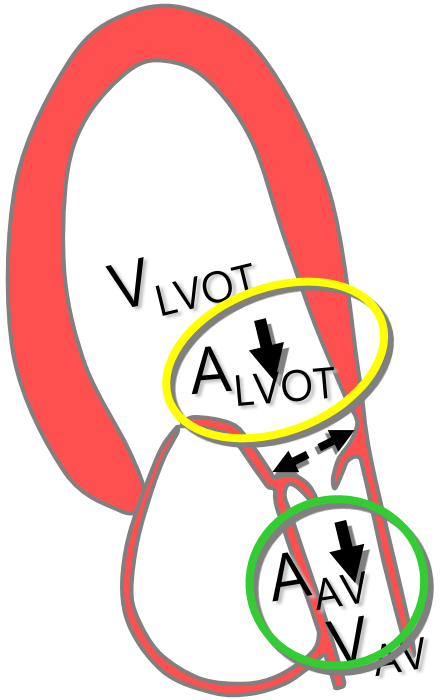
Advanced Measuments_Valvular Stenosis

Continuity Equation

- Continuity Equation is used to calculate
- 1) LVOT Diameter in PLAX
  2) VTI in LVOT(PW) in apical 5 chamber
  3) VTI in AV (CW) in apical 5 chamber

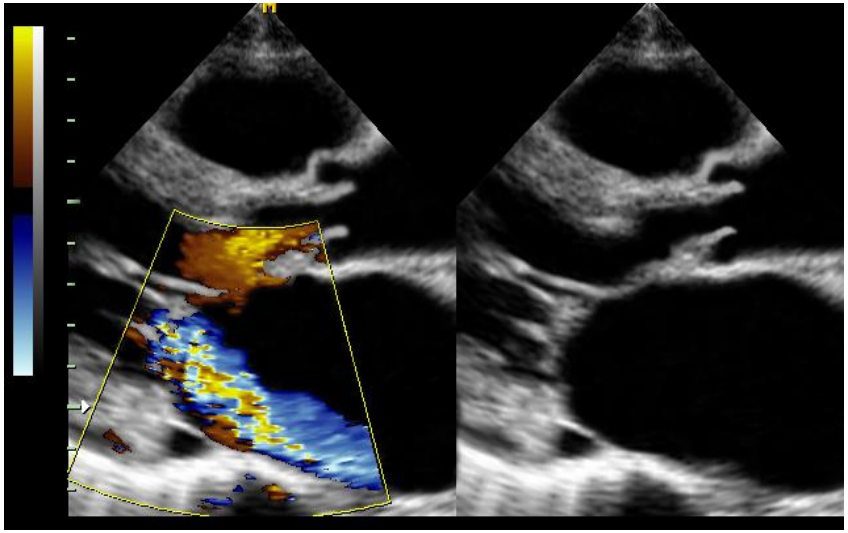
LVOT flow = AV flow





Advanced Measurement_Valvular Regurgitation

Regurgitant Volume Measurement



Semi-Quantitative method

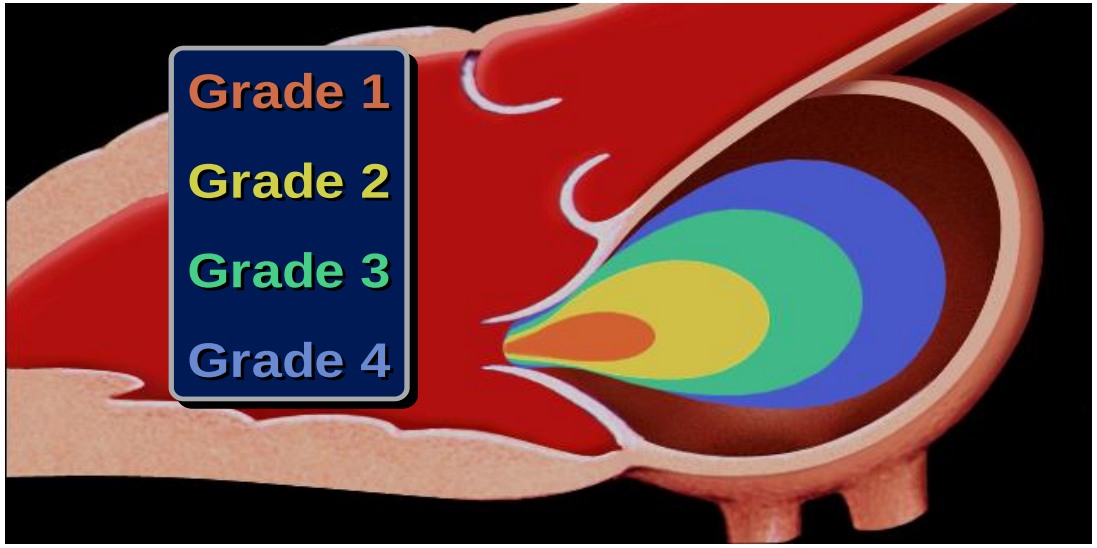
-. Color flow area mapping
-. Vena contracta width
-. CW signal intensity
-. Pulmonary venous flow
-. Peak mitral inflow velocity

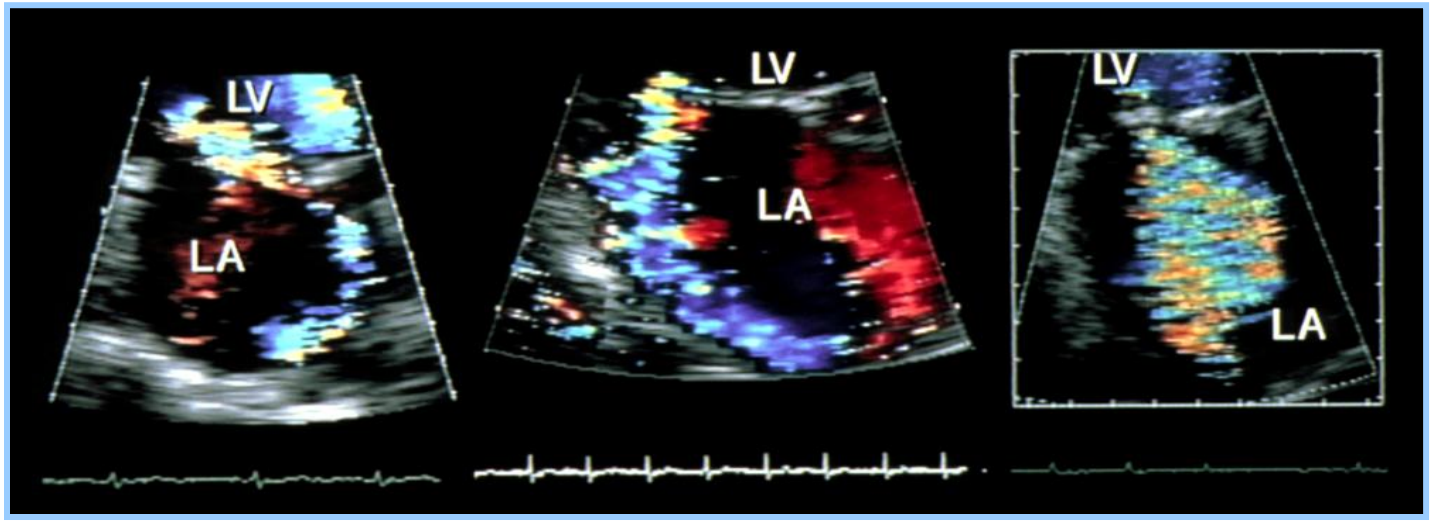
Quantitative Method

-. Volumetric method
-. PISA
-. Automated cardiac output method

Mitral Valve Regurgitation

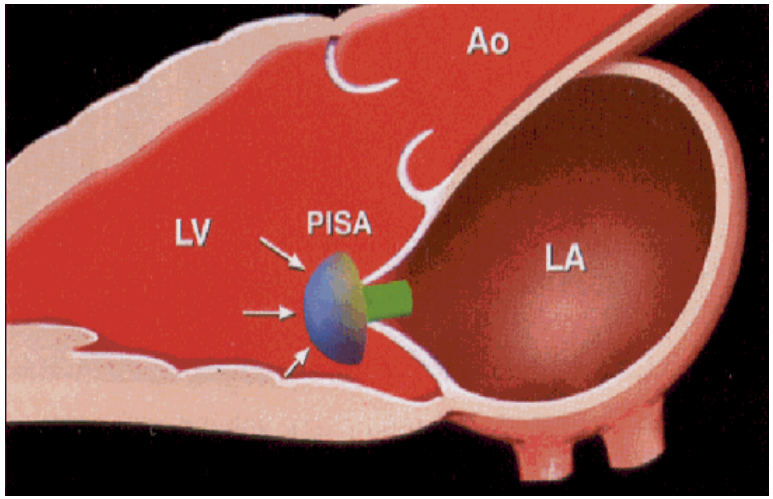
Semi-Quantitative Assessment
(Color flow mapping)





Regurgitation Volume by PISA

Quantitative Assessment



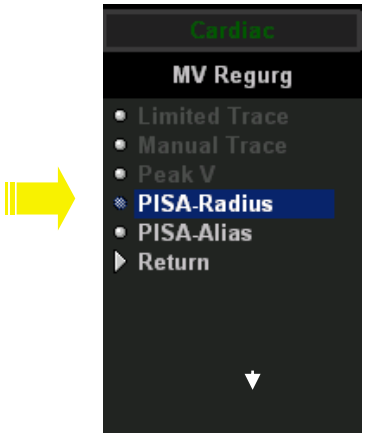
◦ **'MR flow = PISA flow'** (Proximal Isovelocity Surface Area)

◦ **ERO (Effective Regurgitant Orifice) x MR Velocity = 2 x π x R² x PISA Vel.**

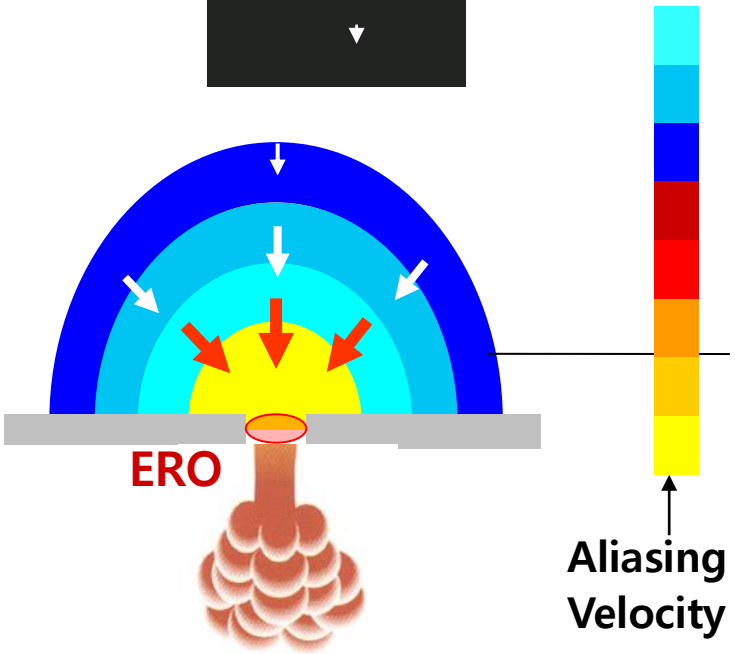
$$ERO \times MR\ Vel. = 2 \times \pi \times R^2 \times Alias\ Vel.$$

$$ERO = \frac{2 \times \pi \times R^2 \times Alias\ Vel.}{MR\ Vel.}$$

Regurgitation Volume by PISA



- Requirements : PISA radius
  Aliasing velocity
  MR Max Velocity, MR TVI
  >> ERO,
  (Effective Regurgitant orifice area)
  >>>Regurgitant Volume



PISA method

1. Optimize regurgitant flow→ Zoom up !!
2. Color flow baseline shift when aliasing velocity of 20~40cm/s is appeared
3. Measure PISA radius & select 'PISA(MR)- aliasing Vel'
4. Measure MR VTI with V max by CW

Regurgitation Volume by PISA