

GUIDELINES AND STANDARDS

Guidelines for the Echocardiographic
Assessment of the Right Heart in Adults and
Special Considerations in Pulmonary
Hypertension: Recommendations from the
American Society of Echocardiography

GUIDELINES AND STANDARDS

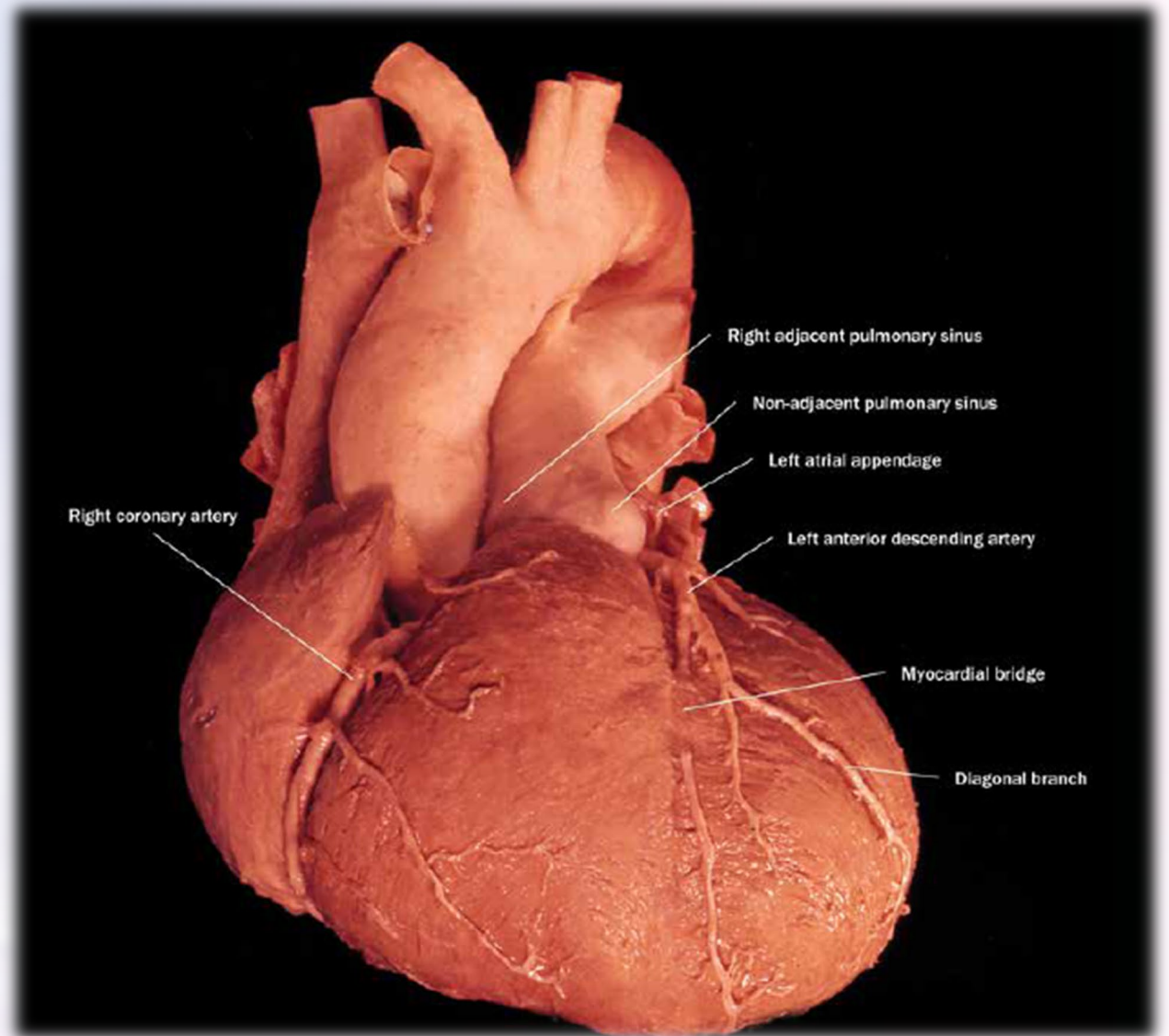
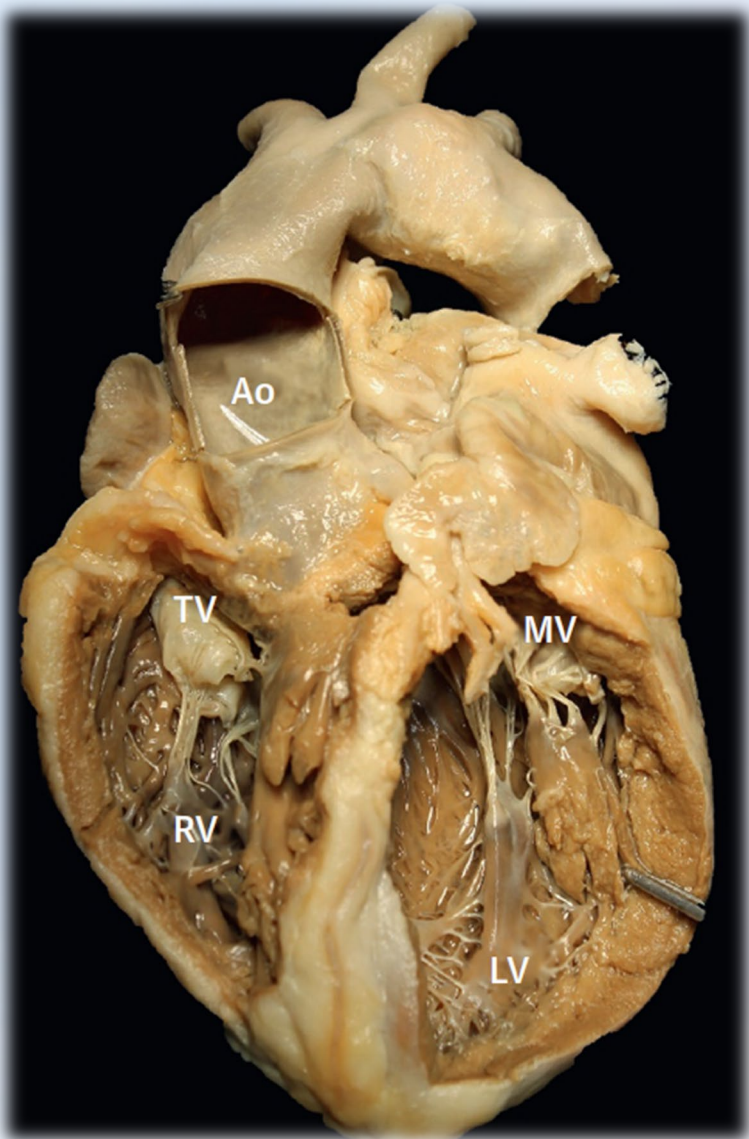
Recommendations for Cardiac Chamber
Quantification by Echocardiography in Adults:
An Update from the American Society
of Echocardiography and the European Association
of Cardiovascular Imaging

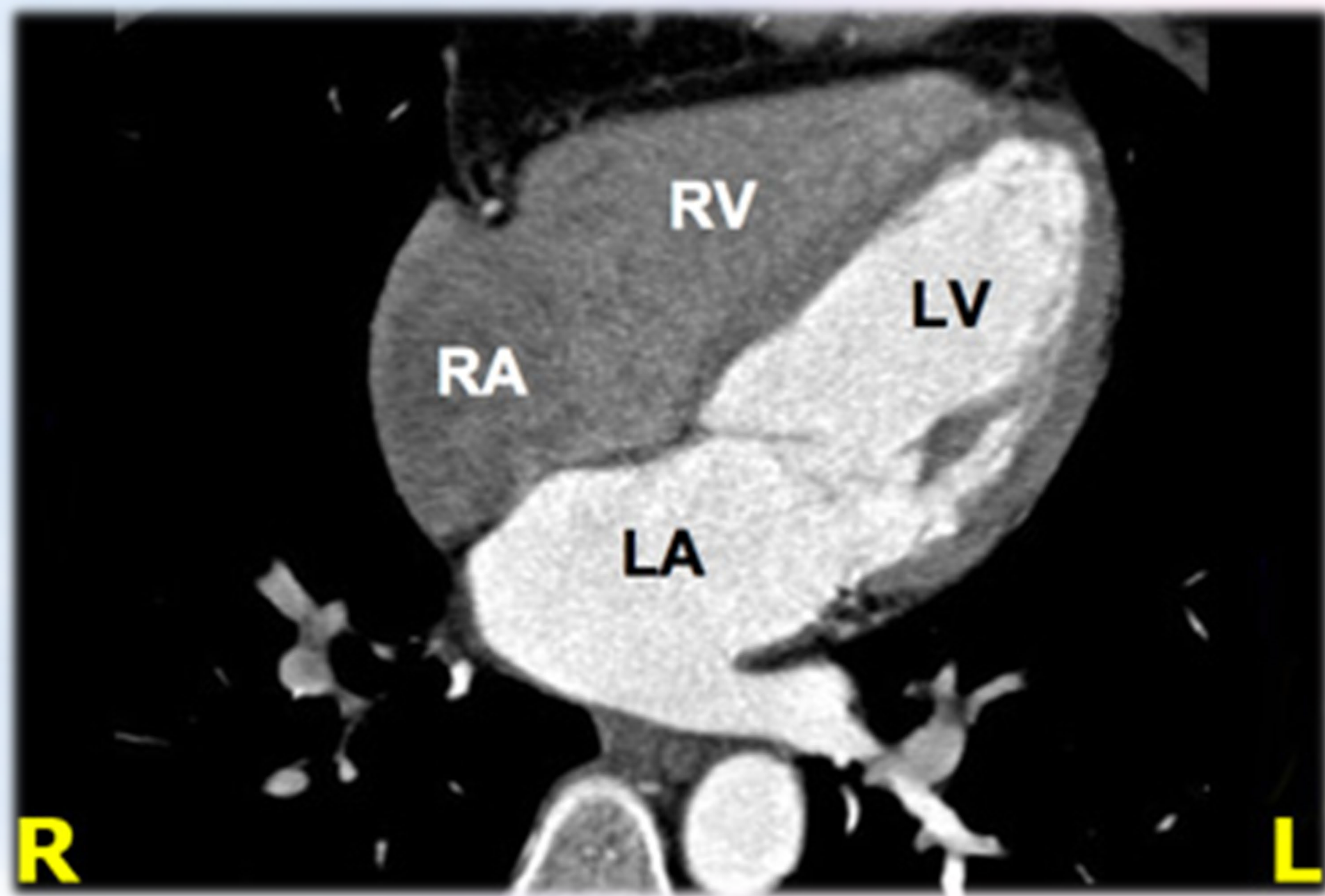
Assessment of LV and RV Function

Mw Chan
Cardiologist HSIS

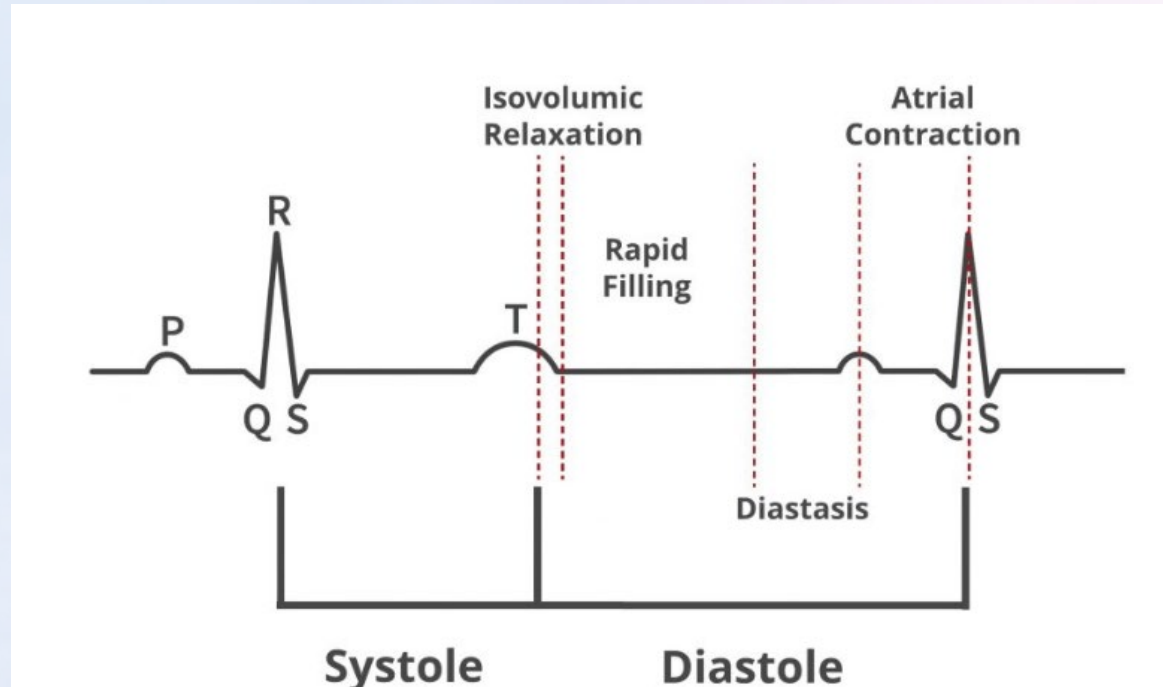
A little bit of anatomy

Vertical Vs Anatomic position of the heart





A little bit about cardiac cycle



- **End diastole (Onset of QRS)** : defined as the first frame **after mitral valve closure** or the frame in the cardiac cycle in which the respective LV dimension or volume measurement is **the largest**
- **End-systole (End of T)** : defined as the frame after **aortic valve closure** or the frame in which the cardiac dimension or volume **is smallest**.

REPORTING for LV function

1. LV size

- LVIDd and LVIDs
- LV wall thickness (concentric /eccentric hypertrophy)
- EDV (index) , ESV (index)

2. Comment on LV systolic function

- LVEF (Biplane simpson's)

3. Regional Function

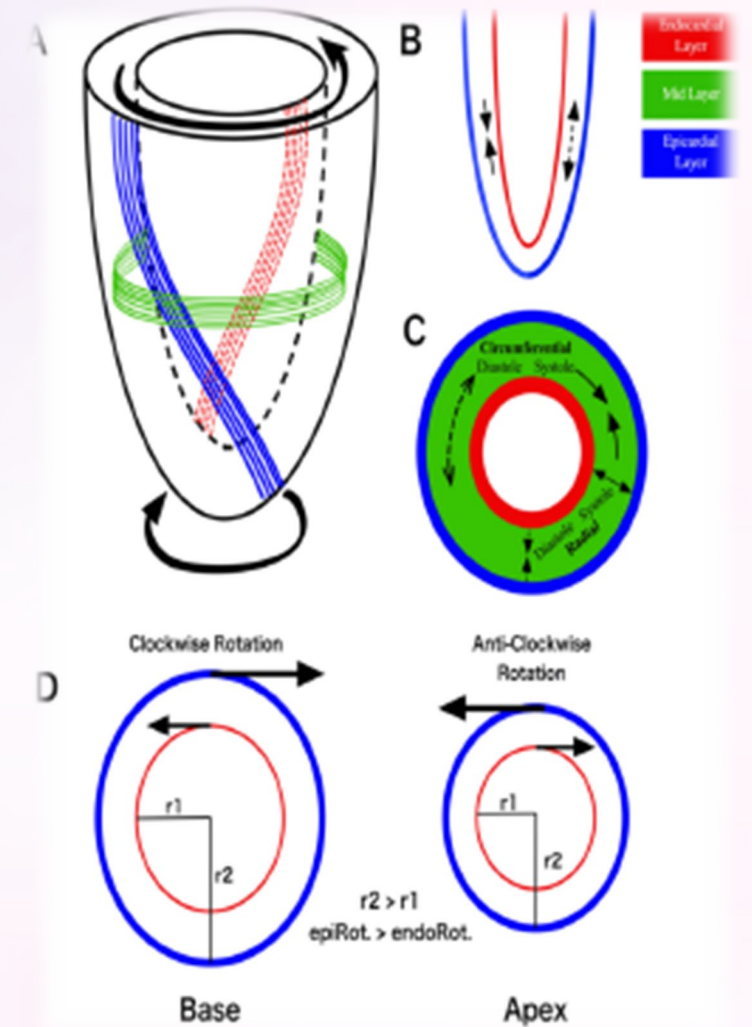
- Presence/absence of RWMA

4. 2D speckle strain for HOCM, CMP, Amyloidosis

5. Any associated valve lesions ,Shunts, Clots, Spontaneous echo contrasts

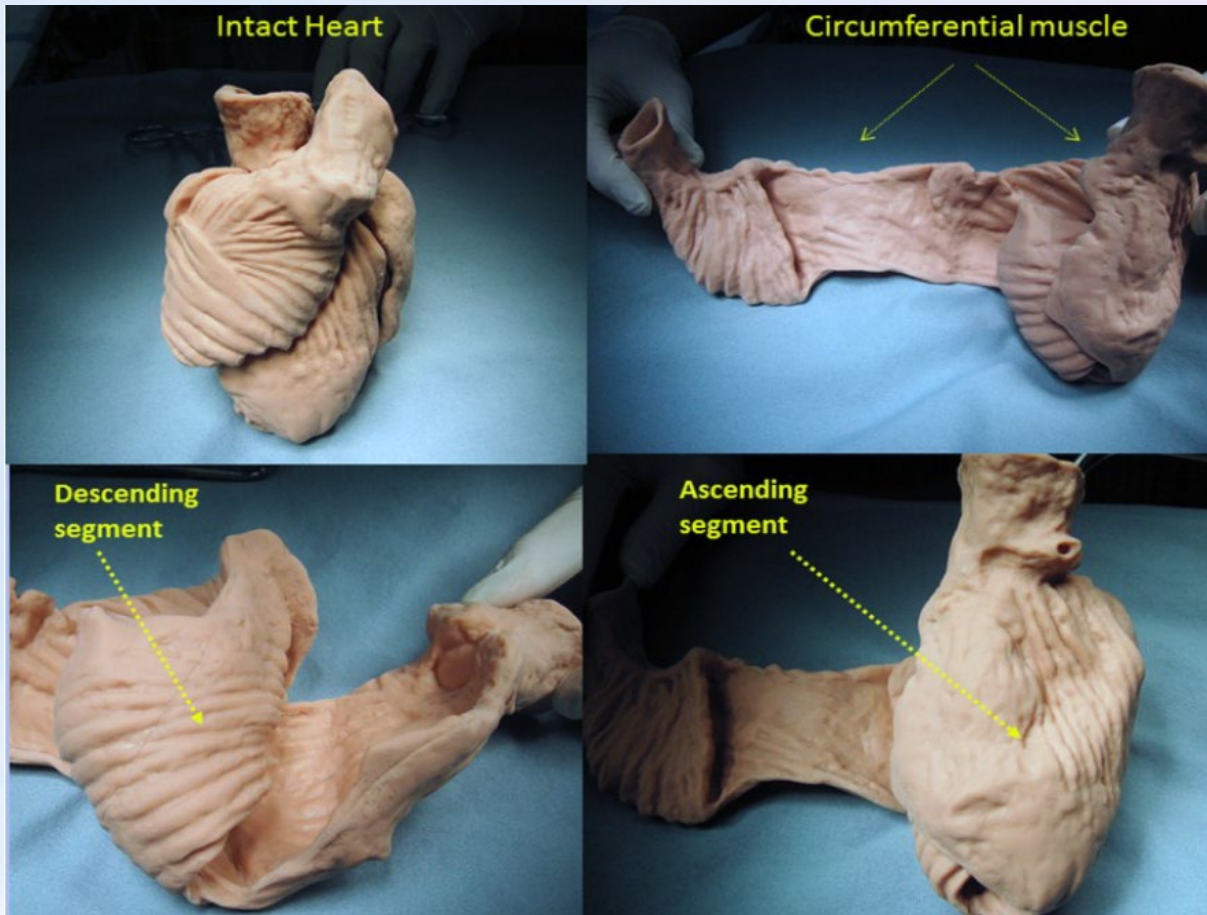
6. Diastolic Function

Left Ventricle Systolic Function



Myocardium

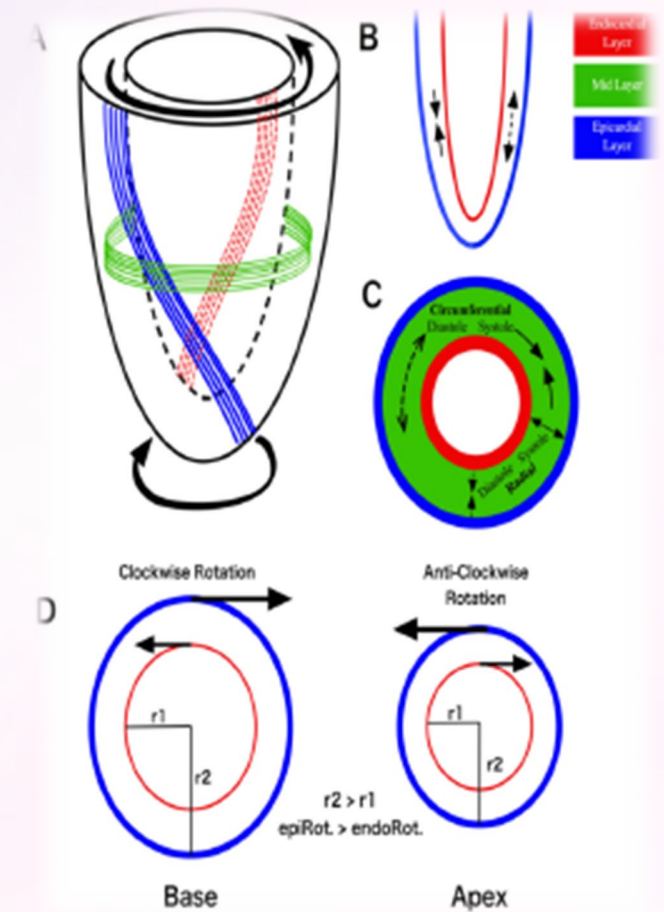
- Cardiac muscle mass is formed by the **helix and circumferential wrap** - the “wrap” and “helical architectural” configuration explains the heart’s mechanical actions



The heart’s functional counterpart involves six movements: **narrowing, shortening, lengthening, widening, twisting, and uncoiling.**

LV Global Systolic Function

- Involves a **complex process** with a coordinated contraction of all muscle fibres.
- Midwall fibers oriented **circumferentially**
 - contraction contribute to decrease in minor axis of LV to generate stroke volume.
- Subendocardial and subepicardial fibers are oriented **longitudinally**
 - shortens in systole to generate SV
- Apex **rotates** counter-clockwise and the base of the heart rotates clockwise
- These **shortening** ,“**twisting**” like motion and wall **thickening** contributes to volume displacement and generation of stroke volume.



How to assess LV Systolic Function ?

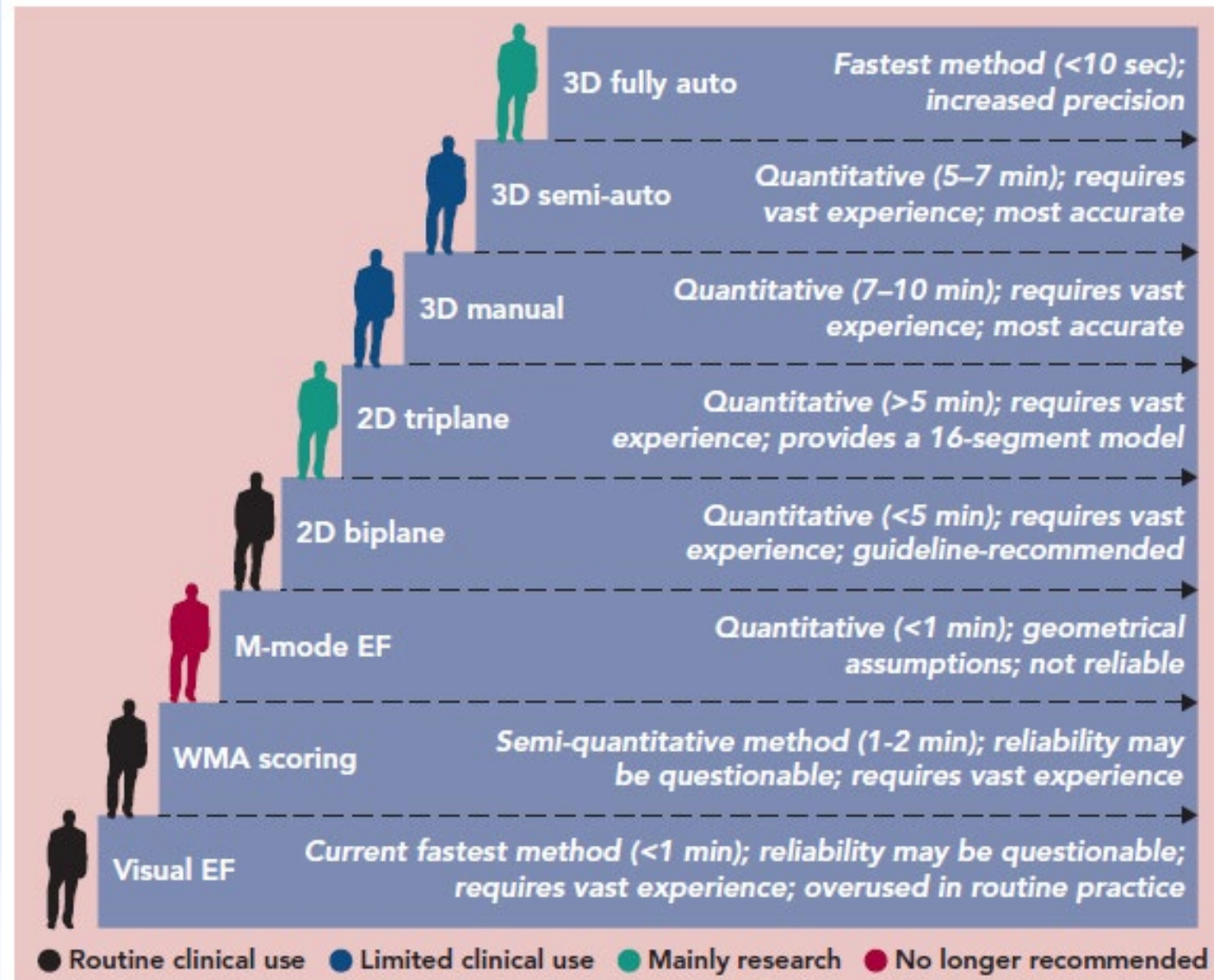
Myocardial deformation	Volume change	Isovolumic indices	Ejection phase indices
• Vcf • Isovolumic acceleration • dP/dt • Tissue Doppler • Strain • Strain rate • Torsion • Twist	• Shortening fraction • Stroke volume • LVEF • Stroke work • Elastance (End systolic pressure-volume relation)	• dP/ dt • Emax	• Area change • Myocardial Performance Index (MPI, Teiindex) • Fractional shortening • Velocity of circumferential fiber shortening (Vcf) • LVEF

LV Systolic Function (Clinical Use)

LV Systolic Function	Methods
LVEF 	Linear measurement (Teicholz / Quinones) 2D Volumetric (Biplane Simpson's / Area Length method) 3D volume
Fractional shortening	by M-Mode / linear measurement
Mitral E point septal separation (EPSS)	- By M-Mode - Distance between the posterior point of IVS and the E point of AMVL during systole
Mitral annular plane systolic excursion (MAPSE)	- Longitudinal function - M-Mode to measure mitral annular excursion distance
LV dp/dt	- Need MR jet - Rate LV pressure rise during isovolumic contraction phase
S' wave	Longitudinal LV systolic function by TDI
Global longitudinal strain 	Speckle tracking

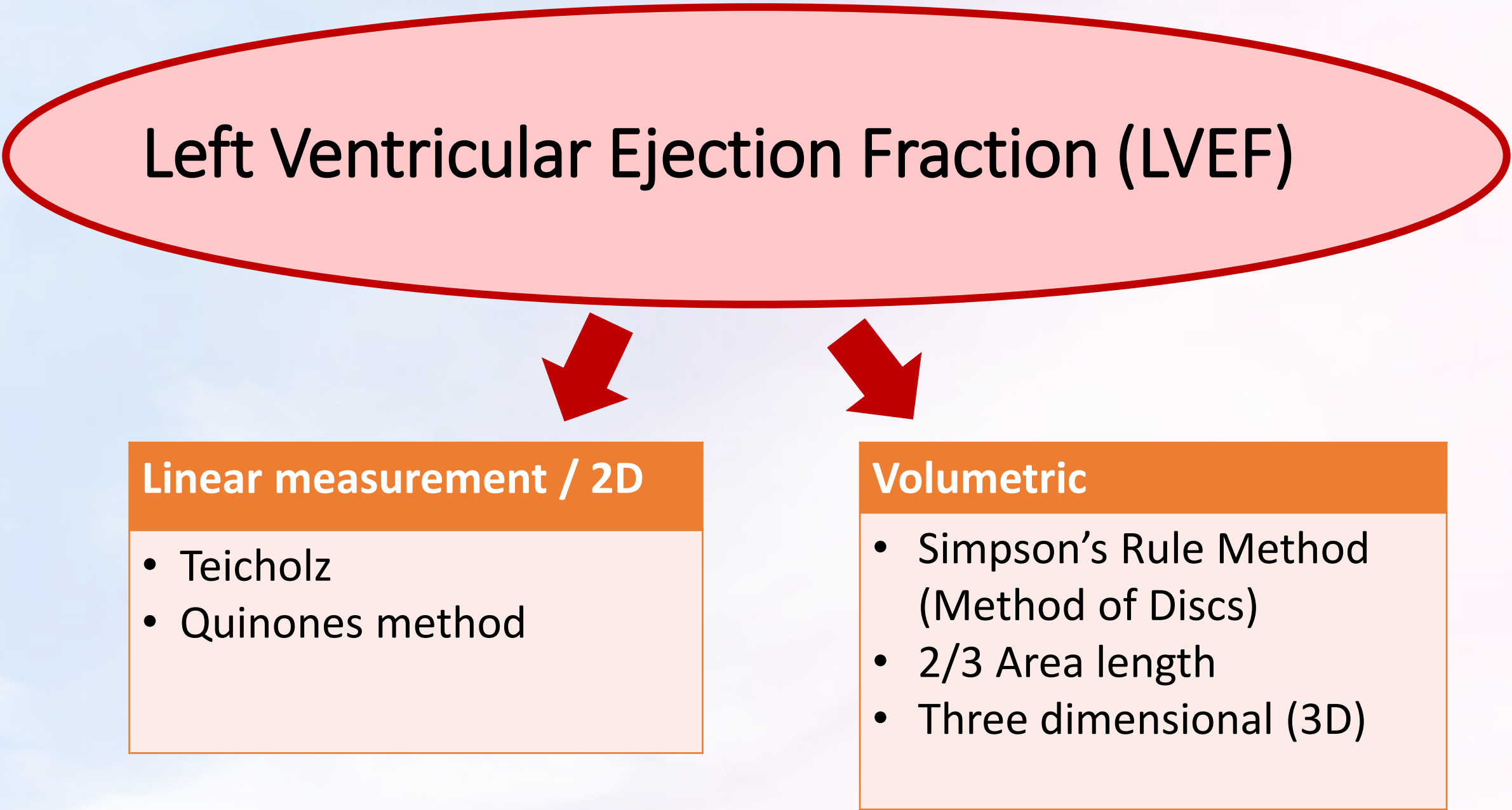
Left Ventricular Ejection Fraction (LVEF)

Figure 3: Stairway of Echocardiographic Methods for the Assessment of Left Ventricular Ejection Fraction



EF = ejection fraction; M-mode = mono-dimensional; WMA = wall motion abnormalities.

Left Ventricular Ejection Fraction (LVEF)



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graph TD; A([Left Ventricular Ejection Fraction (LVEF)]) --> B[Linear measurement / 2D]; A --> C[Volumetric]; B --> B1[• Teicholz]; B --> B2[• Quinones method]; C --> C1[• Simpson's Rule Method (Method of Discs)]; C --> C2[• 2/3 Area length]; C --> C3[• Three dimensional (3D)];
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Linear measurement / 2D

- Teicholz
- Quinones method

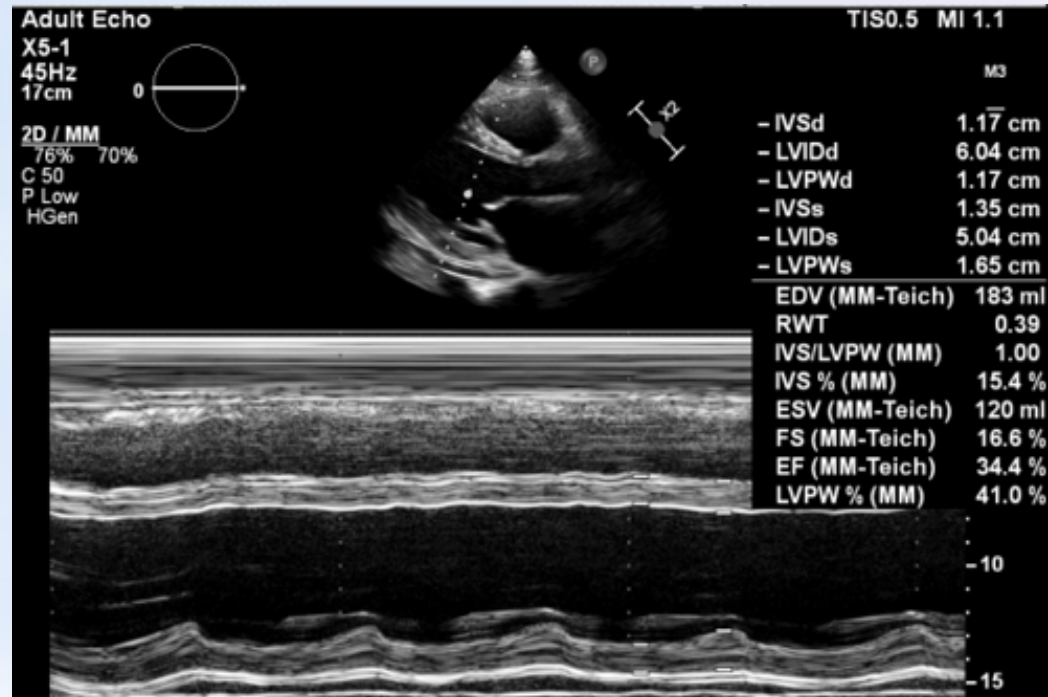
Volumetric

- Simpson's Rule Method (Method of Discs)
- 2/3 Area length
- Three dimensional (3D)

LV Global Systolic Function



1. Fractional shortening – by M-Mode / linear measurement
2. LVEF by linear measurement – Teicholz / Quinones method



LIMITATIONS:

- RWMA
- Geometric assumptions

LVEF by Linear Measurement



QUIÑONES

$$EF (\%) = \frac{LVEDD^2 - LVESD^2}{LVEDD^2} + \text{Apical Factor}$$

Apical Factor

- Normal apex = + 10%
- Hypokinetic apex = + 5%
- Akinetic apex = 0
- Dyskinetic apex = -5%
- Apical aneurysm = -10%

Teichholz

$$V_d = [7 / (2.4 + LVID_d)] \times LVID_d^3$$

$$V_s = [7 / (2.4 + LVID_s)] \times LVID_s^3$$

$$LVEF = (V_d - V_s) / V_d$$



Guidelines recommend against using linear methods to derive LV volumes

LV Global Systolic Function



3. Modified Simpson method (biplane method of disks)

The American Society of Echocardiography recommends this method for measuring LVEF.

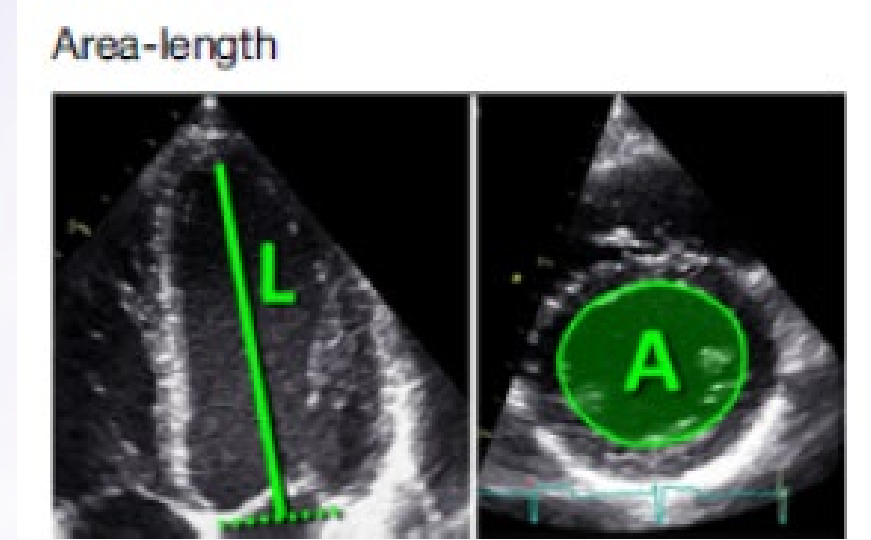
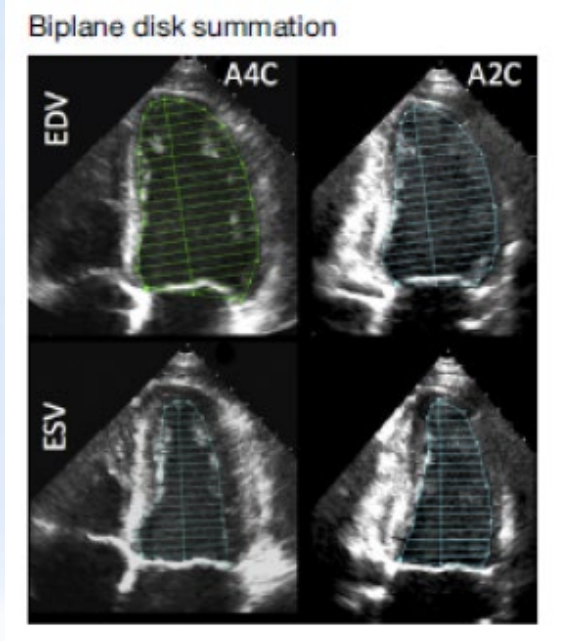
4. 3D volume LVEF

5. Global longitudinal strain (new parameter)

ASE Best Practice : LVEF should be calculated from LV volumes



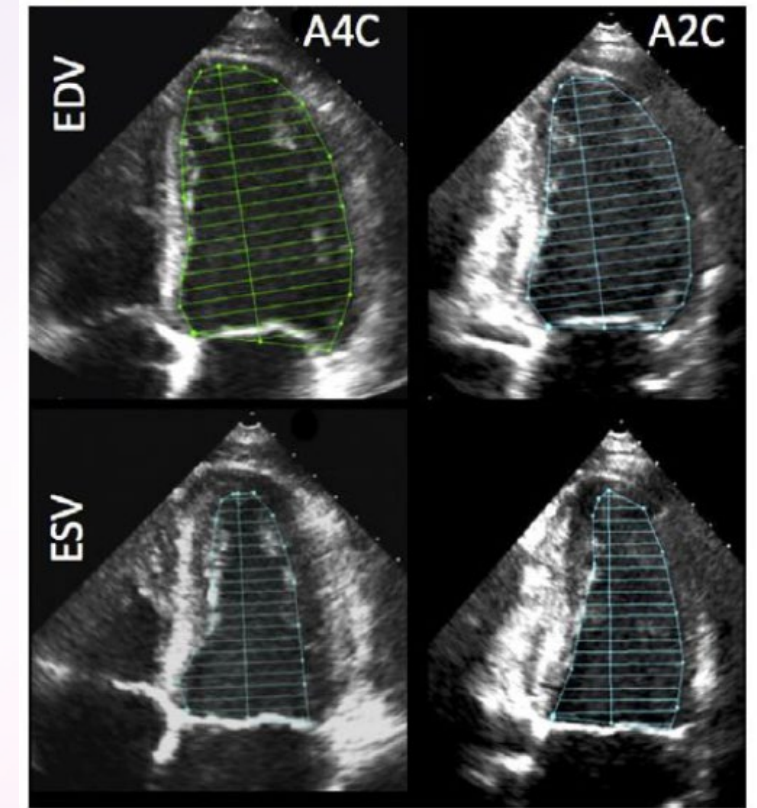
1. **Modified Simpson method (biplane method of disks)** >> preferred technique
2. Area-length method - when u can't appreciate endocardial border



1.Modified Simpson method (biplane method of disks)

- **Apical 4- and 2-chamber views (LV focused view)** tracing the endocardial (between the compacted myocardium and the cavity) at **end-diastole and end-systole** on images with **clear endocardial border definition**.
- Papillary muscles should be excluded from the cavity tracing.
- Maximize LV area and avoid foreshortening.
- 4C and 2C lengths should be within 10% of each other, otherwise suggests foreshortening
- When approaching the MV plane, the contour is closed by connecting the two opposite sections of the MV ring with a straight line.

Biplane disk summation

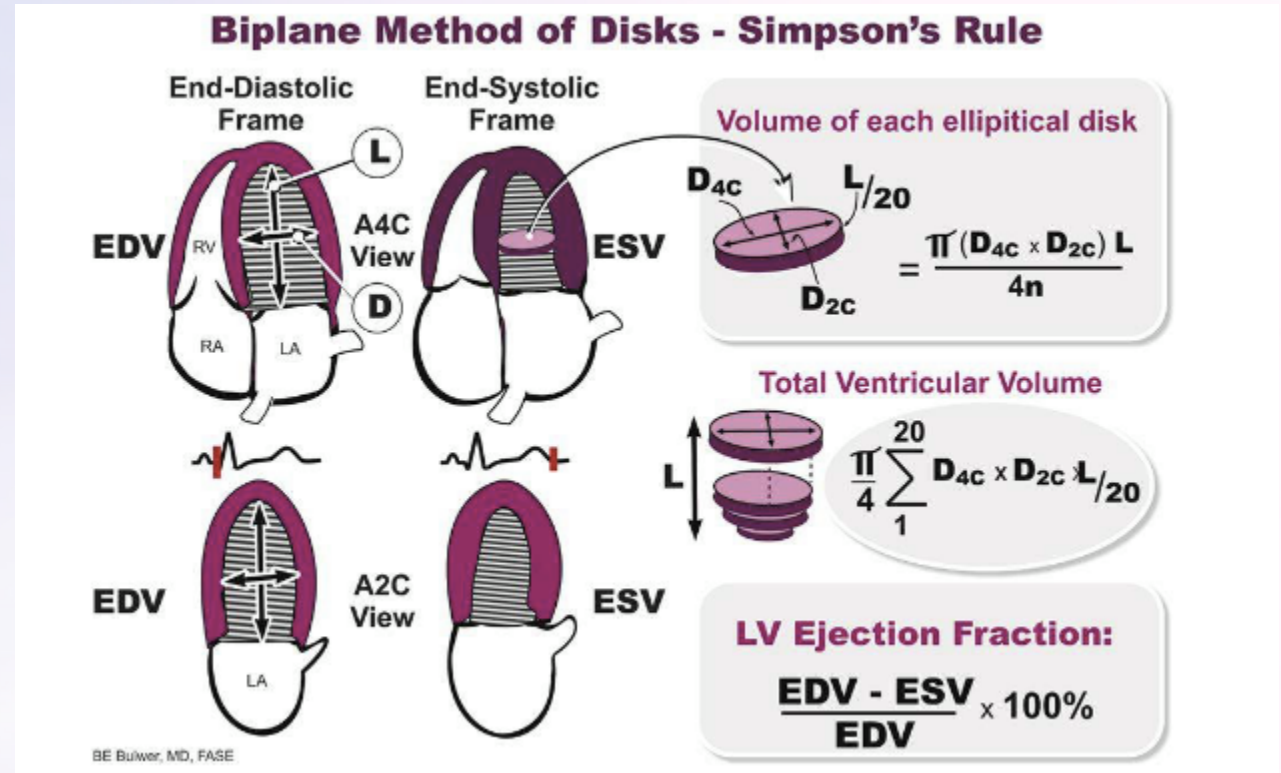


$$EF = \frac{(EDV - ESV)}{EDV} \times 100\%$$

1. Modified Simpson method (biplane method of disks)

How we get the calculation ?

- The left ventricle is considered the **sum of a cylinder** (from the base of the heart to the mitral valve), a truncated cone (from the level of the mitral valve to the level of the papillary muscles), and another cone attributed to the cardiac apex.
- These three sections were **assumed to be of equal height**.



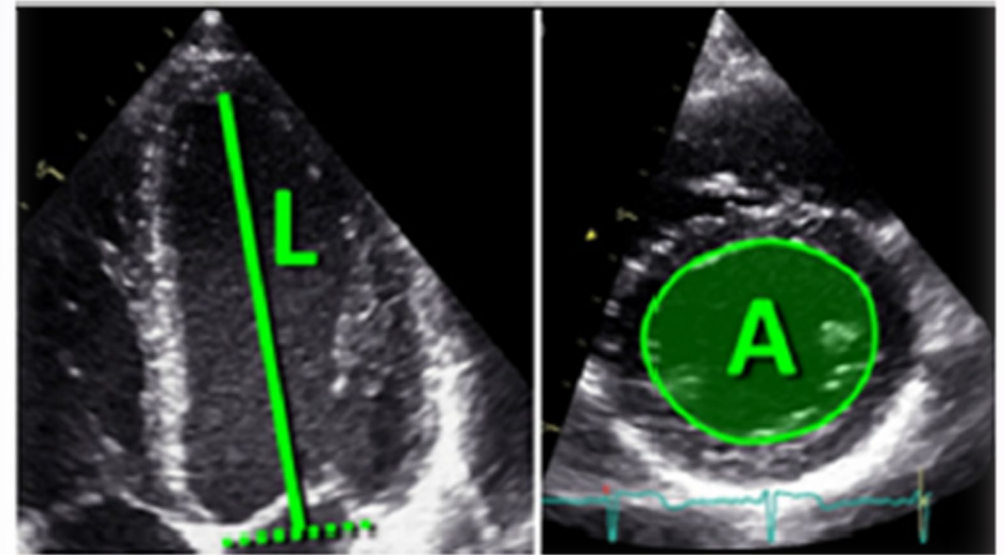
- MEN $\geq 52\%$
- Female $\geq 54\%$

$$Volume = \frac{\pi}{4} \sum_{i=0}^n (a_i \times b_i \times \frac{l}{n})$$

2. Area-length method

- Cross-sectional area of mid-LV measured by planimetry in PSAX and length measured in apical 4C view from mid-mitral annular plane to LV apex.
- **Assumes a bullet-shaped LV**
- Reasonable alternative to modified Simpson's **if poor apical endocardial definition**

Area-length



However :
Limited published data on normal population.
Heavily based on geometrical assumption

Table 2 Normal values for 2D echocardiographic parameters of LV size and function according to gender

Parameter	Male		Female	
	Mean $\pm$ SD	2-SD range	Mean $\pm$ SD	2-SD range
LV internal dimension				
Diastolic dimension (mm)	50.2 $\pm$ 4.1	42.0–58.4	45.0 $\pm$ 3.6	37.8–52.2
Systolic dimension (mm)	32.4 $\pm$ 3.7	25.0–39.8	28.2 $\pm$ 3.3	21.6–34.8
LV volumes (biplane)				
LV EDV (mL)	106 $\pm$ 22	62–150	76 $\pm$ 15	46–106
LV ESV (mL)	41 $\pm$ 10	21–61	28 $\pm$ 7	14–42
LV volumes normalized by BSA				
LV EDV (mL/m ²)	54 $\pm$ 10	34–74	45 $\pm$ 8	29–61
LV ESV (mL/m ²)	21 $\pm$ 5	11–31	16 $\pm$ 4	8–24
LV EF (biplane)	62 $\pm$ 5	52–72	64 $\pm$ 5	54–74

BSA, body surface area; EDV, end-diastolic volume; EF, ejection fraction; ESV, end-systolic volume; LV, left ventricular; SD, standard deviation.

Table 4 Normal ranges and severity partition cutoff values for 2DE-derived LV EF and LA volume

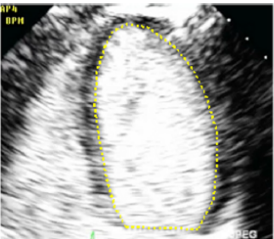
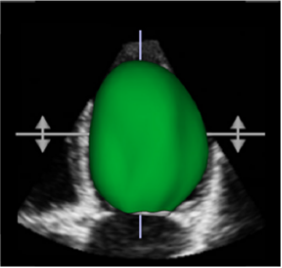
	Male				Female			
	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV EF (%)	52–72	41–51	30–40	<30	54–74	41–53	30–40	<30
Maximum LA volume/BSA (mL/m ²)	16–34	35–41	42–48	>48	16–34	35–41	42–48	>48

Pitfalls in 2D LVEF

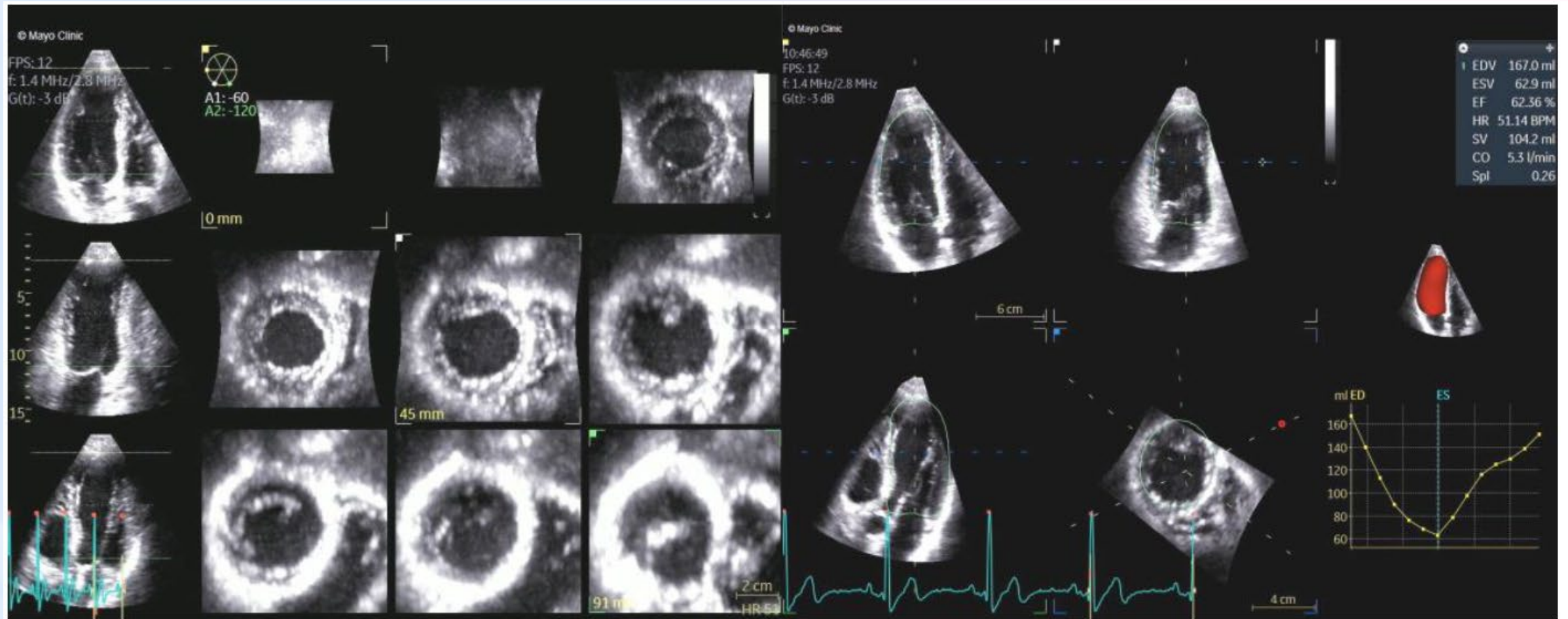
- Assuming a geometric shape of the LV
- Assuming the length of 4C and 2C length as same .
- MOD assumes elliptical shape of each disc
- MOD requires accurate delineation of endocardial borders
- MOD over-weights the size and motion of the LV from 2 apical views
- Reduced accuracy in remodeled LV, states with abnormal septal motion, focal RWMA, foreshortened

- Solutions

- Ultrasound Enhancing Agents (aka Contrast)
- 3D LV echo

Technique	Advantages	Limitations
Endocardial border enhancement 	• Helpful in patients with suboptimal acoustic window • Provides volumes that are closer to those measured with cardiac magnetic resonance	• Same limitations as the above non-contrast 2D techniques • Acoustic shadowing in LV basal segments with excess contrast
3D data sets 	• No geometrical assumption • Unaffected by foreshortening • More accurate and reproducible compared to other imaging modalities	• Lower temporal resolution • Less published data on normal values • Image quality dependent

3D LV volume



3D normal Values

- Volumes larger than 2D
- EF range different

Table 3 Normal values for LV parameters obtained with 3DE

	Aune <i>et al.</i> (2010)	Fukuda <i>et al.</i> (2012)	Chahal <i>et al.</i> (2012)	Muraru <i>et al.</i> (2013)
Number of subjects	166	410	978	226
Ethnic makeup of population	Scandinavian	Japanese	51% European white, 49% Asian Indian	White European
EDVi (mL/m ²)				
Men, mean (LLN, ULN)	66 (46, 86)	50 (26, 74)	White: 49 (31, 67); Indian: 41 (23, 59)	63 (41, 85)
Women, mean (LLN, ULN)	58 (42, 74)	46 (28, 64)	White: 42 (26, 58); Indian: 39 (23, 55)	56 (40, 78)
ESVi (mL/m ²)				
Men, mean (LLN, ULN)	29 (17, 41)	19 (9, 29)	White: 19 (9, 29); Indian: 16 (6, 26)	24 (14, 34)
Women, mean (LLN, ULN)	23 (13, 33)	17 (9, 25)	White: 16 (8, 24); Indian: 15 (7, 23)	20 (12, 28)
EF (%)				
Men, mean (LLN, ULN)	57 (49, 65)	61 (53, 69)	White: 61 (49, 73); Indian: 62 (52, 72)	62 (54, 70)
Women, mean (LLN, ULN)	61 (49, 73)	63 (55, 71)	White: 62 (52, 72); Indian: 62 (52, 72)	65 (57, 73)

EDVi, LV EDV index; ESVi, LV ESV index; LLN, lower limit of normal; NR, not reported; RT3DTTE, real-time 3D TTE; SVi, LV stroke volume index; ULN, upper limit of normal.

Modified with permission from Bhawe *et al.*¹³ LLN and ULN are defined as mean $\pm$ 2 SDs.

3D LVEF

Limitations:

- Image quality
- Rhythm (use single beat capture)
- Lower temporal resolution than 2D
- Less published data for normal values

Advantages :

- Better precision than 2D especially in asymmetric LV
- Can pick up subtle differences on serial studies
- Follow course of a disease

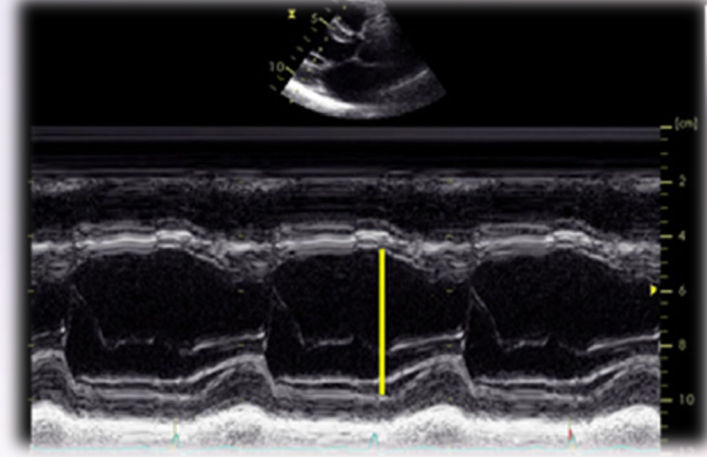
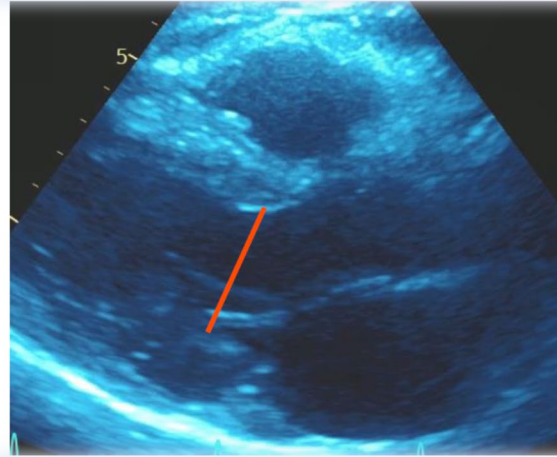
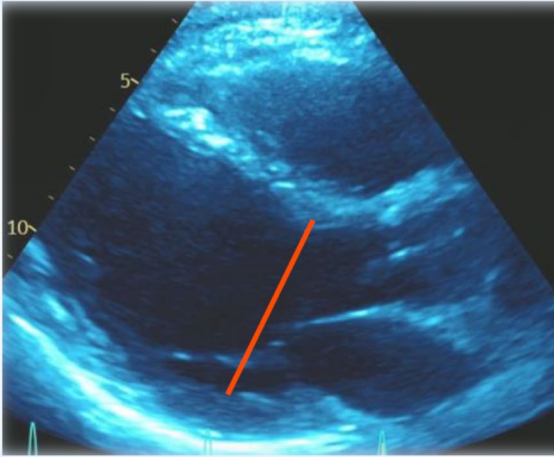
NOT geometric assumptions !

Less variable because the entire LV cavity is detected.

LV SIZE

1. Diameter (2D LINEAR MEASUREMENTS)
2. Volume (2D VOLUMETRIC MEASUREMENTS)

2D LINEAR MEASUREMENTS for LV SIZE

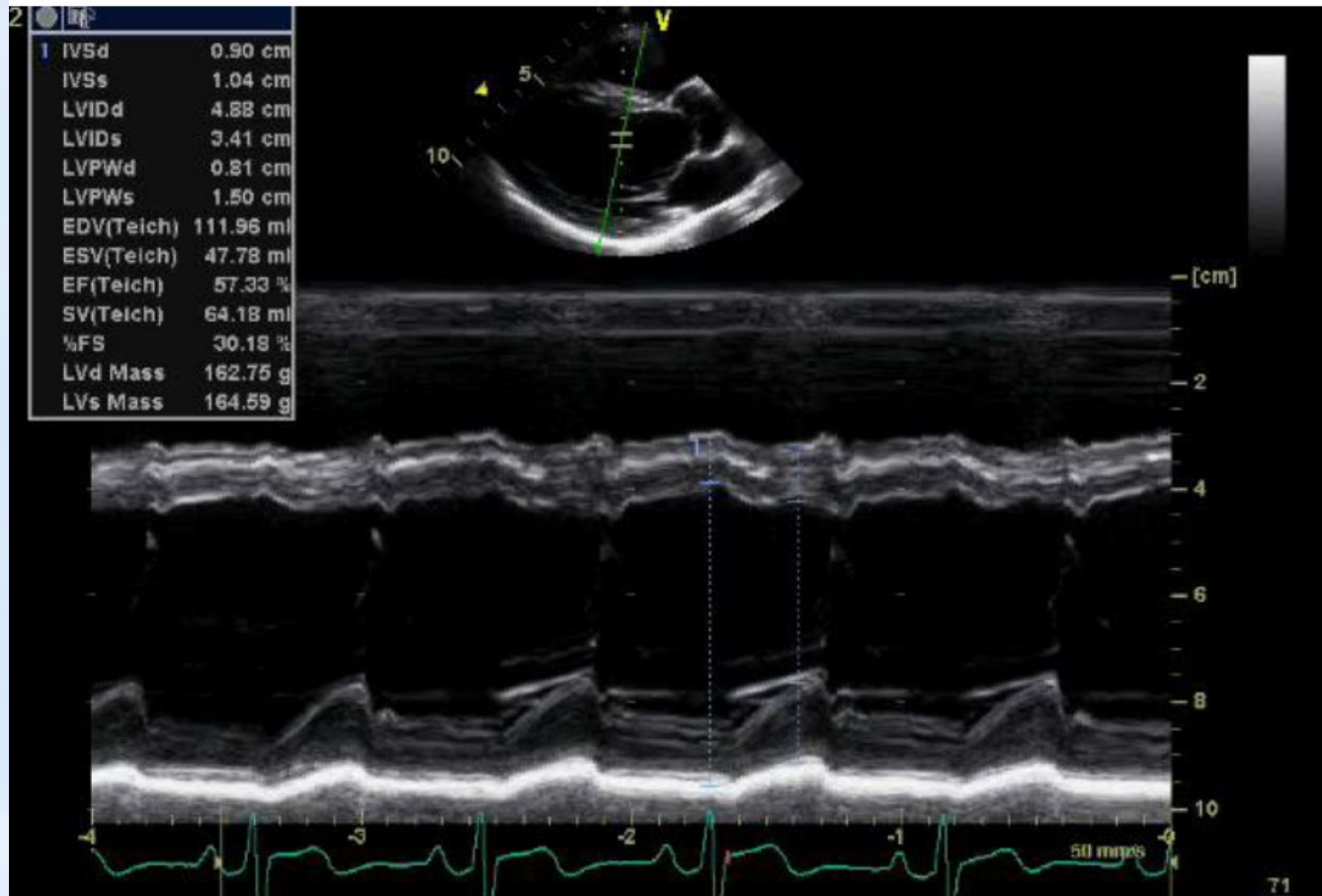


- Performed in **PLAX** and **perpendicular** to the long-axis of the left ventricle
- Measurements performed at **end-systole** and **end-diastole**
- LV internal measurements taken at the level of the mitral leaflet tips (ASE) or just below leaflet tips

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2D LINEAR MEASUREMENTS for LV Volume



- Left ventricular volumetric calculations by 2D linear measurements rely upon **geometric assumption of a fixed prolate ellipsoid**
- LV volumes derived by 2D linear dimensions (Teichholz and Quiñones) not recommended for clinical use

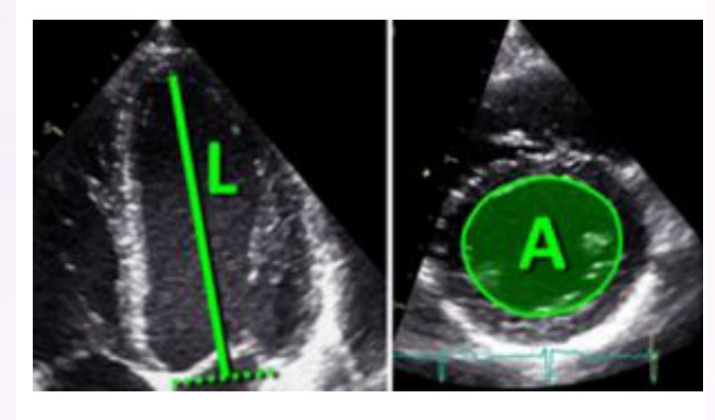


MEASUREMENT OF LEFT VENTRICULAR SIZE

2D VOLUMETRIC MEASUREMENTS

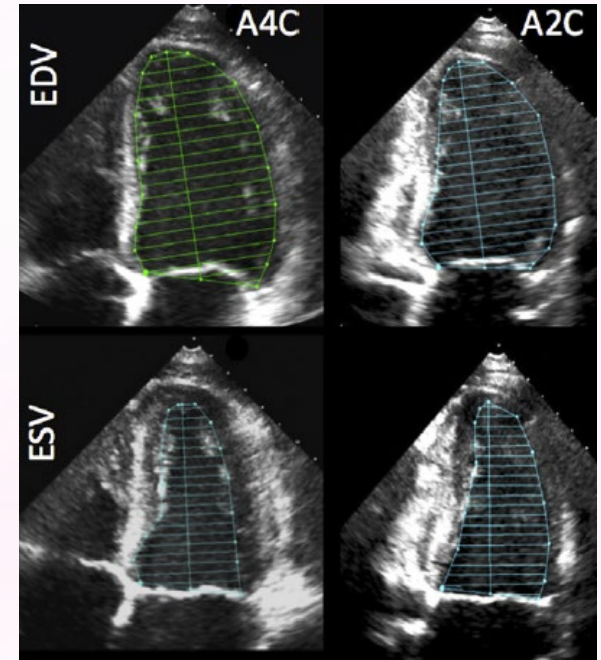
Area-length method:

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- Assumes a bullet-shaped LV
- Reasonable alternative to modified Simpson's if poor apical endocardial definition



Biplane method of disks summation (modified Simpson's)

- Preferred 2D method for volumetric assessment (ASE committee consensus recommendation)
- Accounts for most shape distortions from assumed geometry
- Blind to shape distortions not visible in apical 4C and 2C views
- Caution when apical windows are foreshortened
- Common weakness of this method, will underestimate volume



Index measurements to body surface area

LV Size – Dimension and Volume

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BSA, body surface area; EDV, end-diastolic volume; EF, ejection fraction; ESV, end-systolic volume; LV, left ventricular; SD, standard deviation.

LEFT VENTRICULAR MASS AND GEOMETRY

- 2D LINEAR MEASUREMENTS

LEFT VENTRICULAR MASS

Several methods (M mode, 2D, 3D)

1. Myocardial volume calculated (2D) or measured (3D) then converted to mass (density approx. 1.05 g/mL)
2. Myocardial volume calculated by geometric formulae (M mode, 2D) or measured directly (3D)

>> Linear method –quick, widely used, plethora of published data

$$\text{LV Mass (g)} = 0.8 \times 1.04 \times [(\text{IVS} + \text{LVID} + \text{PWT})^3 - \text{LVID}^3] + 0.6$$

>> Alternate methods (2D-truncated ellipsoid, area-length) and 3D rely on fewer geometric assumptions but more cumbersome and fewer data

LEFT VENTRICULAR MASS – LINEAR METHOD

Linear method:

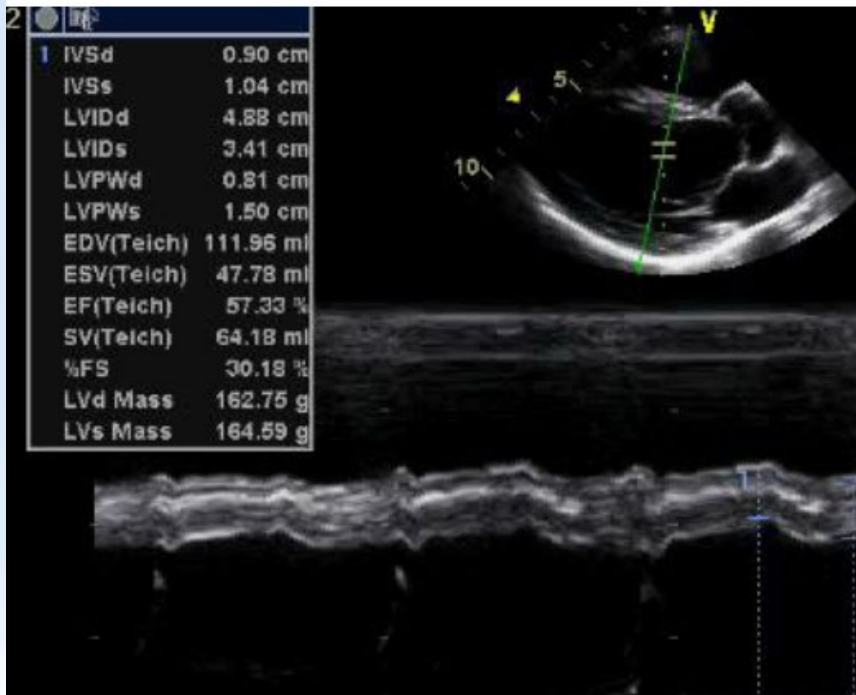
Cube formula

$$\text{LV mass} = 0.8 \cdot 1.04 \cdot [(IVS + LVID + PWT)^3 - LVID^3] + 0.6g$$

Where:

- IVS = interventricular septal thickness (mm)
- LVID = LV internal dimension in diastole (mm)
- PWT = posterior (inferolateral) wall thickness (mm)

- Measurement errors cubed –ensure accurate measurements!
- Caution in abnormally shaped LV and regional variability (eg: basal septal hypertrophy)



Normal LV mass:

- 95 g/m² in women
- 115 g/m² in men

RELATIVE WALL THICKNESS (RWT)

$$\text{Relative wall thickness (RWT)} = \frac{(2 \times \text{posterior wall thickness})}{\text{LV internal dimension (diastole)}}$$

RWT > 0.42 = concentric
(remodeling or increase in wall thickness)

RWT ≤ 0.42 = normal or eccentric

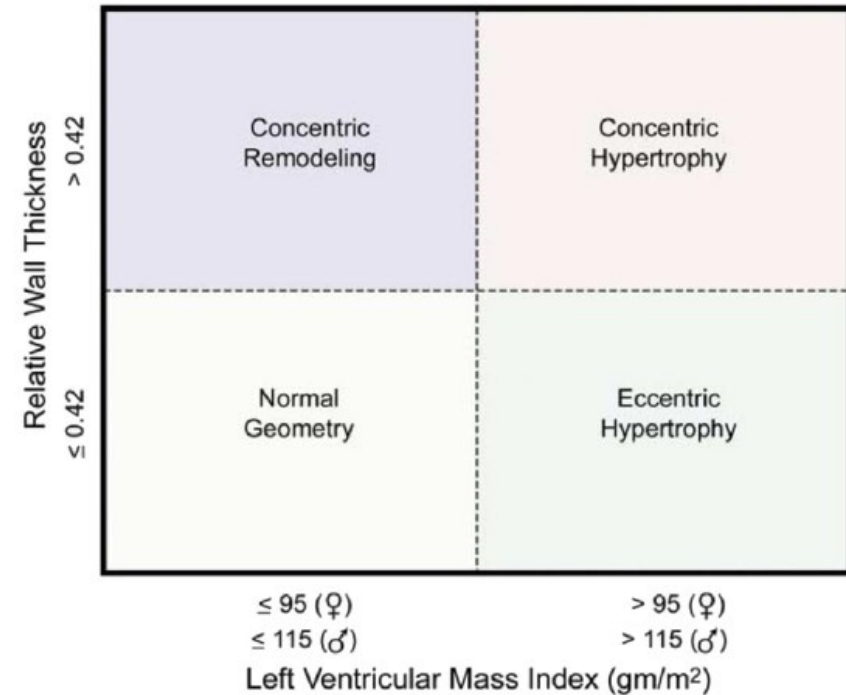


Table 6 Normal ranges for LV mass indices

	Women	Men
Linear method		
LV mass (g)	67–162	88–224
<i>LV mass/BSA (g/m^2)</i>	<i>43–95</i>	<i>49–115</i>
Relative wall thickness (cm)	0.22–0.42	0.24–0.42
<i>Septal thickness (cm)</i>	<i>0.6–0.9</i>	<i>0.6–1.0</i>
<i>Posterior wall thickness (cm)</i>	<i>0.6–0.9</i>	<i>0.6–1.0</i>
2D method		
LV mass (g)	66–150	96–200
<i>LV mass/BSA (g/m^2)</i>	<i>44–88</i>	<i>50–102</i>

Bold italic values: recommended and best validated.

Others :

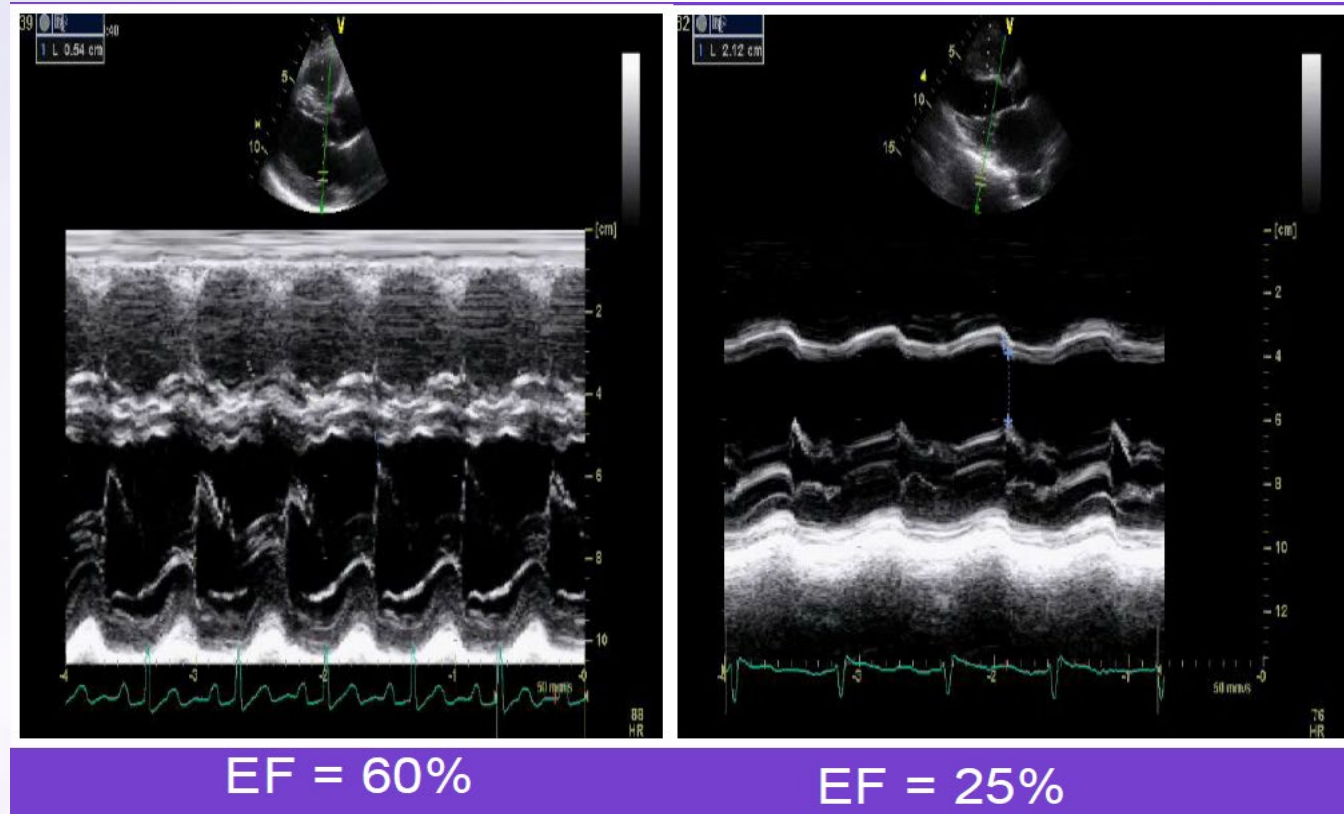
Mitral E point septal separation (EPSS)

- Measure the perpendicular distance between the most posterior point of IVS during systole and the E point of AMVL in the same cardiac cycle
- In impaired LV systolic function : IVS anteriorly displaced as LV dilates and Reduced opening of MV as reduced trans-mitral inflow

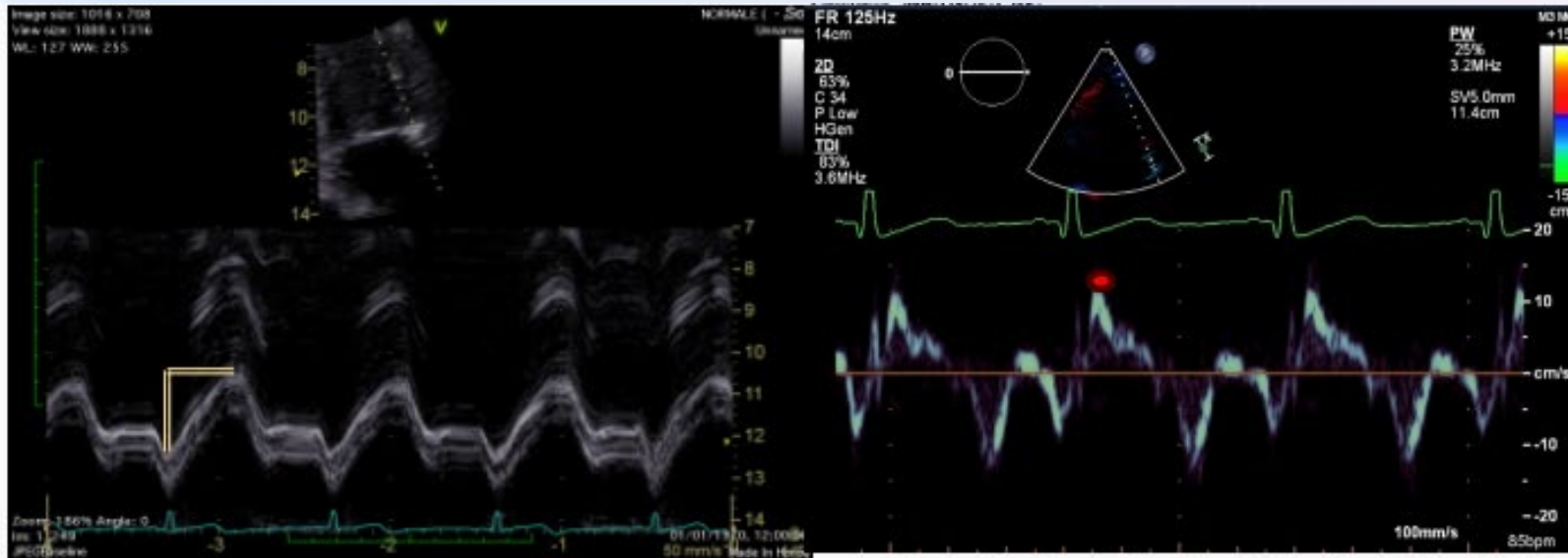
EF	EPSS
$\geq 50\%$	≤ 5.5 mm
$< 50\%$	> 7.0 mm
$\leq 35\%$	≥ 13.0 mm

Source: Bonita Anderson, Echocardiography-Normal examination and echocardiographic measurements, 1st Edition 2000

Limitations : not applicable in MS and significant AR



LV Longitudinal Function



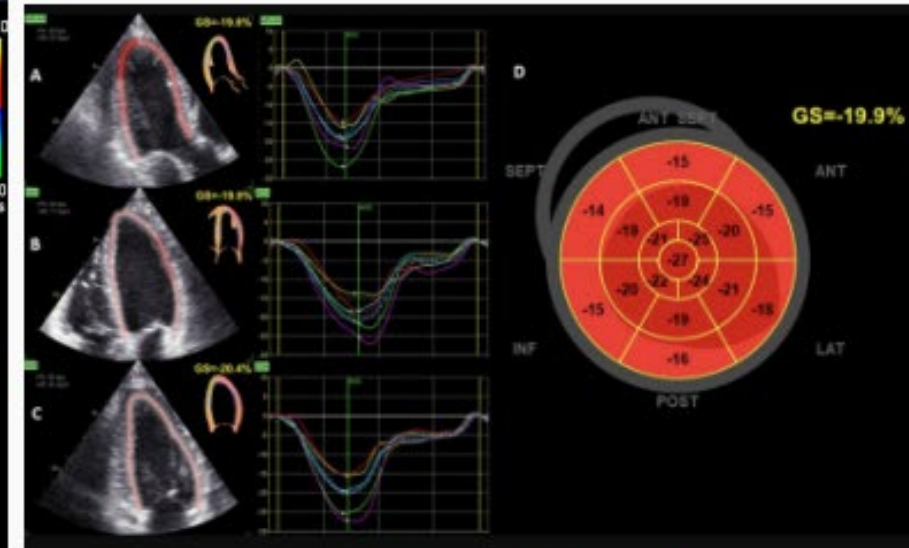
Normal cut off

Septal $> 14.0 \pm 2.5$ mm

Lat $> 15.5 \pm 2.8$ mm

MAPSE

S' wave



Normal cut off

< 40 y.o -21.3 (-24.9 to -17.8)

> 70 y.o -19.0 (-22.9 to -15.0)

GLS

REPORTING for LV function

1. LV size

- LVIDd and LVIDs
- LV wall thickness (concentric /eccentric hypertrophy)
- EDV (index) , ESV (index)

2. Comment on LV systolic function

- LVEF (Biplane simpson's)

3. Regional Function

- Presence/absence of RWMA

4. 2D speckle strain for HOCM, CMP, Amyloidosis

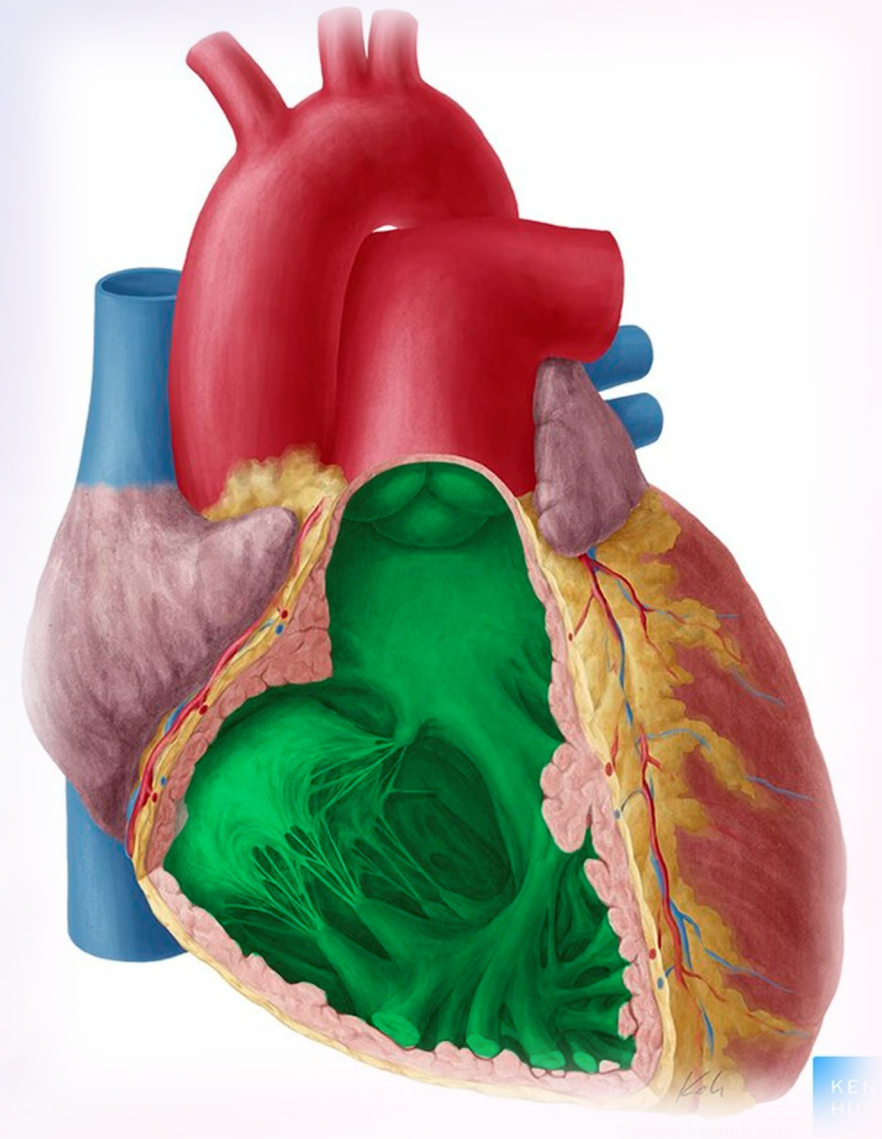
5. Any associated valve lesions ,Shunts, Clots, Spontaneous echo contrasts

6. Diastolic Function

Take home messages :

- Volumetric assessment by modified Simpson's biplane method preferred over linear assessment
- Reported values should be indexed to body surface area
- 3D volumetric measurements recommended in laboratories with experience with 3D

Right ventricle



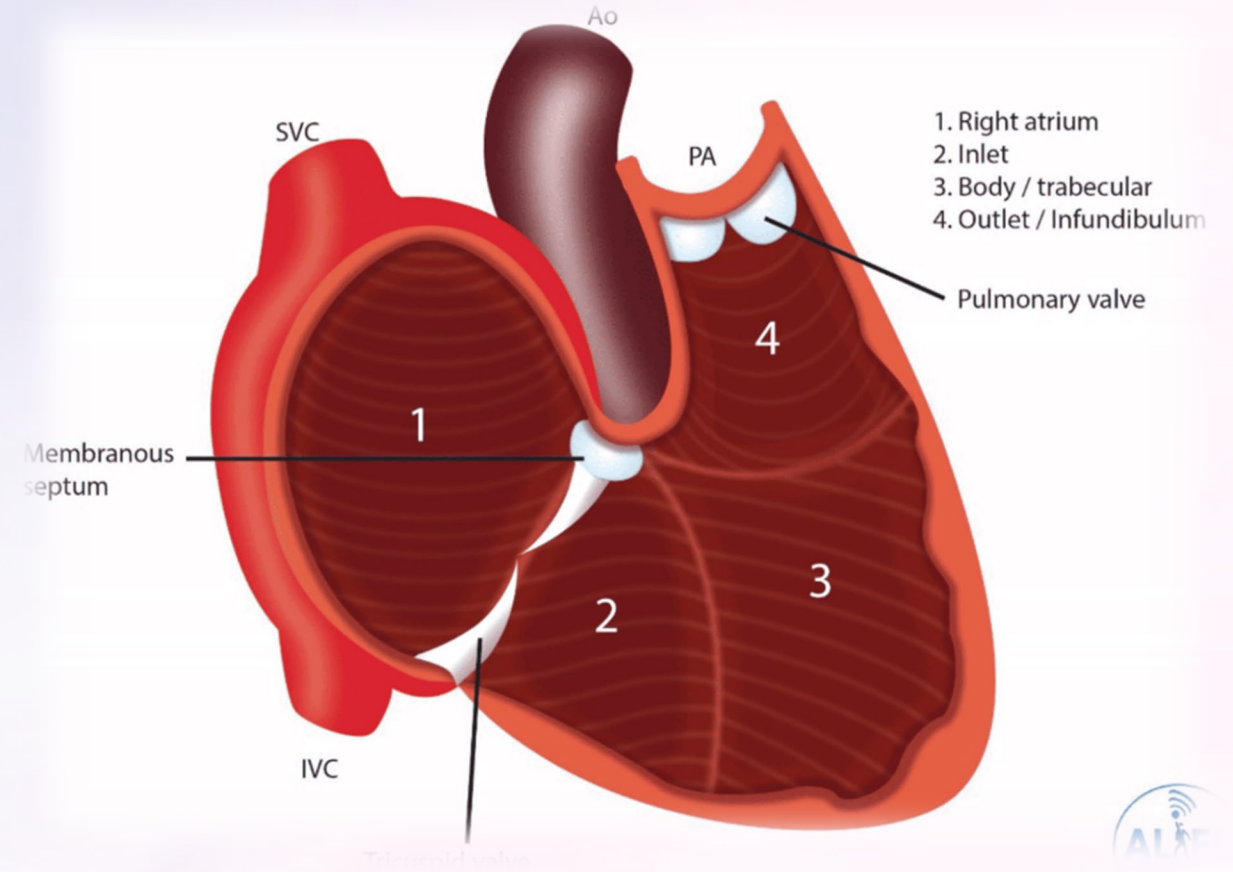
RV anatomy

3 parts :

A. Inlet : The inflow containing the tricuspid valve and valvular apparatus

B. Body: The trabeculated immobile apical myocardium

C. Infundibulum : The funnel-shaped outflow



RV Contraction Pattern

RV contracts in a **peristaltic-like fashion**

- starting at the inlet and ending at the infundibulum.
- **After tricuspid valve closure**, RV systole begins. The right ventricle is circumferentially – radially – deformed, creating a ‘bellow effect’ by inward movement of the RV free wall.
- During the ejection phase , **the longitudinal myocardial fibres in the subendocardial layer (75% of total RV ejection)** shorten, pulling the tricuspid annulus towards the apex (i.e., TAPSE).
- At the **end of systole the infundibulum contracts**, contributing to **15-20%** of RV ejection. LV contraction also contributes significantly to RV ejection via shared myocardial fibres, intraventricular septum and pericardium (i.e., ventricular interdependence).
- The interventricular septum plays a crucial role in this regard, through longitudinal shortening during the ejection phase.

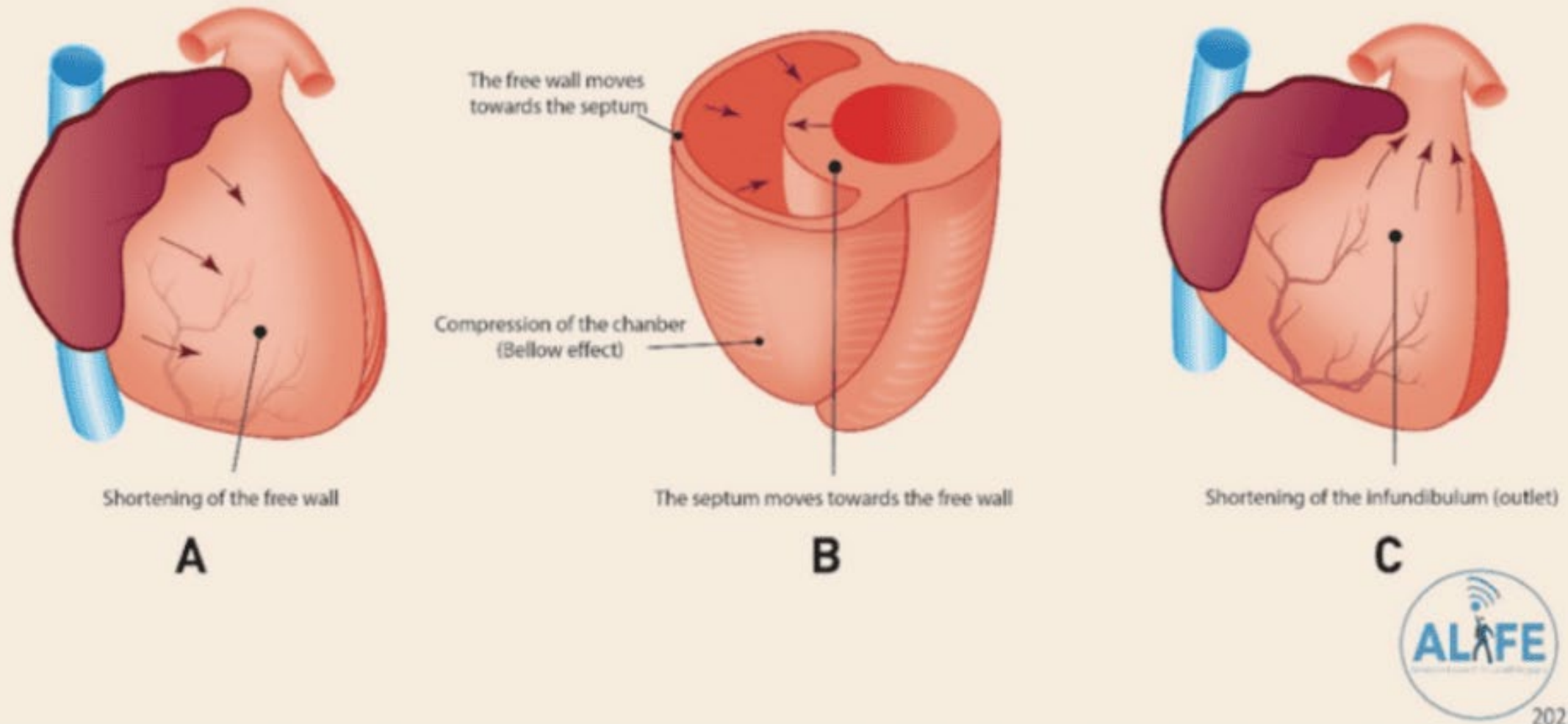
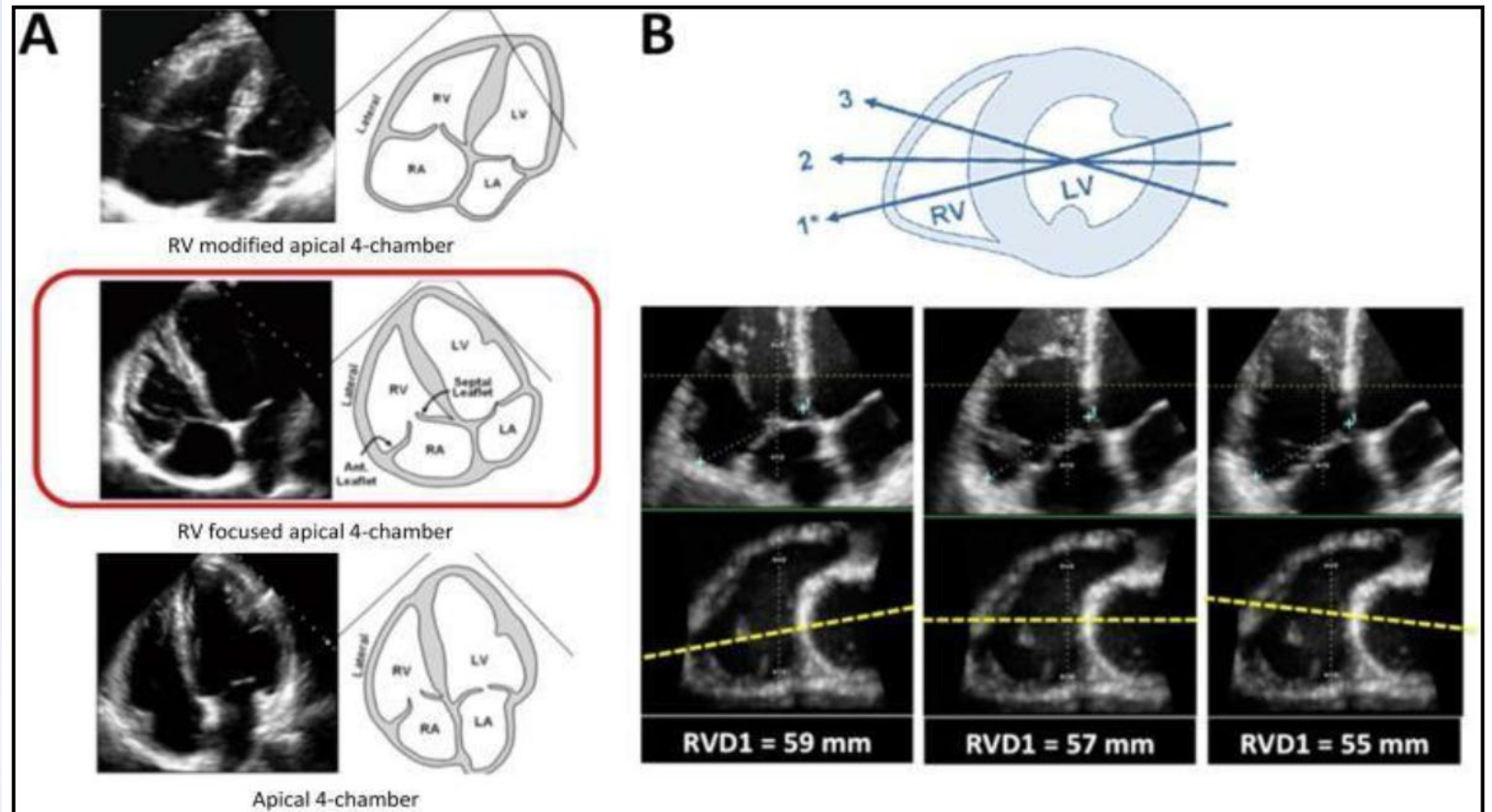
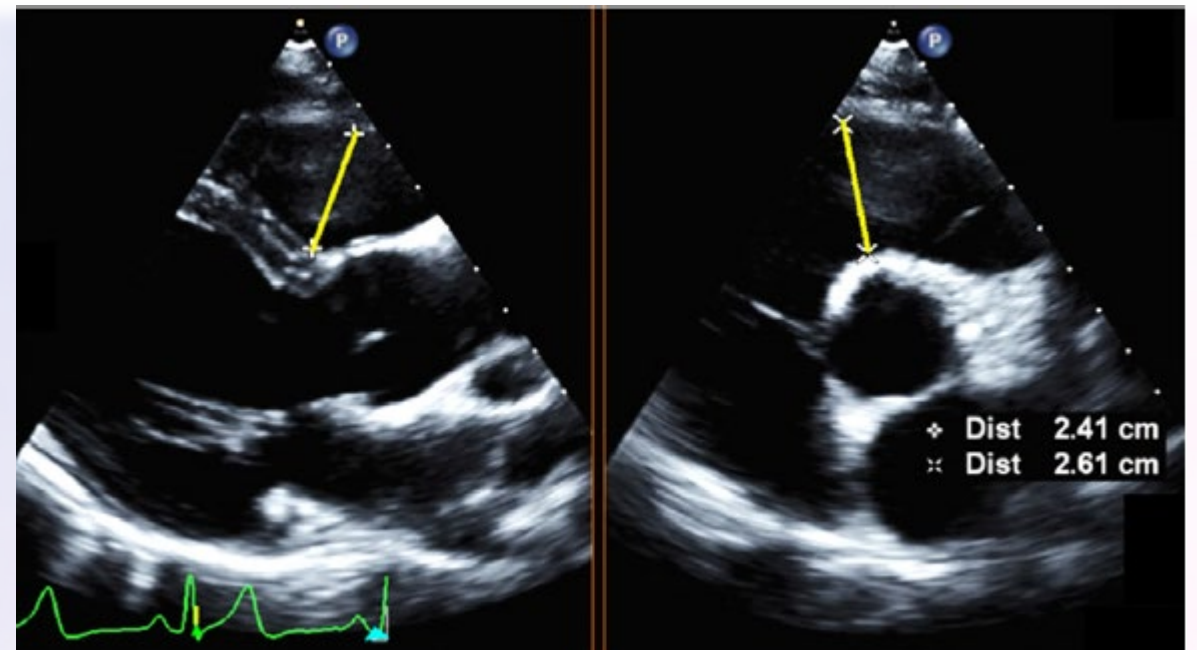
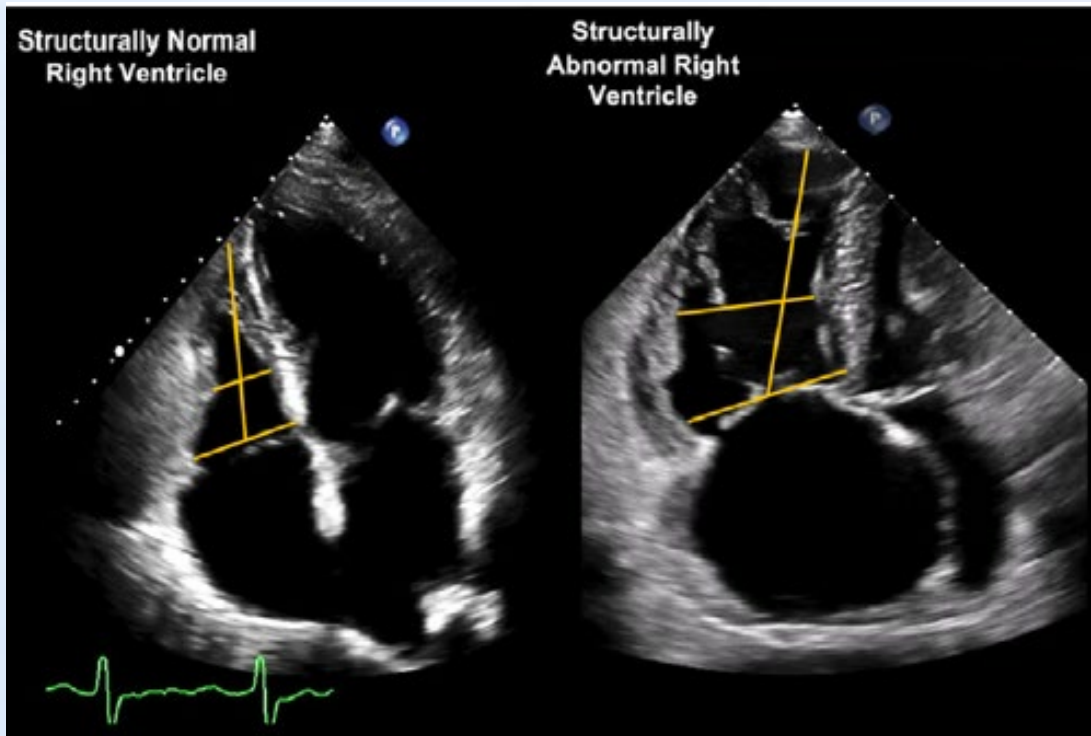


Figure 2. Diagram of right ventricular contraction. A. Ejection phase: shortening of the free wall and pulling the tricuspid annulus towards the apex (i.e., TAPSE). B. Isovolumetric face: the right ventricle is circumferentially – radially – deformed, creating a 'bellow effect' by inward movement of the RV free wall. C. End of contraction: infundibulum shortens, and blood is ejected into the common pulmonary artery. Adapted from

Right Ventricle Size

- By 2DE, unable to capture all three components in a single plane > **multiple imaging planes** are required for a comprehensive quantitative assessment.
- Qualitatively, the RV should appear **no more than two-thirds the size of the left ventricular (LV)** with relative predominance of the LV apex from the apical four-chamber view





Proximal RVOT diameter (PLAX and PSAX)
End diastole

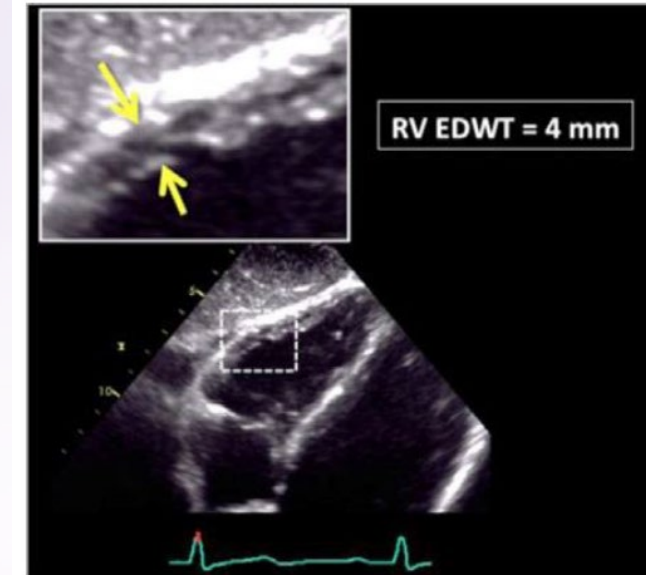
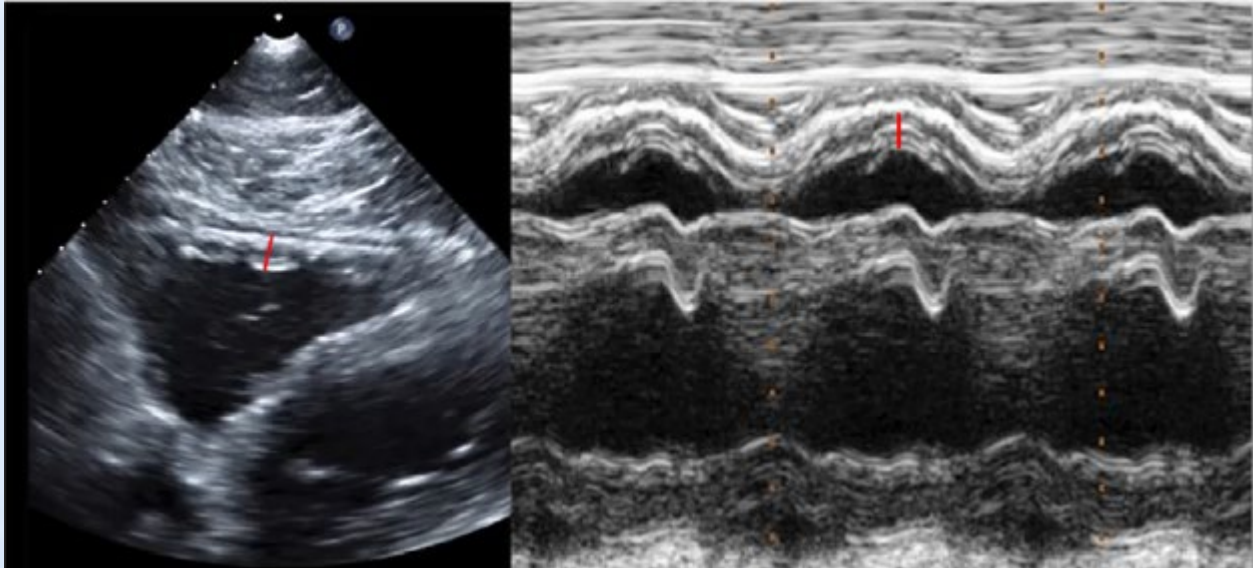
Table 8 Normal values for RV chamber size

Parameter	Mean $\pm$ SD	Normal range
RV basal diameter (mm)	33 $\pm$ 4	25-41
RV mid diameter (mm)	27 $\pm$ 4	19-35
RV longitudinal diameter (mm)	71 $\pm$ 6	59-83
RVOT PLAX diameter (mm)	25 $\pm$ 2.5	20-30
RVOT proximal diameter (mm)	28 $\pm$ 3.5	21-35
RVOT distal diameter (mm)	22 $\pm$ 2.5	17-27
RV wall thickness (mm)	3 $\pm$ 1	1-5



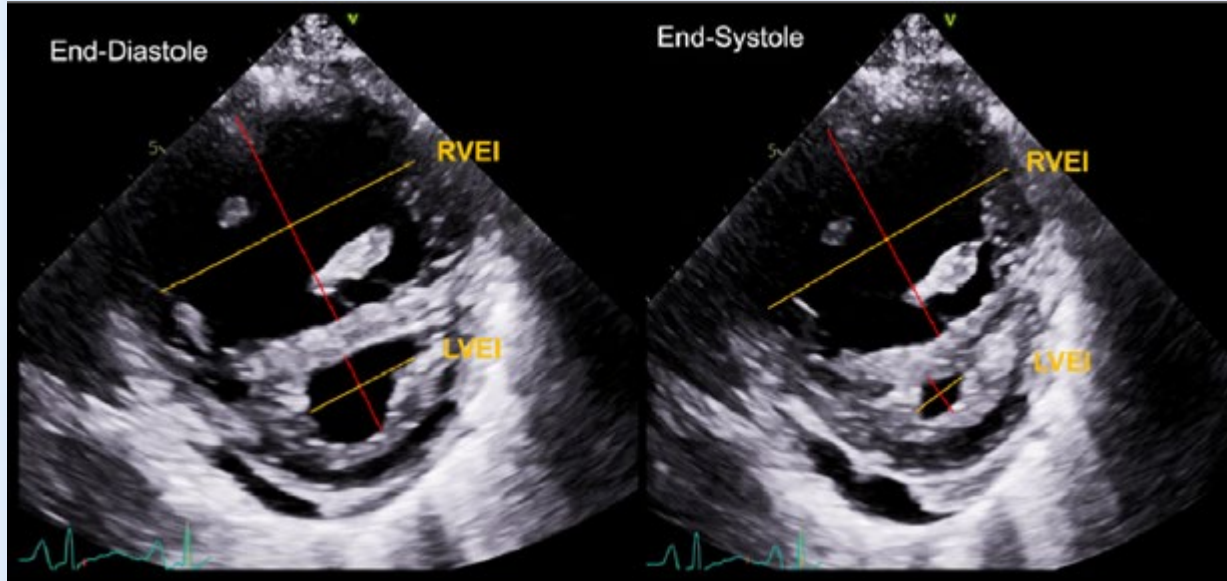
Distal RVOT diameter

Wall Thickness



- Subcostal view, Zoomed on RV mid-wall
- End-diastole
- 2DE or M-mode
- **>5mm** is abnormal

LV eccentricity index (LVEI)



$$EI = D2/D1$$

(D2: Yellow, D1 : Red)

- LVEI is the ratio of LV anteroposterior and LV septolateral dimensions measured from the PSAX view at the level of the papillary muscles and has prognostic value in PH.
- $LVEI = 1$ in both end-systole and end-diastole reflects a circular LV profile throughout the cardiac cycle and normal RV hemodynamic conditions.
- $LVEI > 1$ at end-diastole suggests RV volume overload.
- $LVEI > 1$ in end-systole suggests RV pressure overload.
- $LVEI > 1$ in end-systole and end-diastole suggests RV pressure overload with or without concomitant volume overload.

1. LVEI should be measured to evaluate the presence and extent of RV volume and/or pressure overload.
2. Quantification and reporting of LVEI should be included when abnormal.

RV Function

RV Function

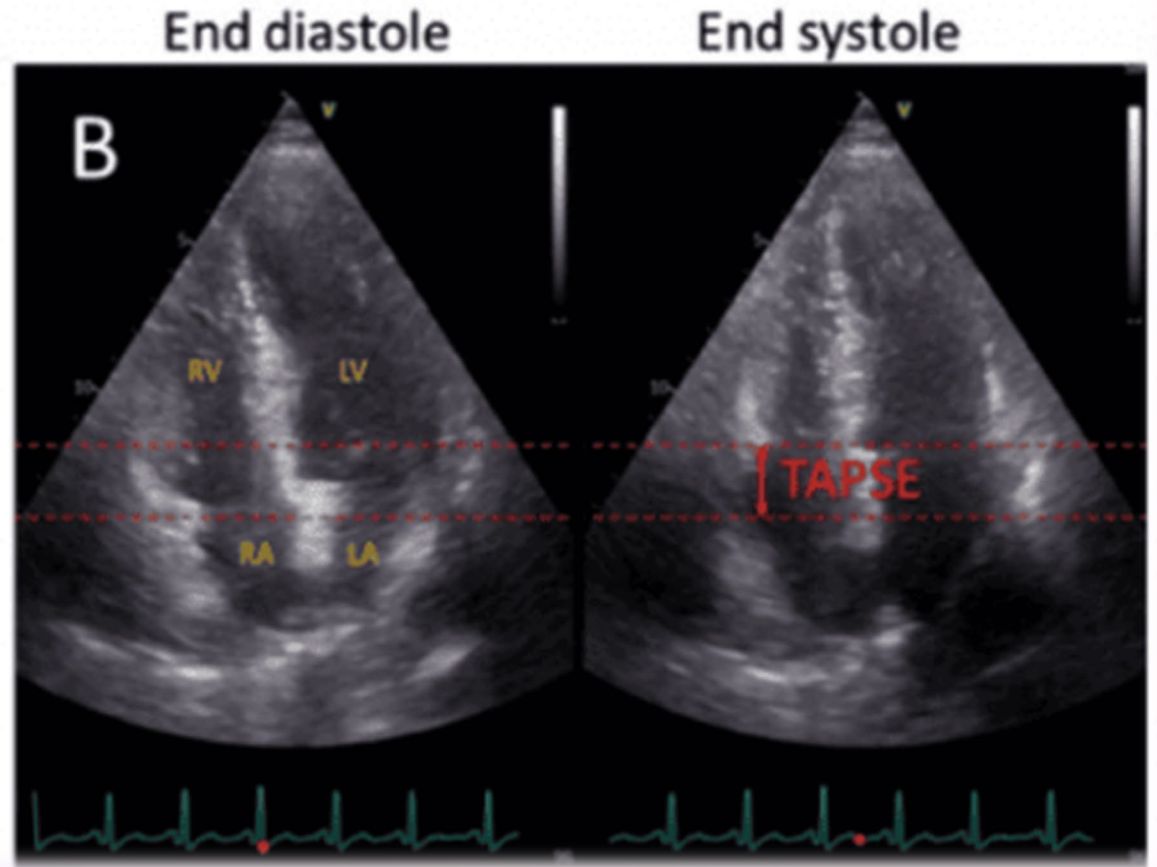
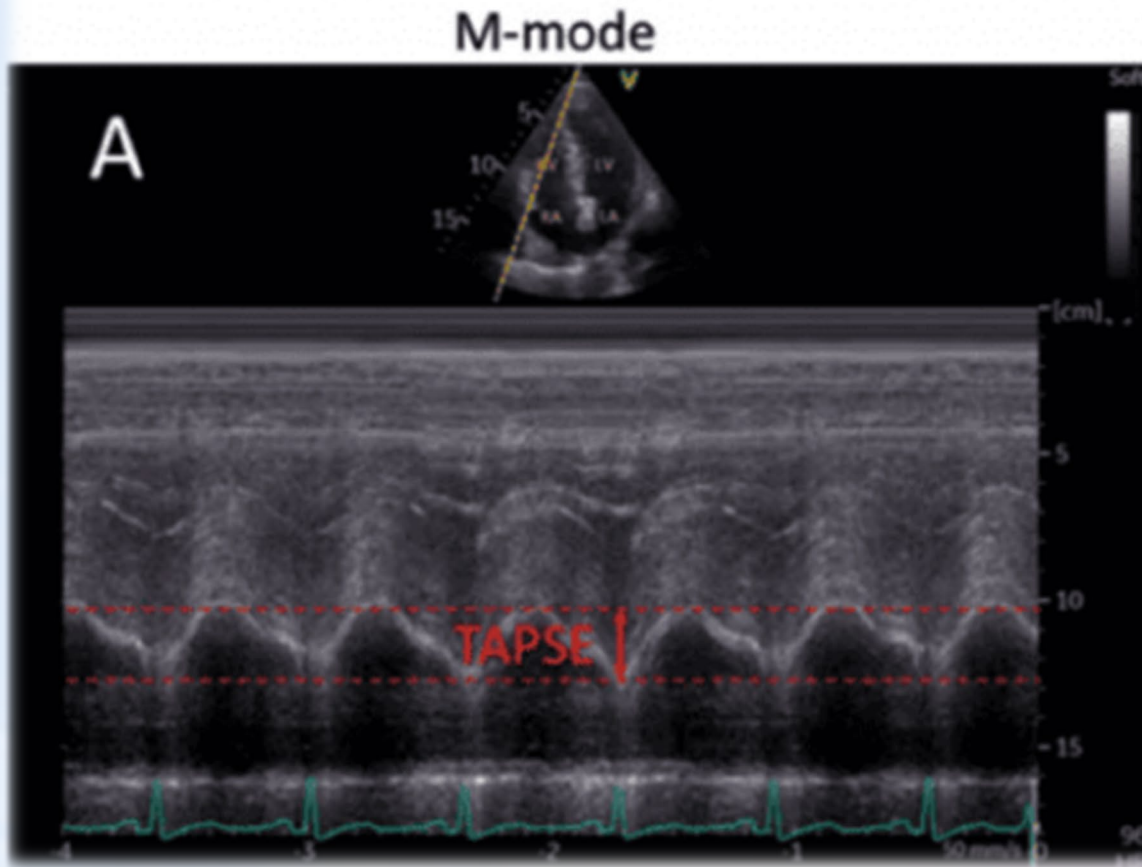
RV systolic function should be assessed by **at least one or a combination** of the following **recommended parameters**:

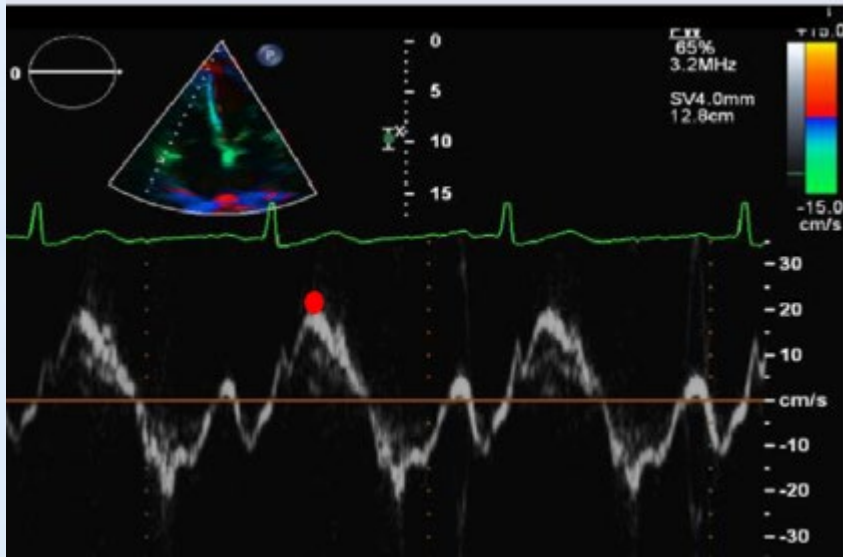
1. TAPSE (Tricuspid Annular Plane Systolic Excursion)
2. DTI-Derived Tricuspid Lateral Annular Systolic Velocity S'
3. FAC (fractional area change)
4. RV longitudinal strain
5. 3D EF
6. Right Index of Myocardial Performance (RIMP or MPI)

1. TAPSE (Tricuspid Annular Plane Systolic Excursion)

RV-focused apical 4Ch view

TAPSE : abnormal $< 17\text{mm}$

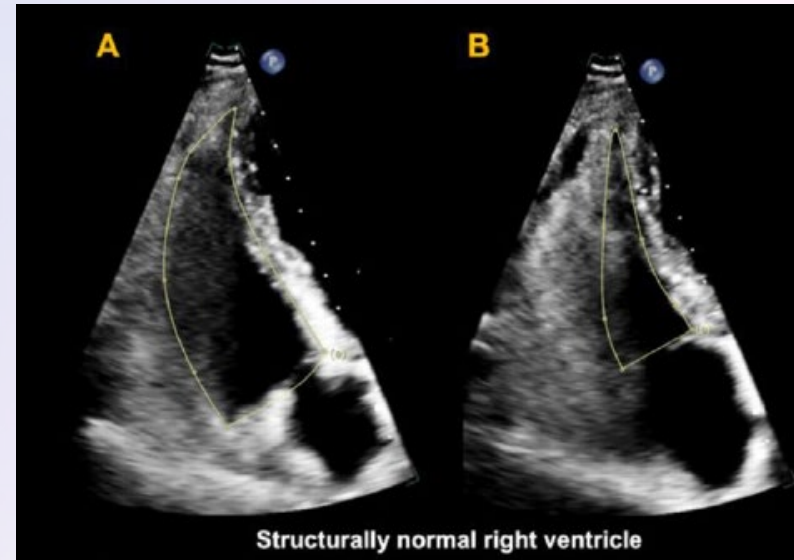




2. Tissue Doppler S' velocity (cm/s)

RV-focused 4Ch view.

S' wave : abnormal < 9.5 cm/s



3. FAC (Fractional Area Change)

RV-focused apical 4Ch view

RV FAC in RV-focused apical four-chamber view:

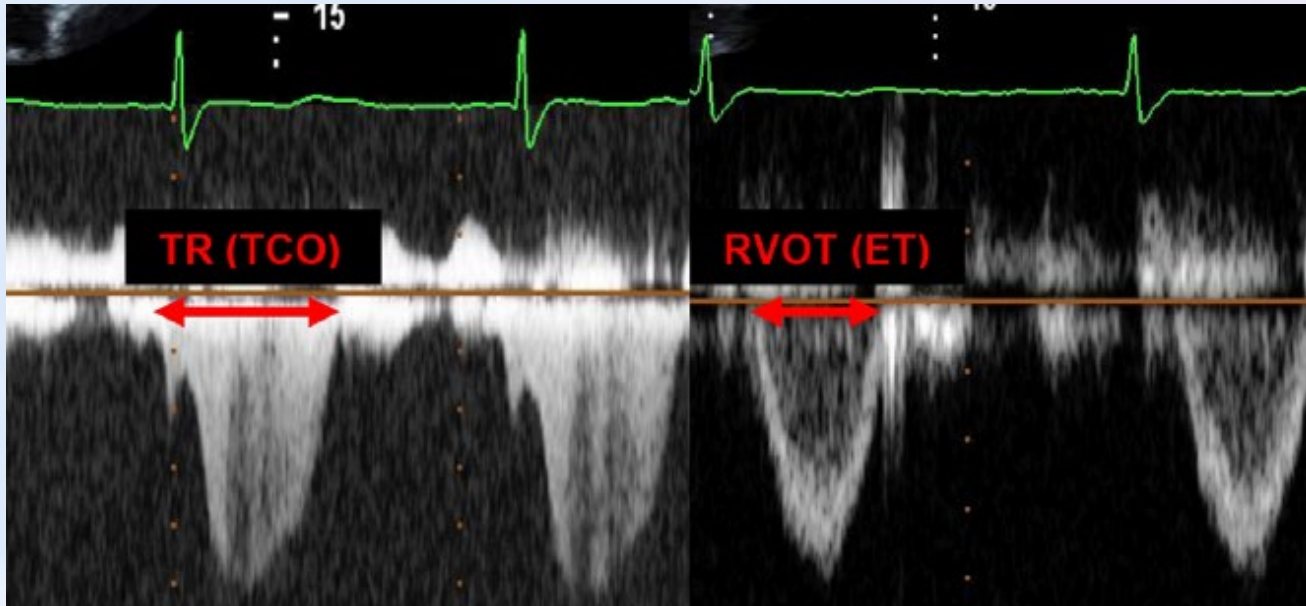
$$\text{RV FAC (\%)} = 100 \times (\text{EDA} - \text{ESA}) / \text{EDA}$$

- Established prognostic value
- Reflects both longitudinal and radial components of RV contraction
- Correlates with RV EF by CMR

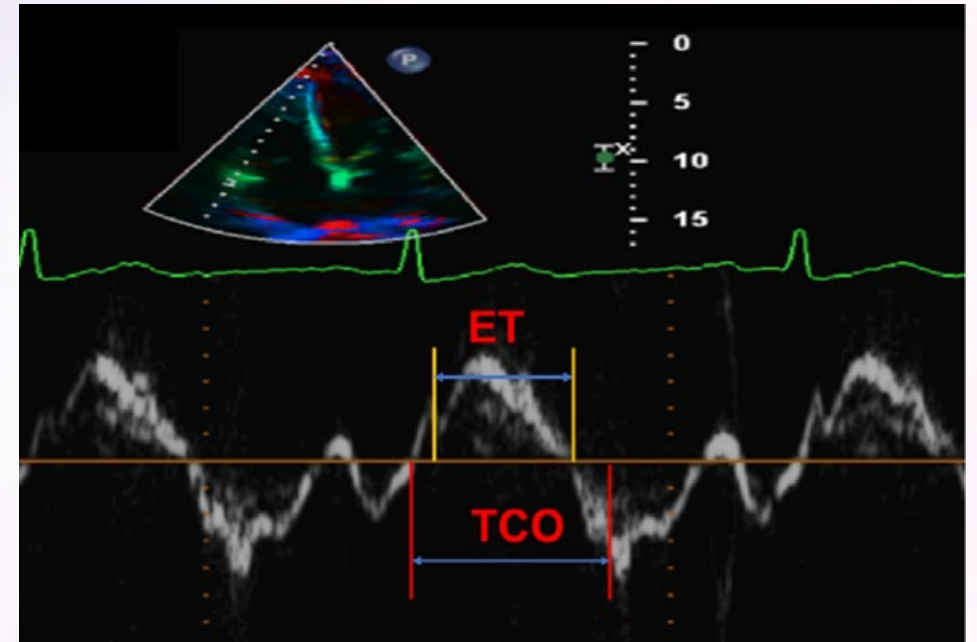
FAC : abnormal < 35%

4. RV MPI / RV index of myocardial performance (RIMP) / Tei Index

- Formula : $RV\ MPI = (TCO - ET) / ET$
- Method : PW Doppler across the RVOT or
- TDI method.



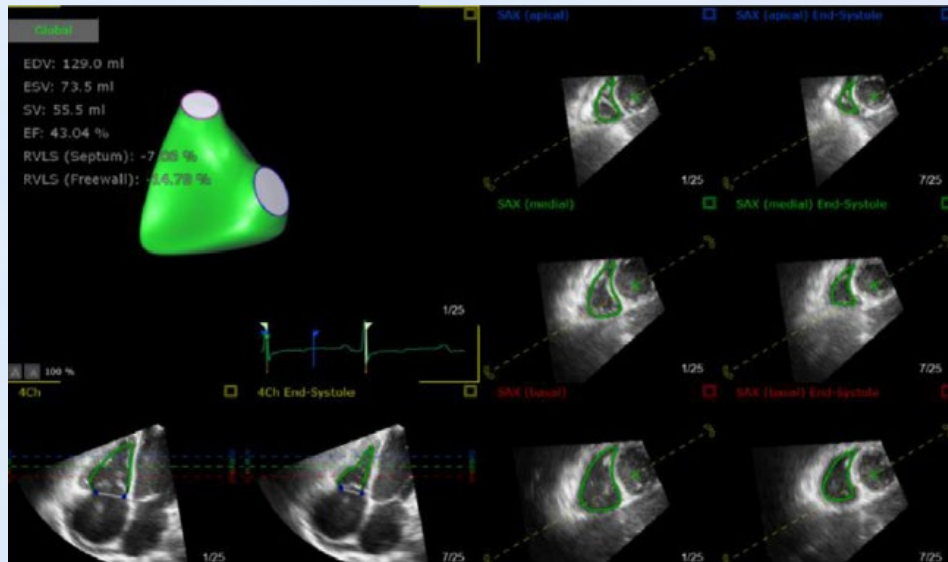
Pulsed Doppler MPI : abnormal > 0.43



Tissue Doppler MPI : abnormal > 0.54

Table 9 Recommendations for the echocardiographic assessment of RV function

Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV global function Pulsed Doppler RIMP	RIMP (Tei index) by pulsed Doppler: $\text{RIMP} = (\text{TCO} - \text{ET})/\text{ET}$	• Prognostic value • Less affected by heart rate	• Requires matching for R-R intervals when measurements are performed on separate recordings • Unreliable when RA pressure is elevated
Tissue Doppler RIMP	RIMP by tissue Doppler: $\text{RIMP} = (\text{IVRT} + \text{IVCT})/\text{ET} = (\text{TCO} - \text{ET})/\text{ET}$	• Less affected by heart rate • Single-beat recording with no need for R-R interval matching	• Unreliable when RA pressure is elevated

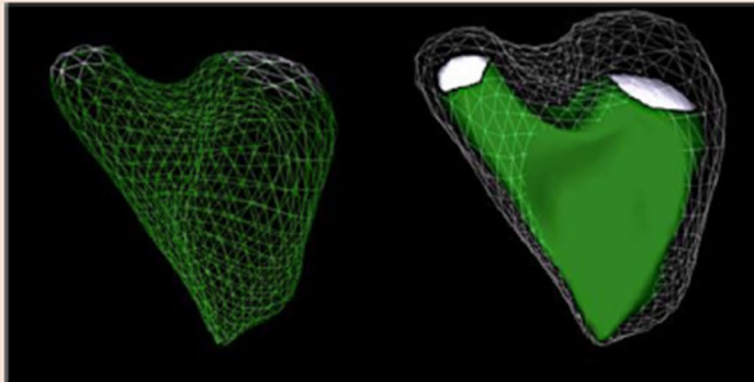


5. 3D RVEF

derived from RVEDV and RVESV using specialized software

RV 3DEF : abnormal <45%

EF



Fractional RV volume

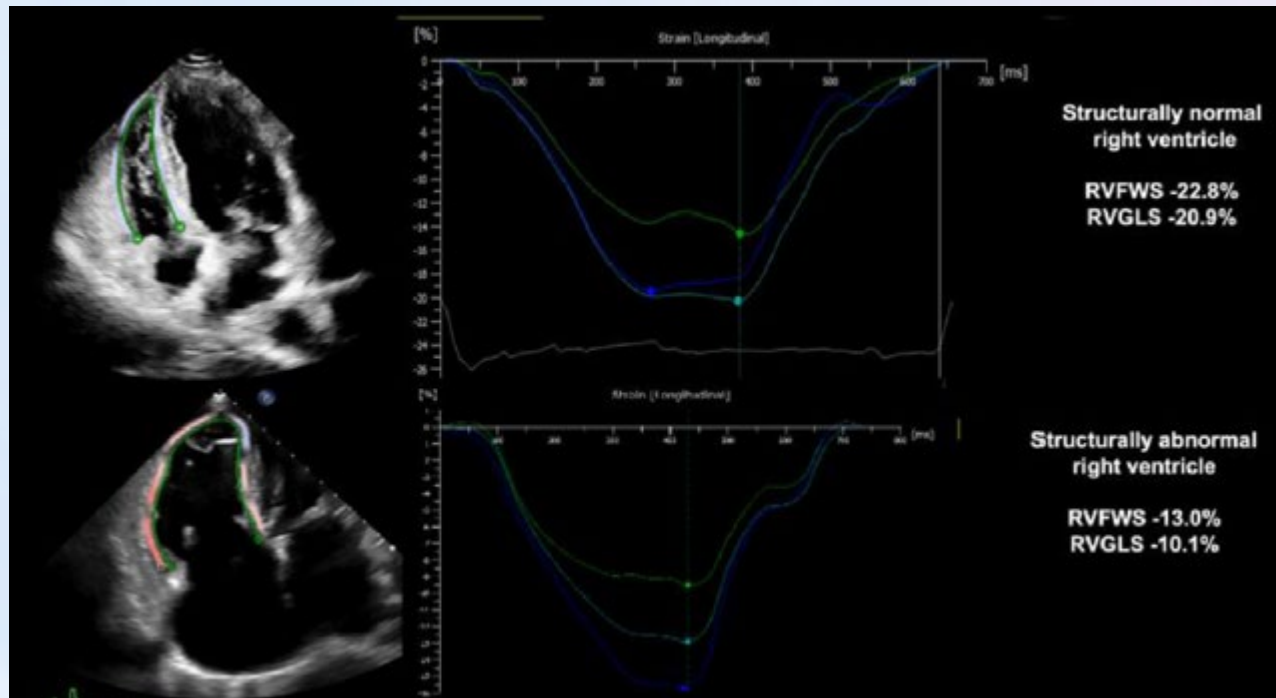
change by 3D TTE:

$$\text{RV EF (\%)} = 100 \times (\text{EDV} - \text{ESV}) / \text{EDV}$$

- Includes RV outflow tract contribution to overall function
- Correlates with RV EF by CMR
- Dependent on adequate image quality
- Load dependency
- Requires offline analysis and experience
- Prognostic value not established

6. Global longitudinal strain

6-Segment RVGLS and 3-Segment RVFWS



RV FWS : abnormal > - 20 %

Summary

- Given the complex geometric configuration of the right heart, which varies in shape with loading conditions, the comprehensive qualitative and quantitative assessment of chamber size is essential.

RV systolic function should be assessed by **at least one or a combination** of the following **recommended parameters**:

1. TAPSE (Tricuspid Annular Plane Systolic Excursion)
2. DTI-Derived Tricuspid Lateral Annular Systolic Velocity S'
3. FAC (fractional area change)
4. RV longitudinal strain
5. 3D EF
6. Right Index of Myocardial Performance (RIMP or MPI)

Thank you