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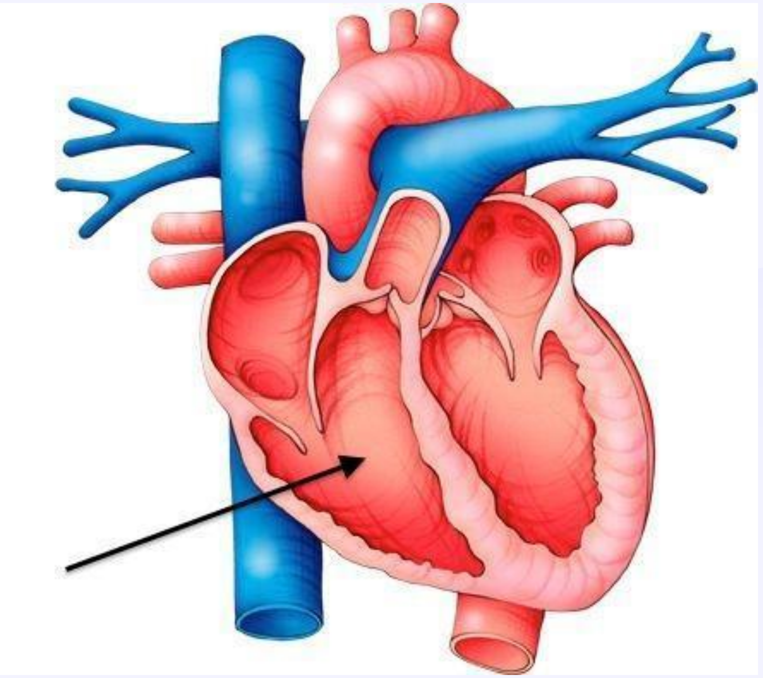
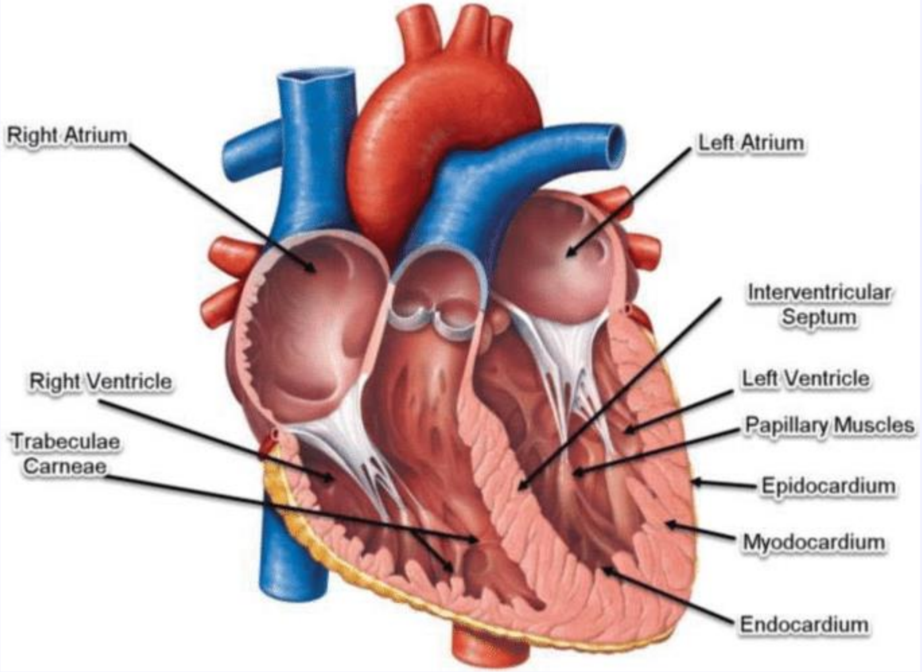
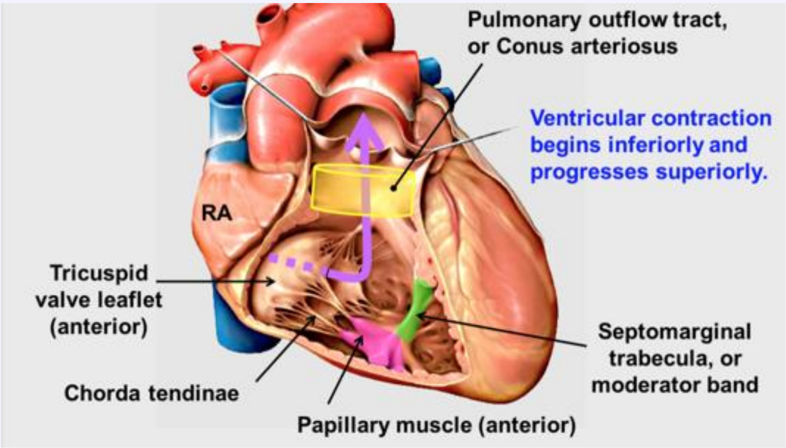
Ventricular Function (Systolic, LV and RV)

Aug 14, 2019

Department of Anesthesia and Pain Management- TGH, Toronto




Right Atrium
Left Atrium
Interventricular Septum
Right Ventricle
Left Ventricle
Papillary Muscles
Trabeculae Carneae
Epidocardium
Myodocardium
Endocardium


Pulmonary outflow tract, or Conus arteriosus
Ventricular contraction begins inferiorly and progresses superiorly.
RA
Tricuspid valve leaflet (anterior)
Septomarginal trabecula, or moderator band
Chorda tendinae
Papillary muscle (anterior)

Functional anatomy of the RV

1. **Right ventricle is a right- anterior structure. It consists of an inlet, coarse trabecular and outlet segments.**

2. **Morphologic TV is always connects to morphologic RV by chordae and 3 papillary muscles. Prominent arch-shaped muscular ridge known as crista supraventricularis is separating TV from PV.**

3. **Prominent moderator band forms an intracavitary muscle that connect the septal band with the anterior tricuspid papillary muscle.**
4. **The outflow portion of the RV, conus or infandibulum is a smooth-walled muscular subpulmonary channel.**

Functional anatomy of the LV

1. **LV is made of inlet, outlet and a finely trabeculated apical zone.**
2. **Average thickness of LV free wall is about 7-11 mm and is 3 times thicker than RV free wall.**
3. **Morphologic MV always connects to morphologic LV.**
4. **LV chamber in cross section appears circular (donut) whereas RV chamber appears crescentic (banana).**
5. **Two papillary muscles (anterolateral and posteromedial) are connecting MV to the LV wall.**
6. **LV false tendons are discrete, thin that connect two walls of LV.**
7. **In cardiac imaging LV wall are divided in to 16, 17 or 18 segments.**

Functional anatomy of the RA

1. Crista terminalis is a prominent internal muscle ridge which separates the RA free wall into:
   a) smooth-walled posterior region that receives the IVC, SVC and coronary sinus.
   b) muscular anterior region that is lined by parallel pectina muscles and form the right atrial appendage (RAA).

2. Inferior vena cava (IVC) blood flow is directed by the Eustachian valve towards the foramen ovale. Superior vena cava (SVC) blood is directed towards the TV.
3. Coronary sinus blood is directed into the RA via a rudimentary valve called Thebesian valve.

Functional anatomy of the LA

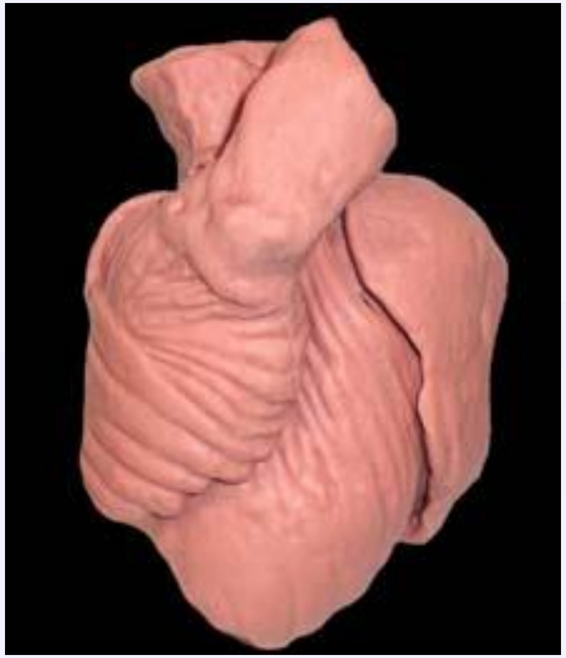
1. **Left pulmonary veins (LUPV and LLPV) are connected to the posterolateral and right pulmonary veins (RUPV and RLPV) are connected to the posteromedial aspect of LA.**
2. **Left atrial appendage (LAA) arises anterolaterally in the left A-V groove. LAA is smaller, more tortuous and has narrower base compared to RAA. At least 80% of times, LAA are multilobed.**
3. **In contrast to the right atrial free wall, the LA has no crista terminalis and no pectina muscle outside its appendage.**
4. **Coronary sinus (CS) travels along the posterior wall of the LA within the left A-V groove.**
5. **Esophagus and descending aorta are in contact with posterior LA wall.**

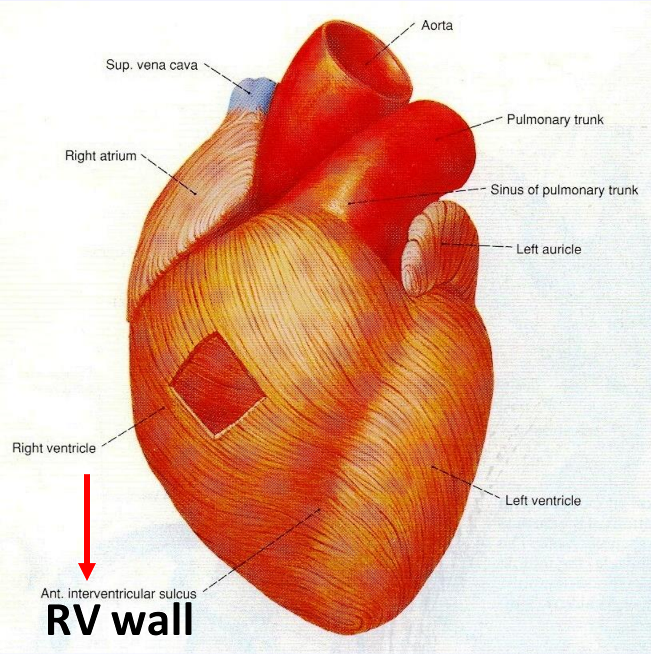
Functional anatomy of the ventricular septum

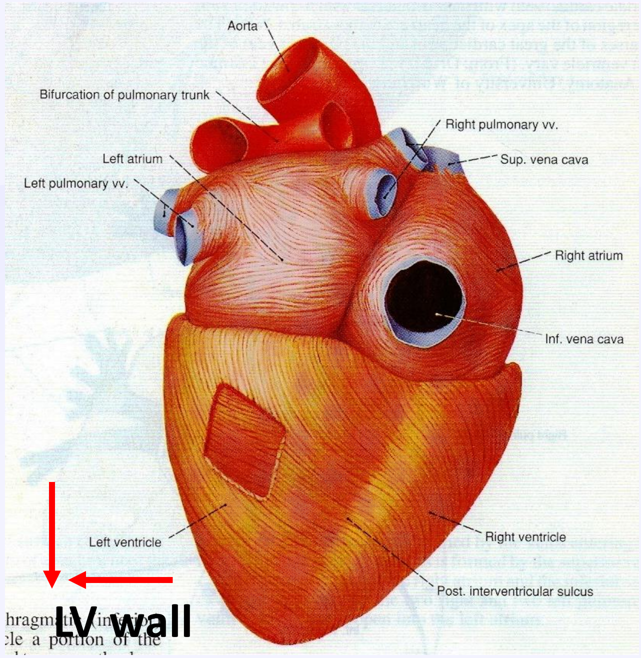
1. **Ventricular septum is a complex intracardiac partition that can be considered to comprise of four parts: inlet, trabecular, membranous and infundibular.**

2. **Defect in each portion of septum creates ventricular septal defect (VSD). Majority of clinically significant VSDs are membranous type.**

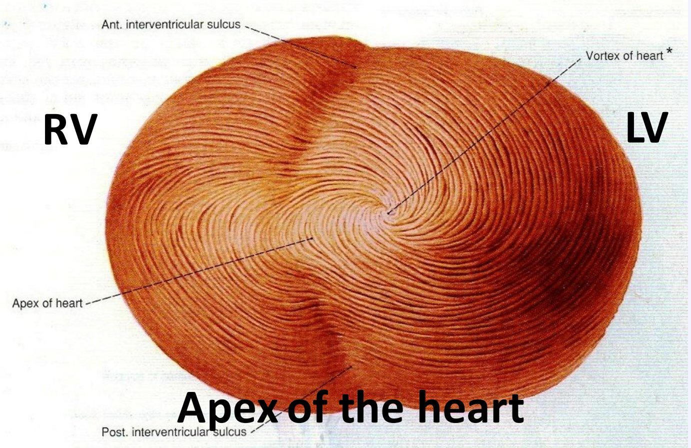
3. **Age-related basal septal hypertrophy or sigmoid shape septum can be seen by echocardiography in older people and should be differentiated with other causes of left ventricular hypertrophy .**

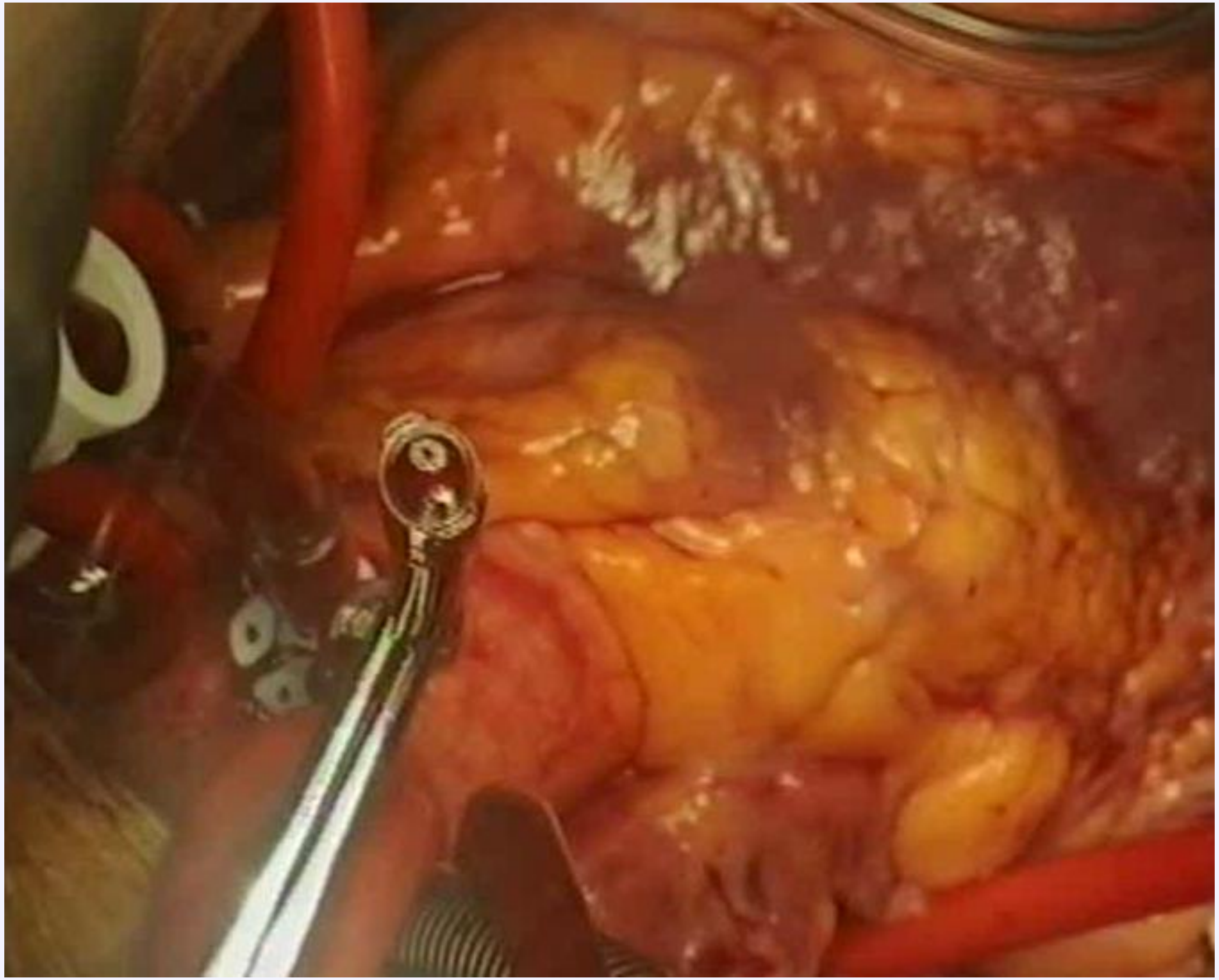


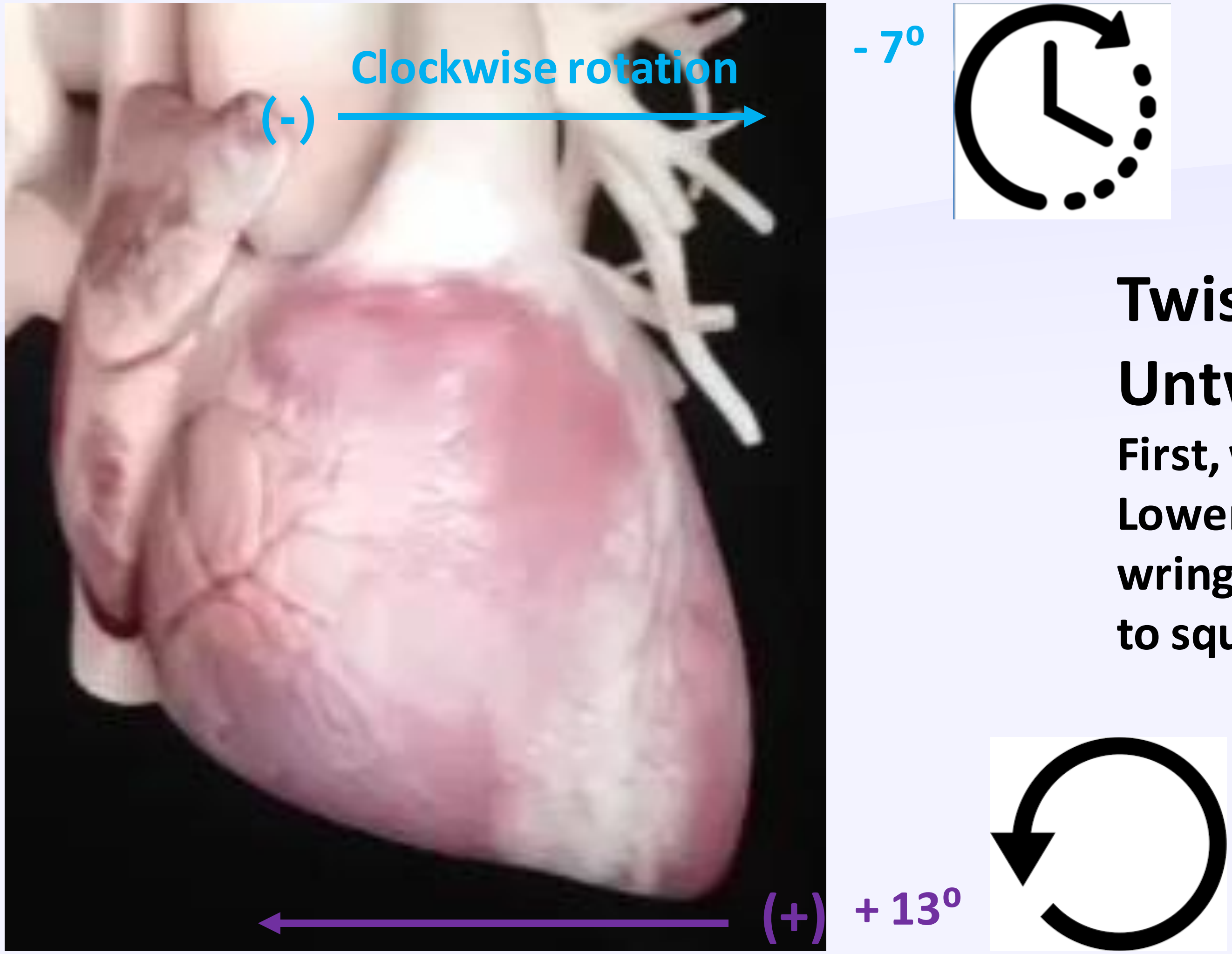




Helical structure of the heart was thought about 500 years ago, but Dr. Torrent-Guasp (Spanish, died in 2005) was the first to unfold this anatomic architecture. The helical shape of the heart causes twisting and untwisting to eject the blood in systole and suctioning of the blood in diastole. Disruption of this function happens when the geometry of the heart changed from normal conical shape to diseased spherical shape as happens in patients with CHF.

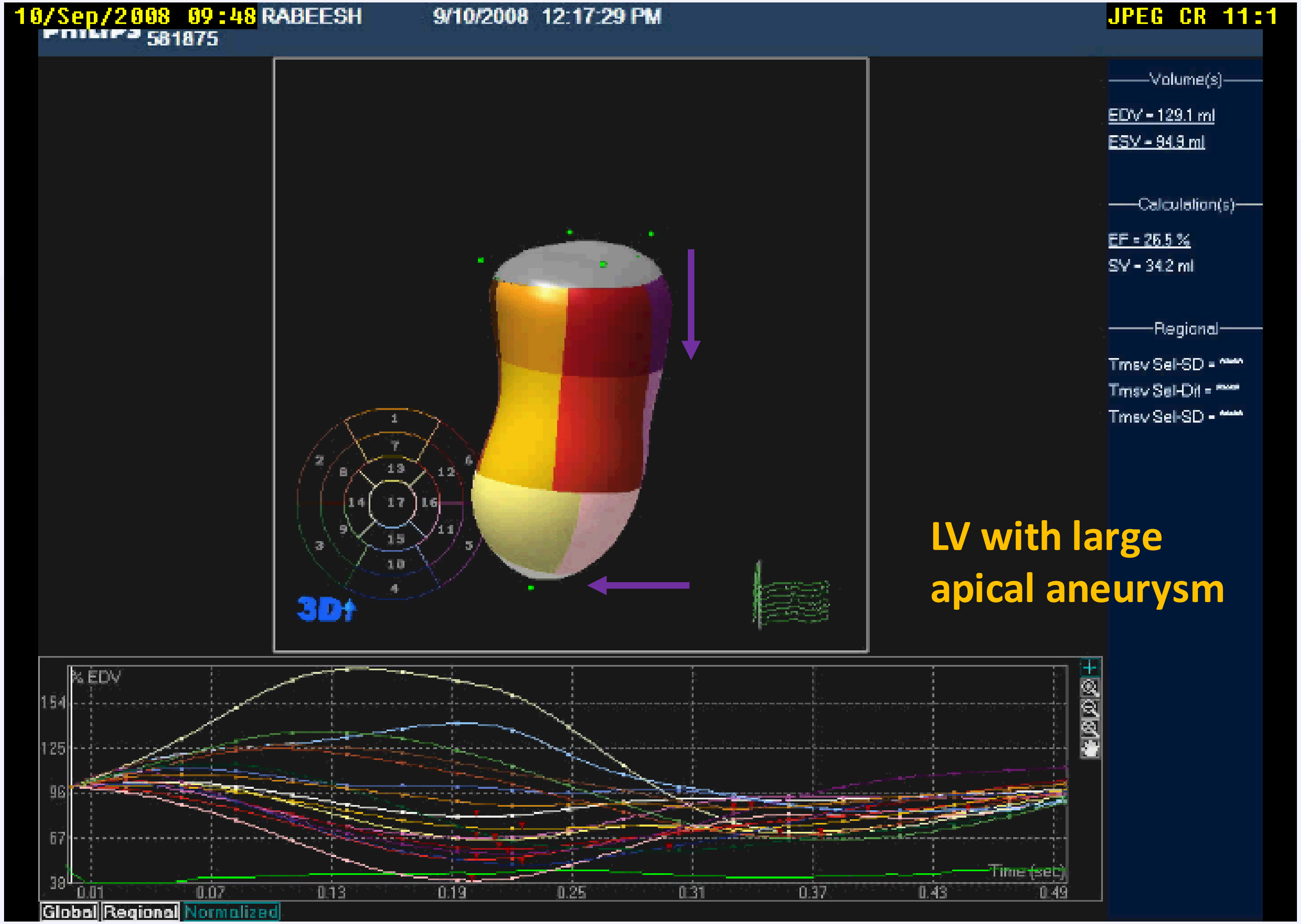




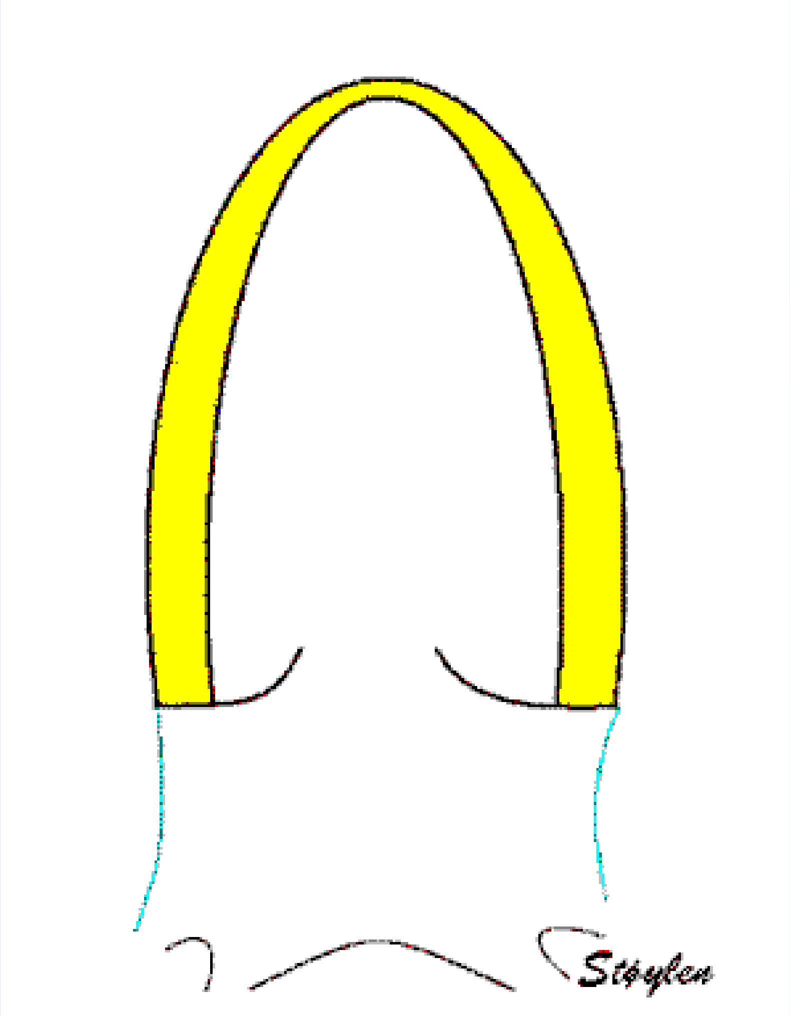


Twist (torsion) & Untwist

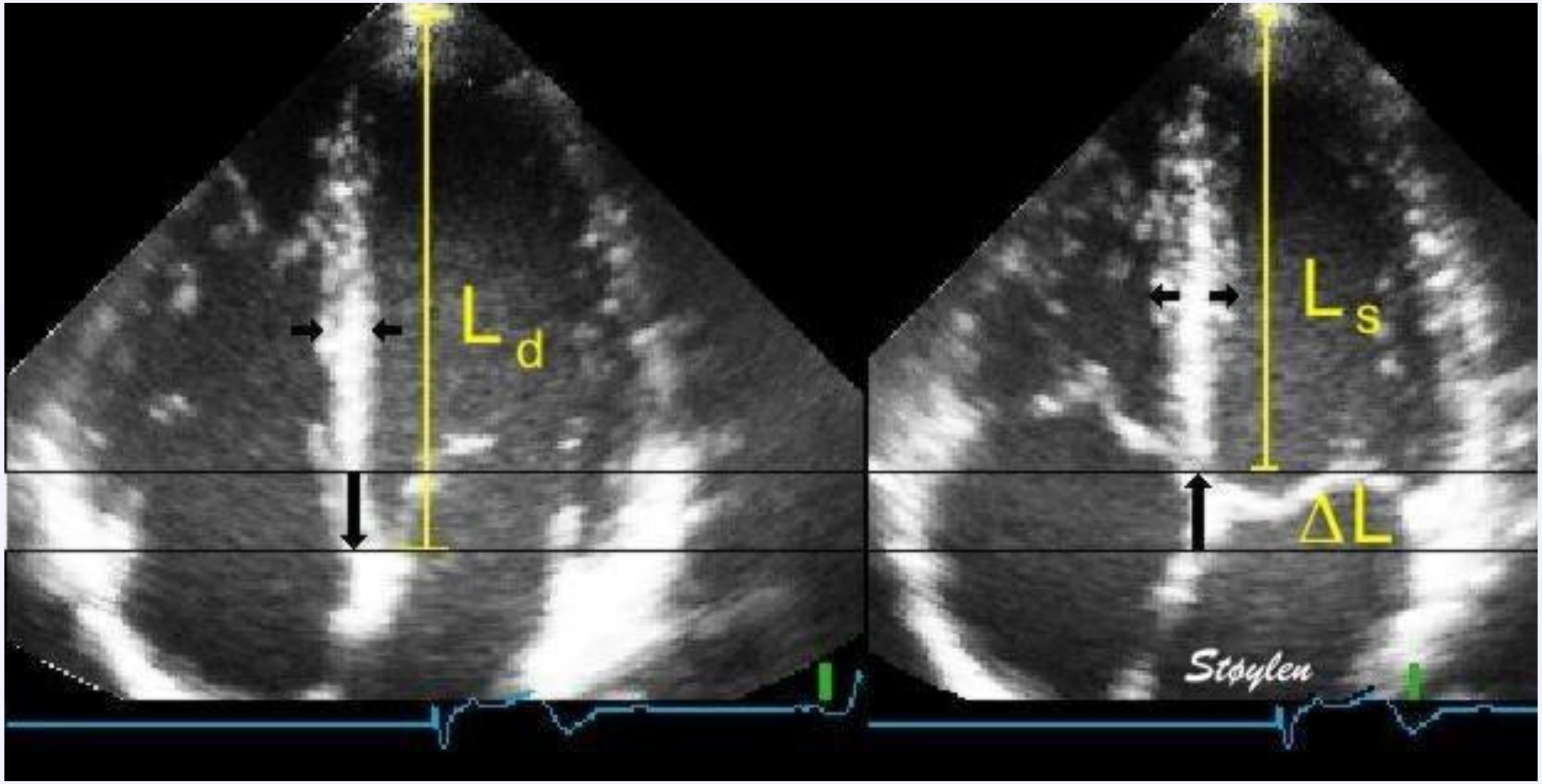
First, was described by Lower in 1669 as "......the wringing of a linen cloth to squeeze out the water"



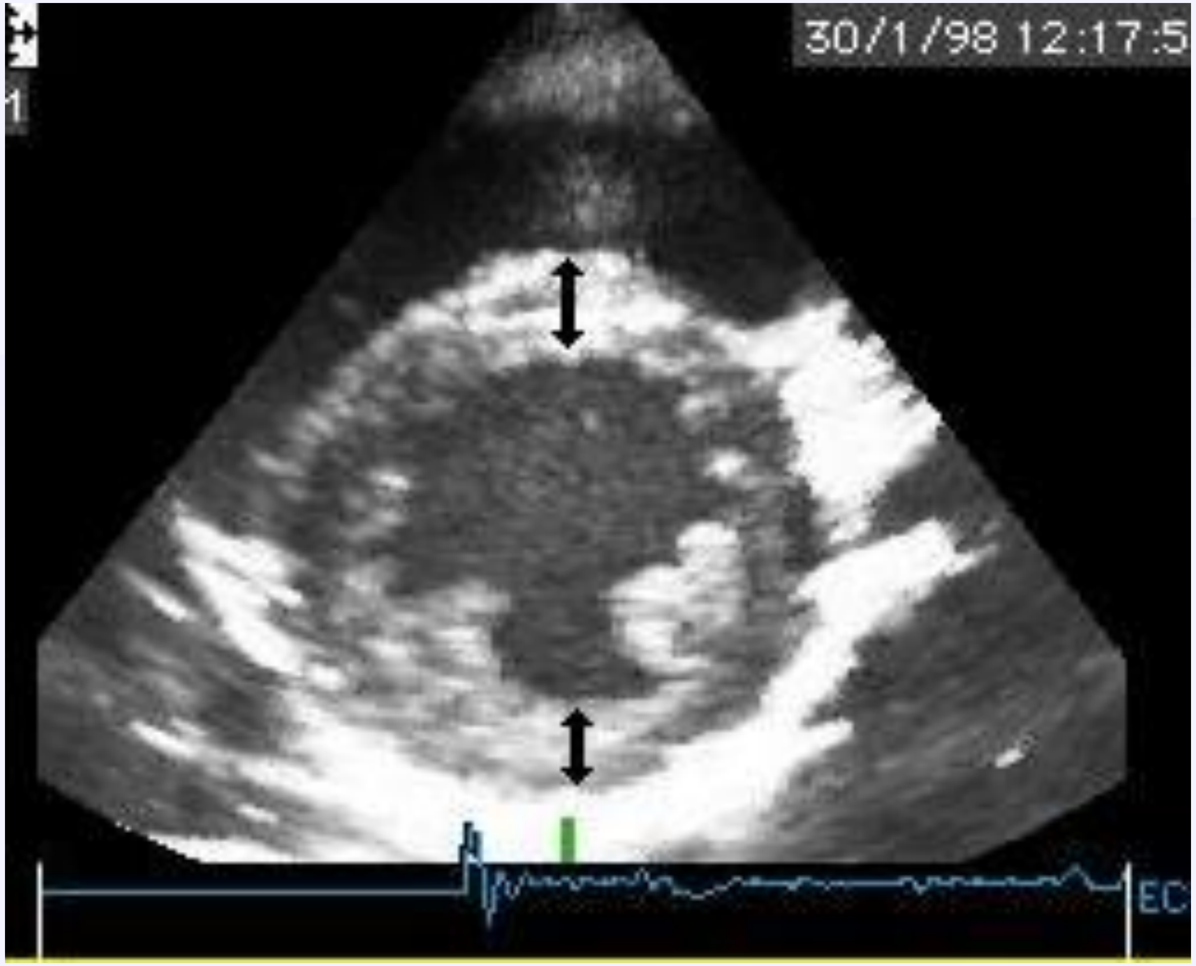
LV with large apical aneurysm



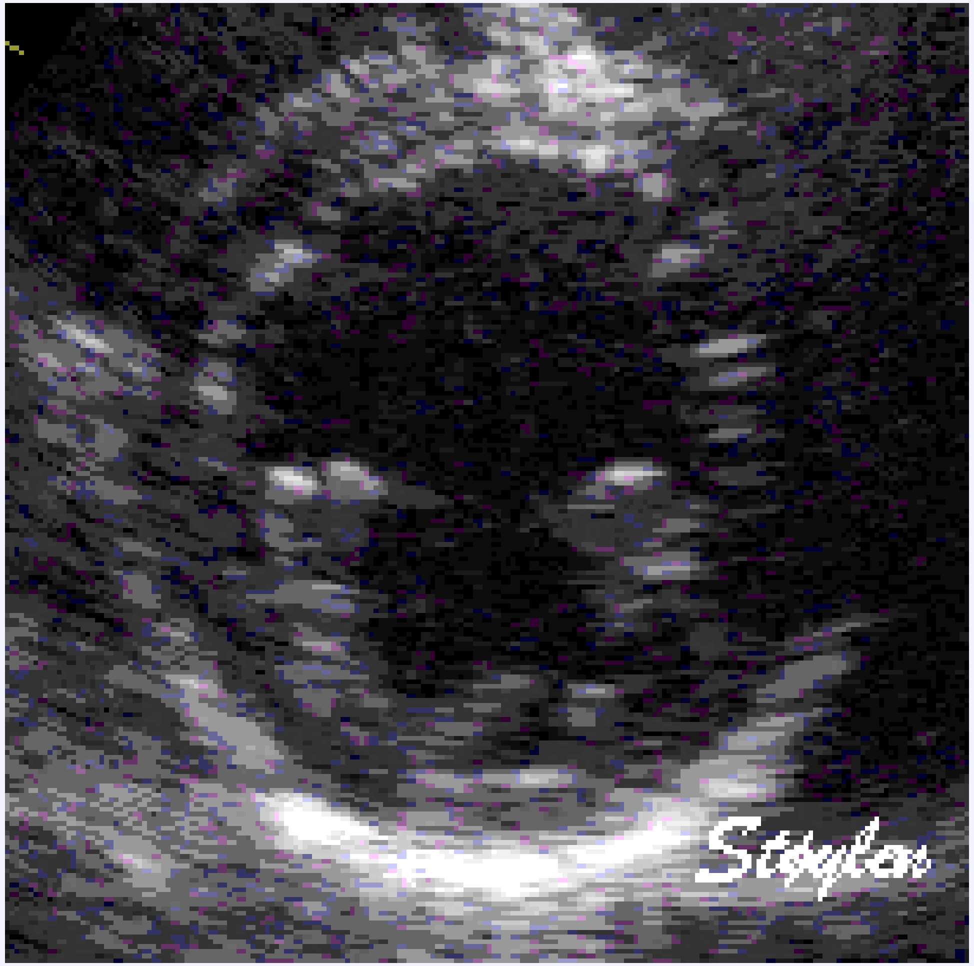
Longitudinal contraction of LV



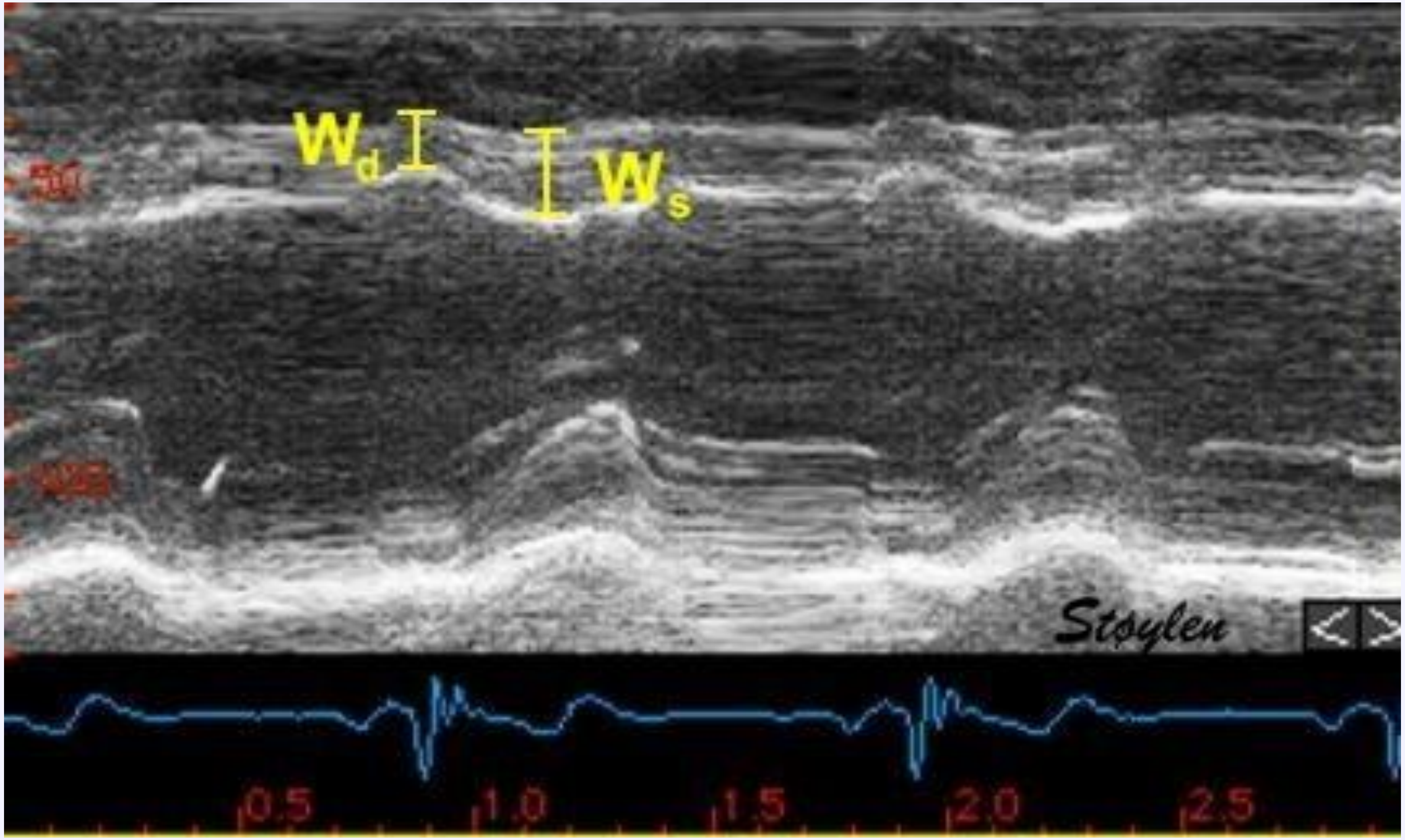
Longitudinal contraction of the LV



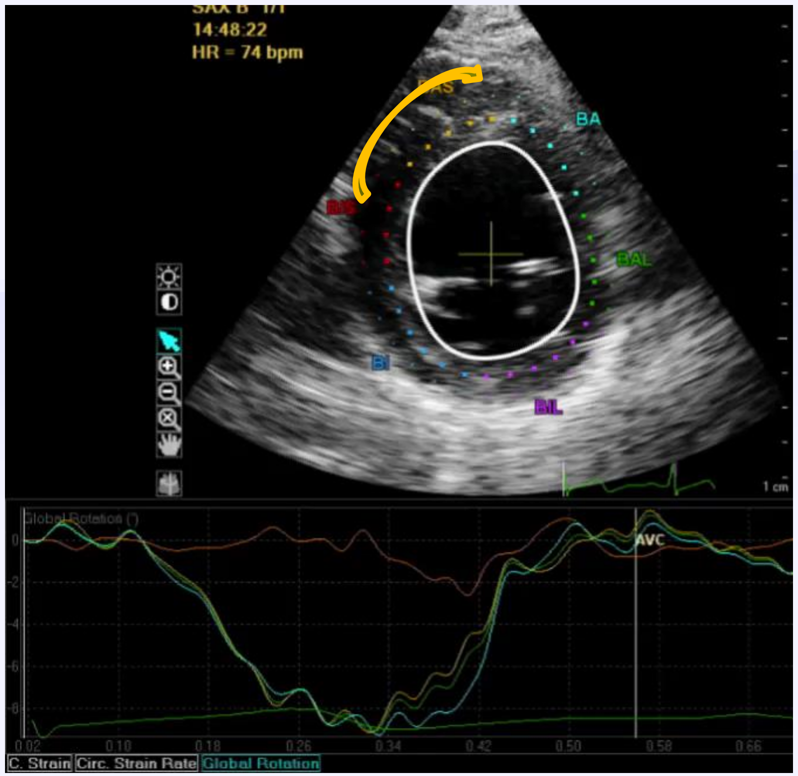
Radial contraction of the LV

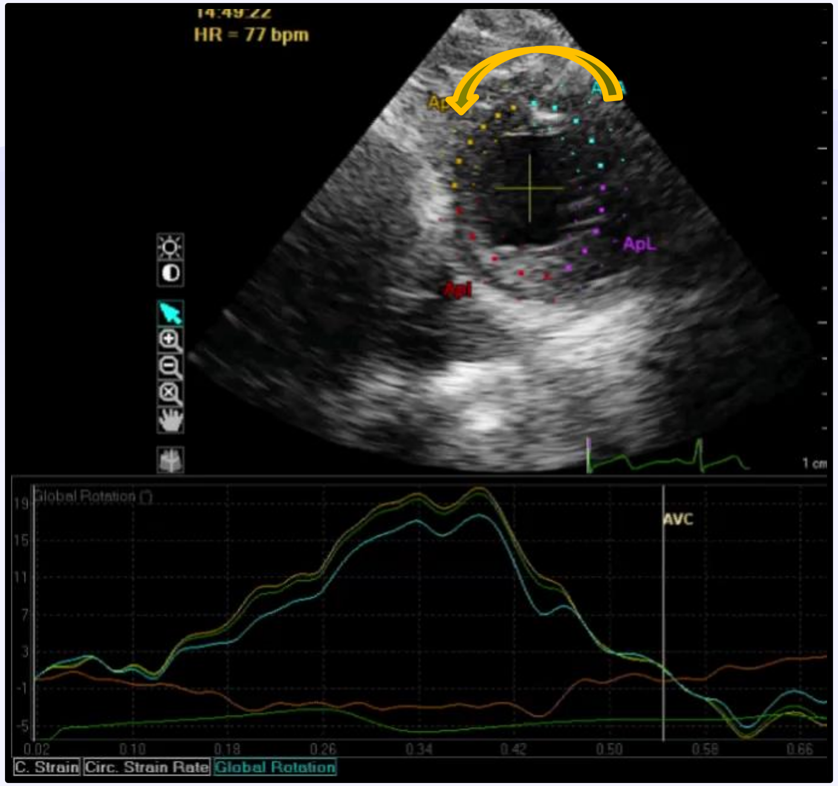


Circumferential contraction of the LV



M-mode of the left ventricle showing radial contraction of the LV

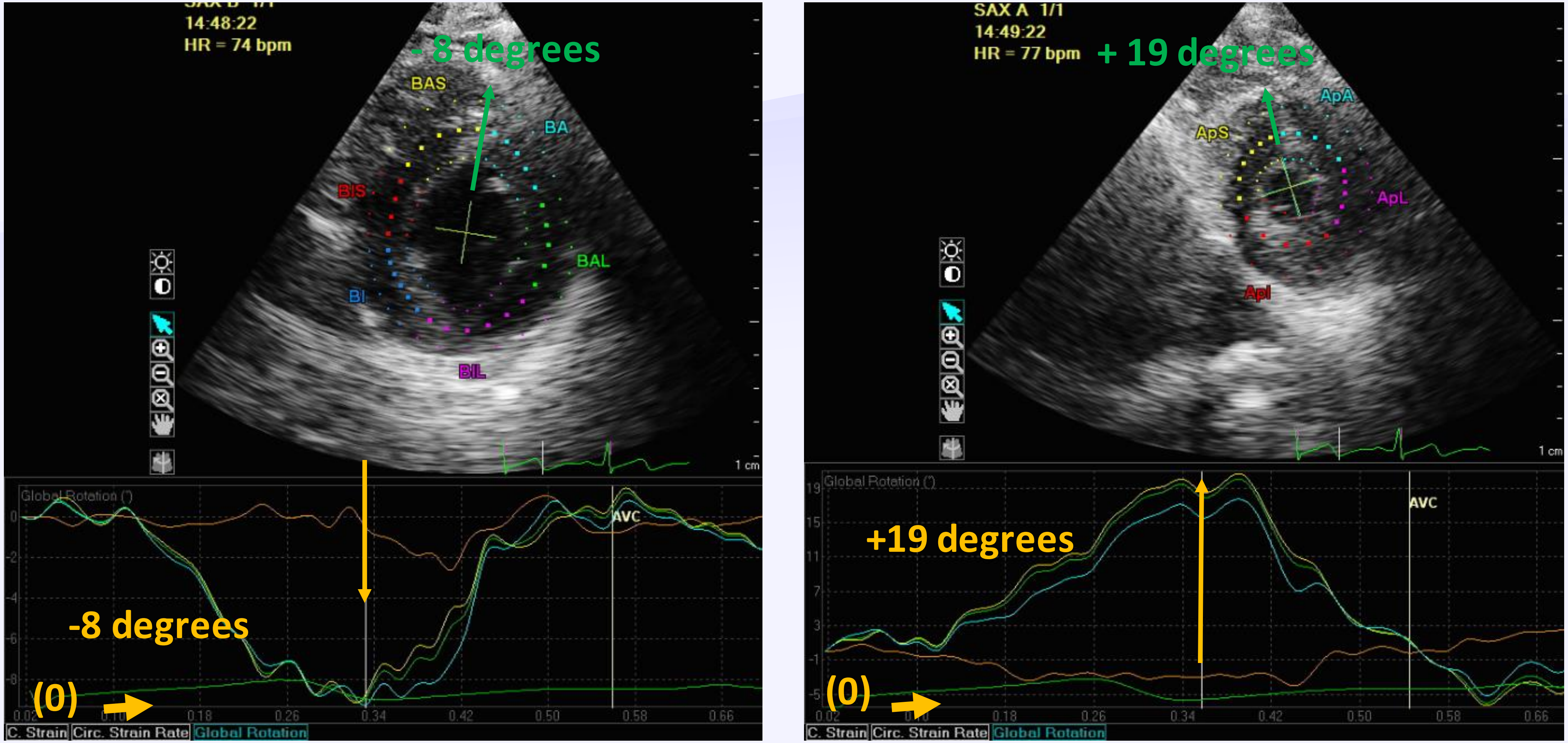




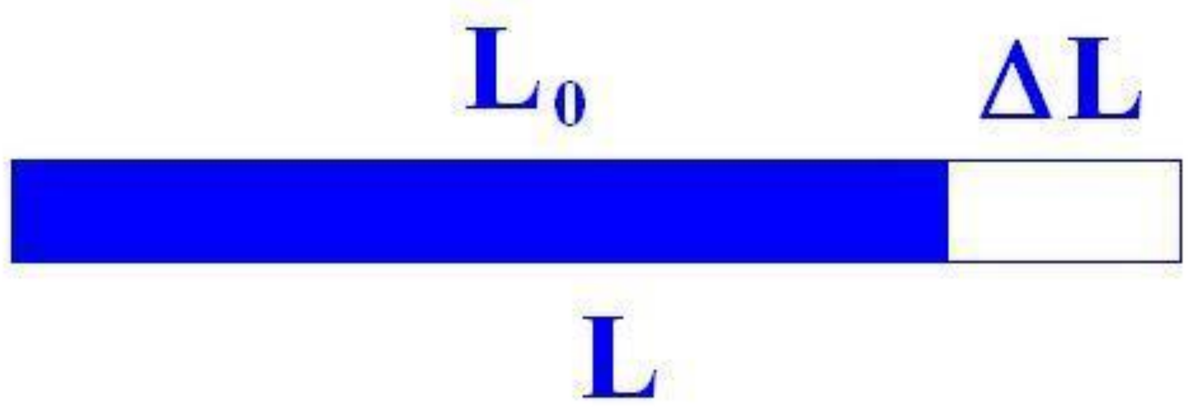
Basal LV, clockwise rotation= -8 degrees (N= -7)

Apical LV, counter-clockwise rotation= + 19 degrees (N= +13)

51-year-old male with severe AS, AI



Net LV twist angle = 27 degrees (Normal= 20)



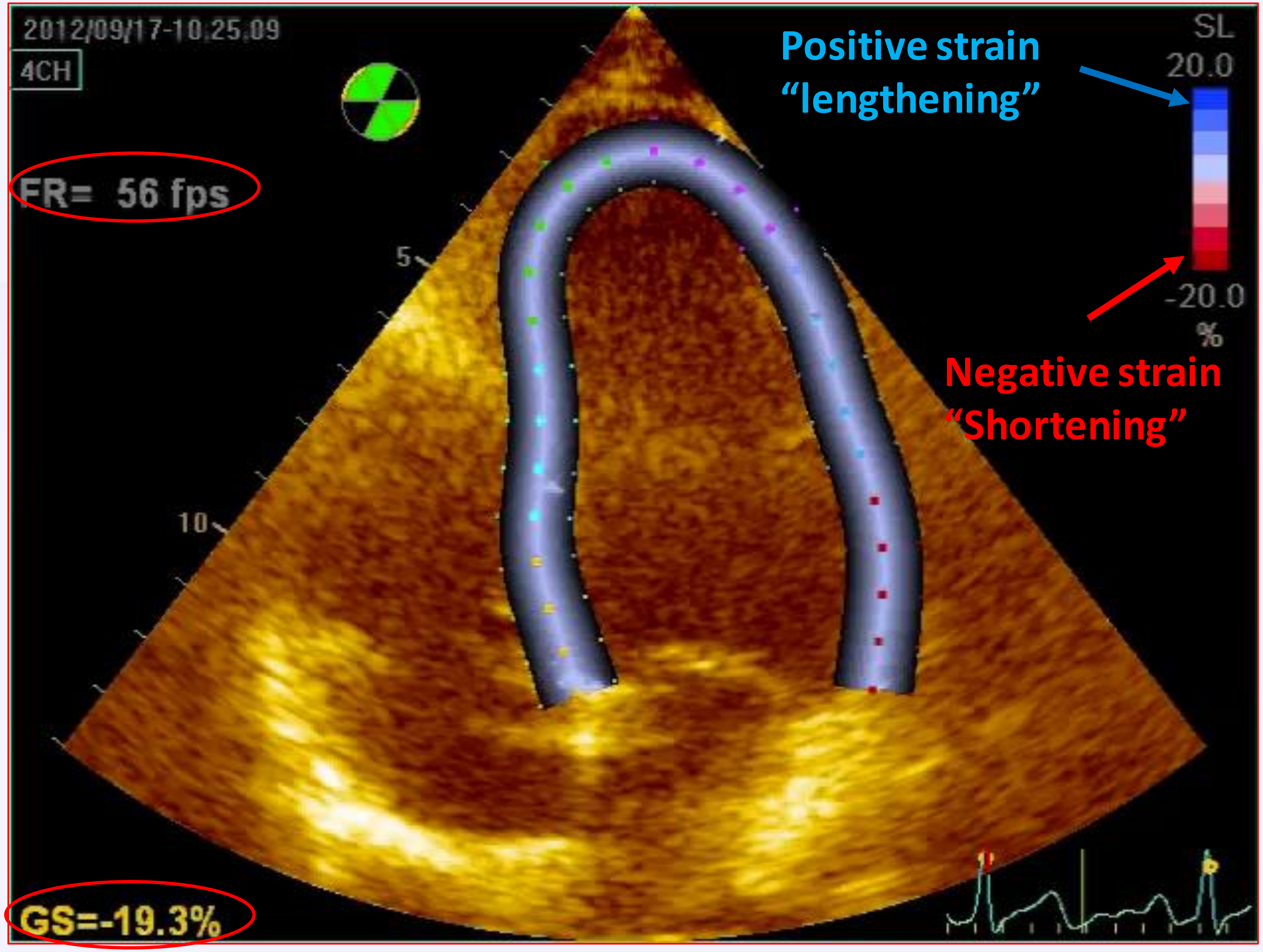
$$\varepsilon = \frac{L - L_0}{L_0} = \frac{\Delta L}{L_0}$$

Støylen

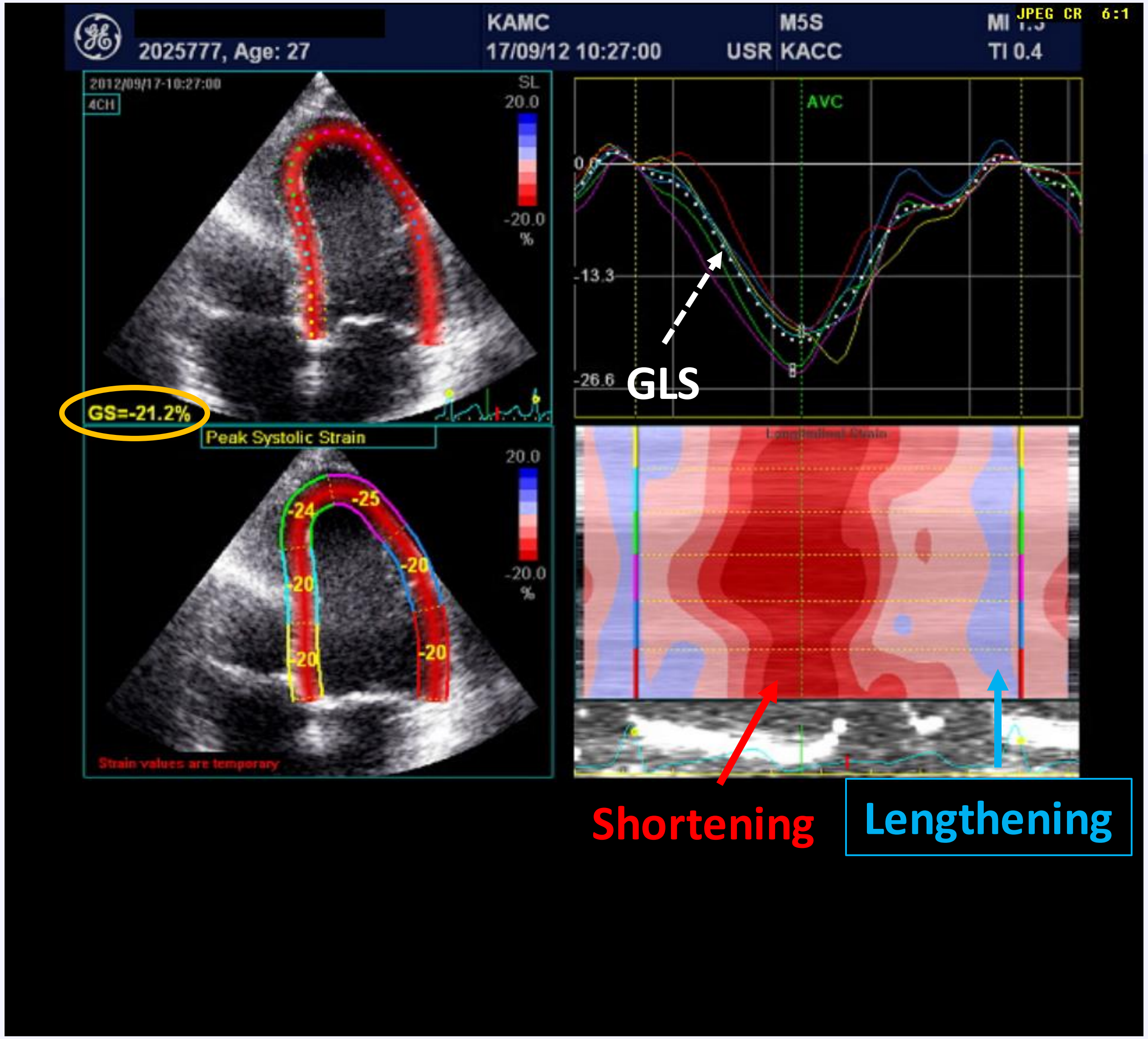
Strain, **“stretching” means the deformation(unit less)**

Strain Rate is the rate by which the deformation occurs, i.e. deformation of strain per time unit. The unit of strain rate is /s or s^{-1}.

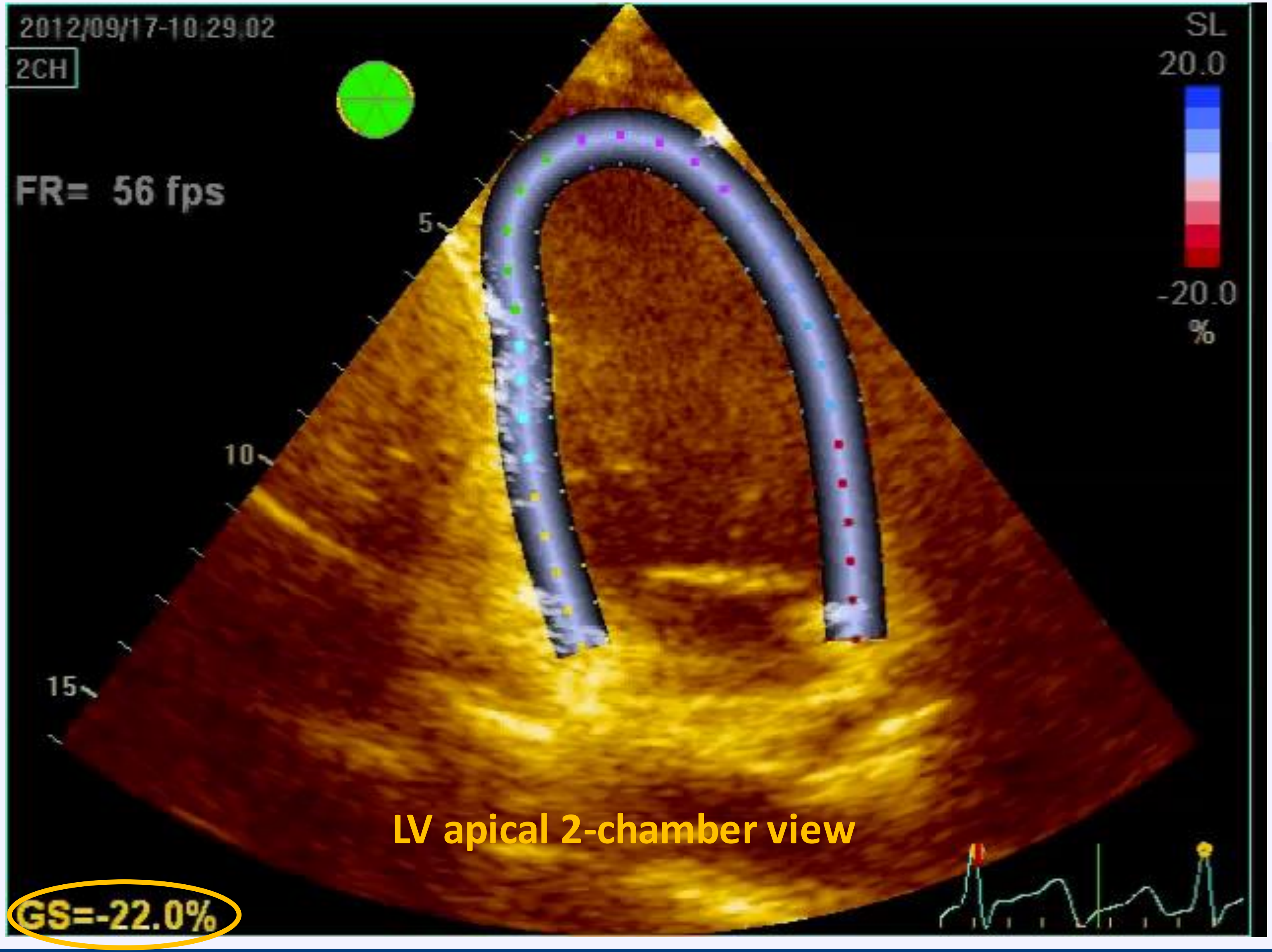
$$\dot{\varepsilon} = \frac{\Delta\varepsilon}{\Delta t}$$



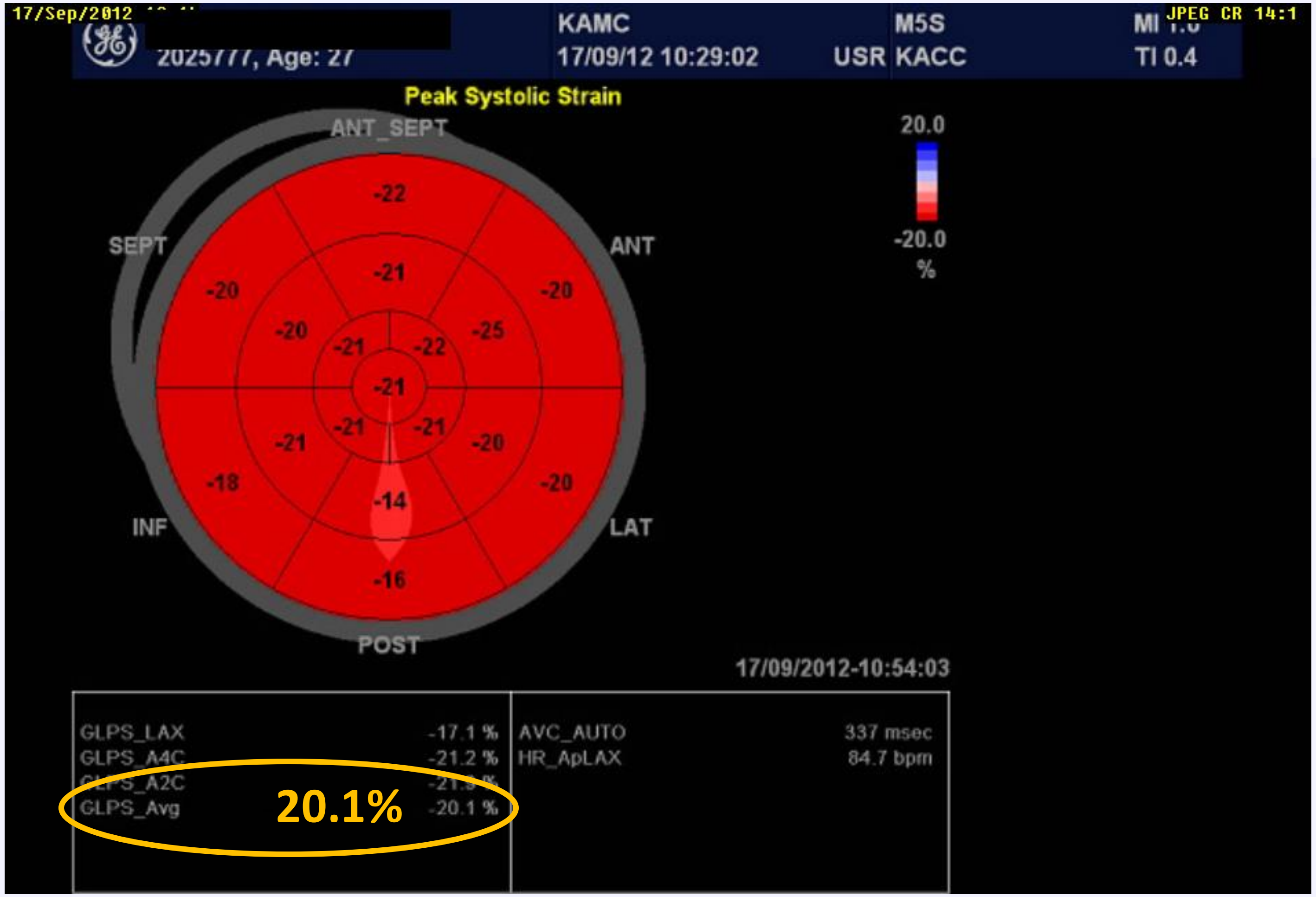
2012/09/17-10:25:09
4CH
FR= 56 fps
GS=-19.3%
SL
20.0
-20.0
%
Positive strain
"lengthening"
Negative strain
"Shortening"



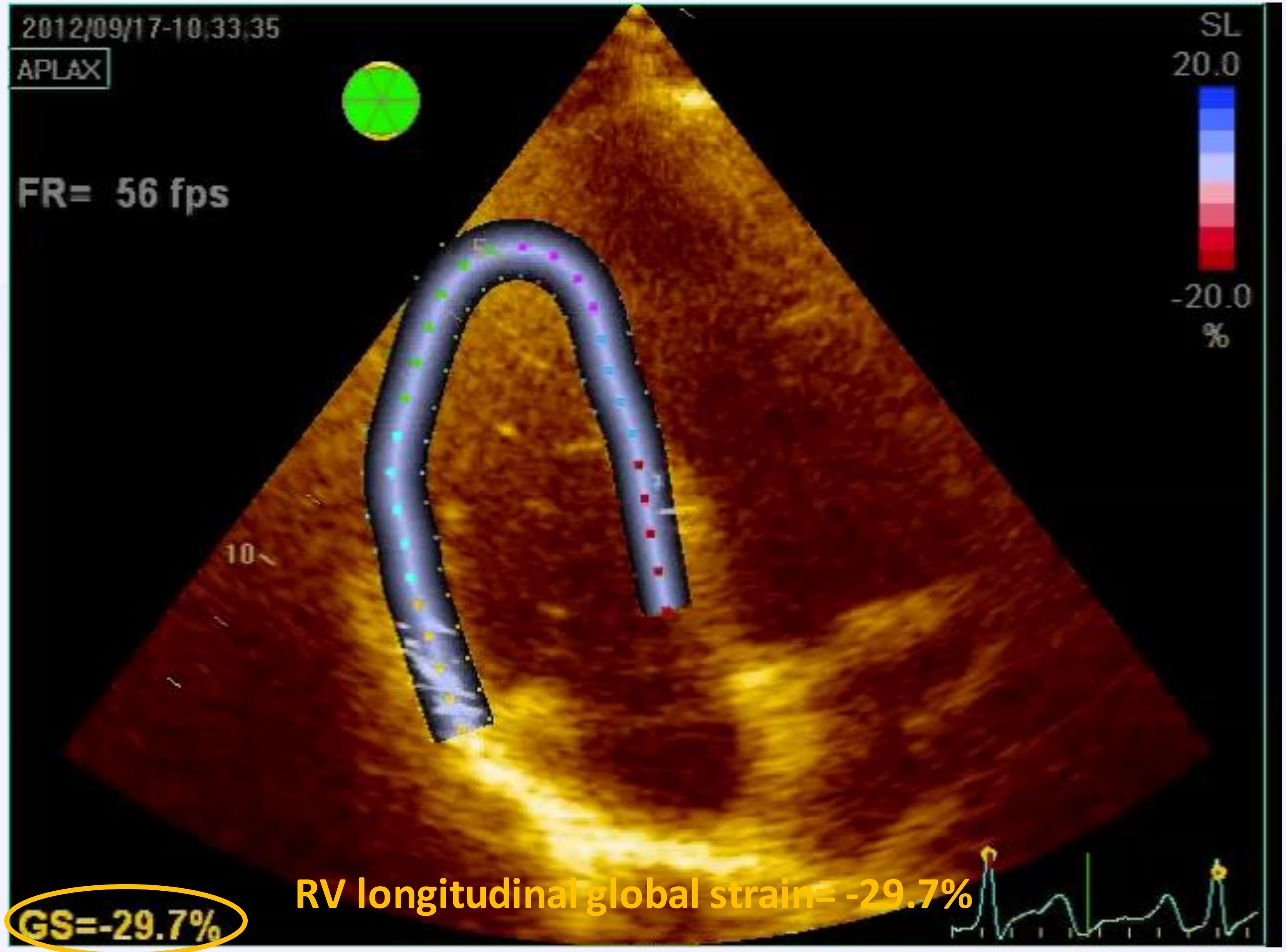
[redacted]
2025777, Age: 27
KAMC
17/09/12 10:27:00
M5S
USR KACC
JPEG CR 6:1
TI 0.4
2012/09/17-10:27:00
4CH
SL
20.0
-20.0
%
AVC
0.0
-13.3
-26.6
GLS
GS=-21.2%
Peak Systolic Strain
-24
-25
-20
-20
-20
-20
Strain values are temporary
Shortening
Lengthening



2012/09/17-10:29:02
2CH
FR= 56 fps
SL
20.0
-20.0
%
5
10
15
LV apical 2-chamber view
GS=-22.0%



“Bull’s eye” plot of strain values for each of the 17 myocardial segments


2012/09/17-10:33:35
APLAX
FR= 56 fps
SL
20.0
-20.0
%
10
GS=-29.7%
RV longitudinal global strain= -29.7%

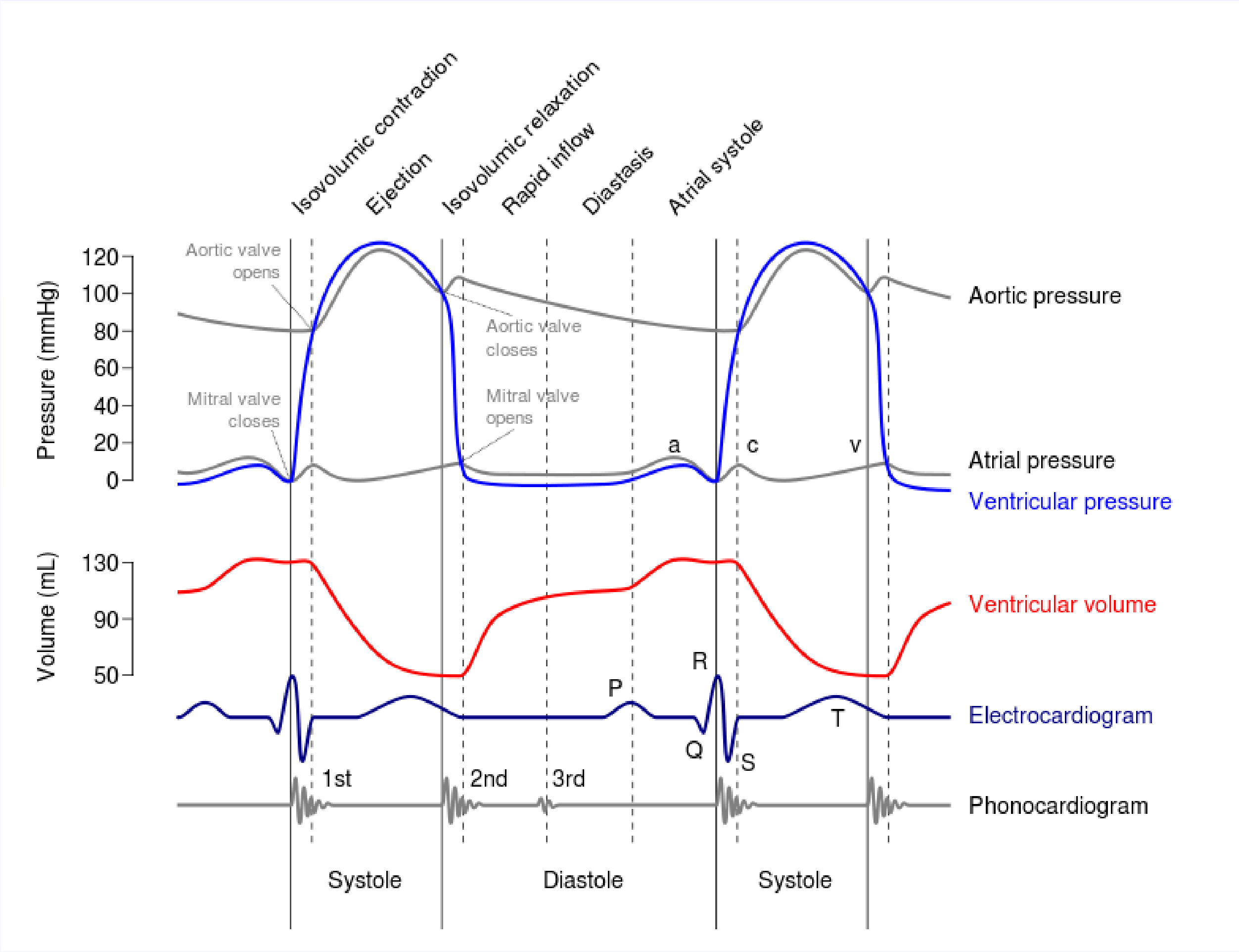
Contractile Performance of the Intact Heart

There are 4 main determinants of myocardial contractile performance:

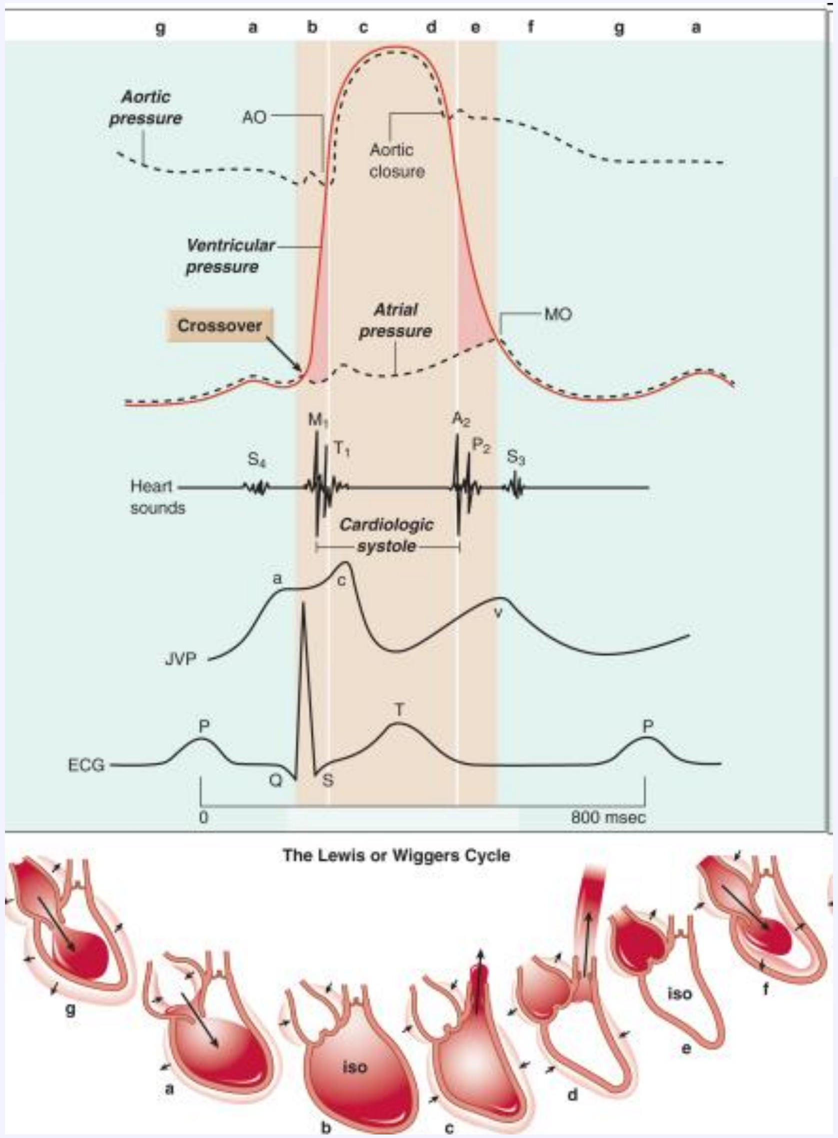
1. **Contractility (inotropic state of the myocardium)**
2. **Loading conditions**
3. **Heart rate**
4. **Synergy of LV contraction (ventricular synchrony)**

1883- 1963

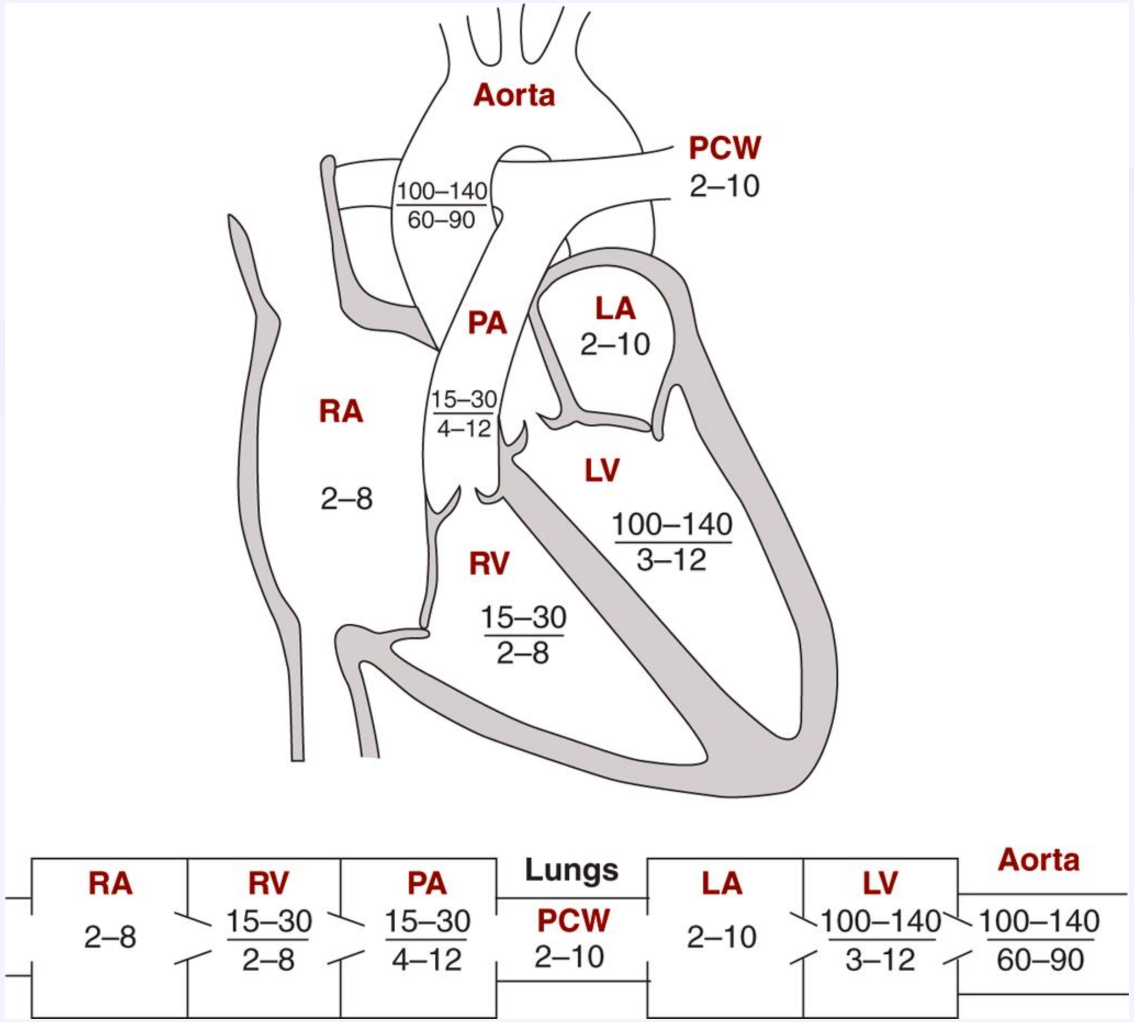
Wiggers diagram for cardiac events (left heart)



The mechanical events in the cardiac cycle, first assembled by Lewis in 1920 but conceived earlier by Wiggers, in 1915.



g
a
b
c
d
e
f
g
a
Aortic pressure
AO
Aortic closure
Ventricular pressure
Crossover
Atrial pressure
MO
Heart sounds
S4
M1
T1
A2
P2
S3
Cardiologic systole
a
c
v
JVP
ECG
P
Q
S
T
P
0
800 msec
The Lewis or Wiggers Cycle
iso
iso



Normal pressures in cardiac chambers

How to assess RV and LV systolic function by TEE?

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

Roberto M. Lang, MD, FASE, FESC, Luigi P. Badano, MD, PhD, FESC, Victor Mor-Avi, PhD, FASE, Jonathan Afilalo, MD, MSc, Anderson Armstrong, MD, MSc, Laura Ernande, MD, PhD, Frank A. Flachskampf, MD, FESC, Elyse Foster, MD, FASE, Steven A. Goldstein, MD, Tatiana Kuznetsova, MD, PhD, Patrizio Lancellotti, MD, PhD, FESC, Denisa Muraru, MD, PhD, Michael H. Picard, MD, FASE, Ernst R. Rietzschel, MD, PhD, Lawrence Rudski, MD, FASE, Kirk T. Spencer, MD, FASE, Wendy Tsang, MD, and Jens-Uwe Voigt, MD, PhD, FESC, *Chicago, Illinois; Padua, Italy; Montreal, Quebec and Toronto, Ontario, Canada; Baltimore, Maryland; Créteil, France; Uppsala, Sweden; San Francisco, California; Washington, District of Columbia; Leuven, Liège, and Ghent, Belgium; Boston, Massachusetts*

JASE 2015

Table 1 Recommendations for the echocardiographic assessment of LV size and function

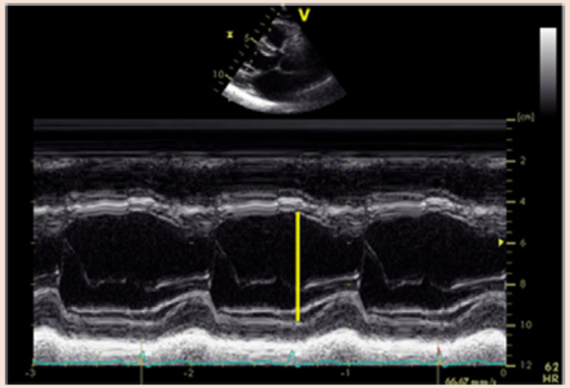
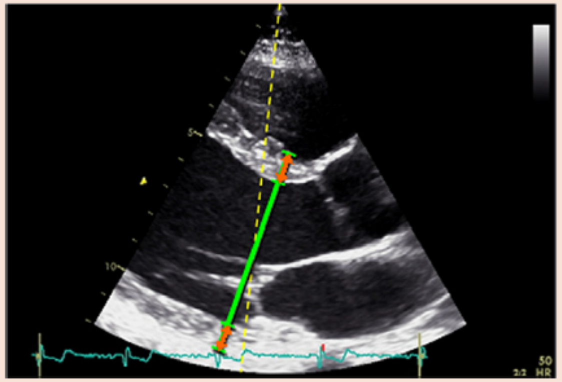
Parameter and method	Technique	Advantages	Limitations
Internal linear dimensions. Linear internal measurements of the LV should be acquired in the parasternal long-axis view carefully obtained perpendicular to the LV long axis, and measured at the level of the mitral valve leaflet tips. Electronic calipers should be positioned on the interface between myocardial wall and cavity and the interface between wall and pericardium (*orange arrows*).	M-mode tracing 	• Reproducible • High temporal resolution • Wealth of published data	• Beam orientation frequently off axis • Single dimension, i.e., representative only in normally shaped ventricles
	2D-guided linear measurements 	• Facilitates orientation perpendicular to the ventricular long axis	• Lower frame rates than M-mode • Single dimension, i.e., representative only in normally shaped ventricles

Table 1 Recommendations for the echocardiographic assessment of LV size and function **Cont.**

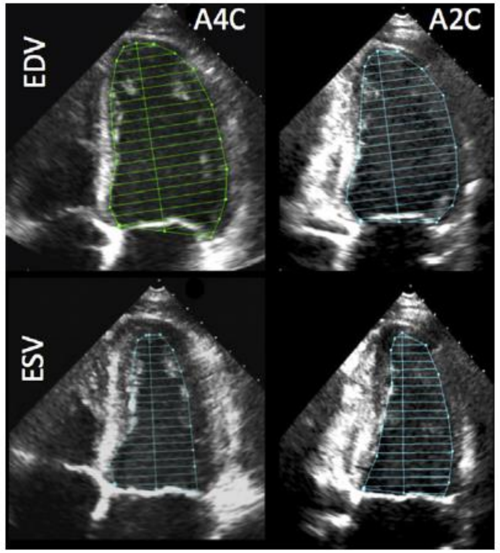
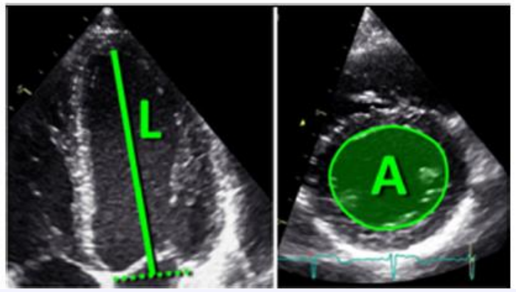
Parameter and method	Technique	Advantages	Limitations
Volumes. Volume measurements are usually based on tracings of the blood-tissue interface in the apical four- and two-chamber views. At the mitral valve level, the contour is closed by connecting the two opposite sections of the mitral ring with a straight line. LV length is defined as the distance between the middle of this line and the most distant point of the LV contour.	Biplane disk summation 	• Corrects for shape distortions • Less geometrical assumptions compared with linear dimensions	• Apex frequently foreshortened • Endocardial dropout • Blind to shape distortions not visualized in the apical two- and four-chamber planes
	Area-length 	• Partial correction for shape distortion	• Apex frequently foreshortened • Heavily based on geometrical assumptions • Limited published data on normal population

Table 1 Recommendations for the echocardiographic assessment of LV size and function **Cont.**

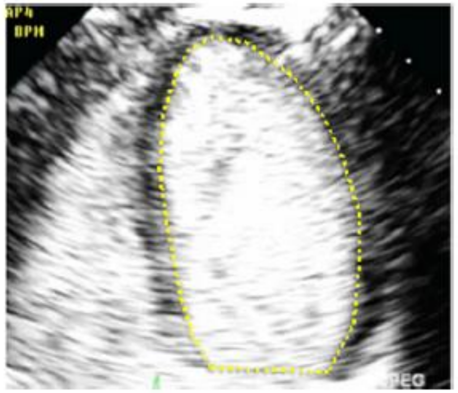
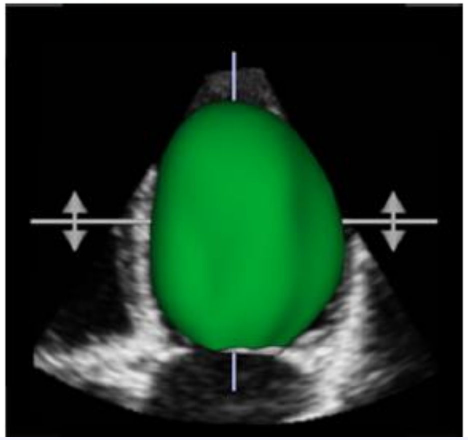
Parameter and method	Technique	Advantages	Limitations
	Endocardial border enhancement 	• Helpful in patients with suboptimal acoustic window • Provides volumes that are closer to those measured with cardiac magnetic resonance	• Same limitations as the above non-contrast 2D techniques • Acoustic shadowing 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

Table 1 Recommendations for the echocardiographic assessment of LV size and function **Cont.**

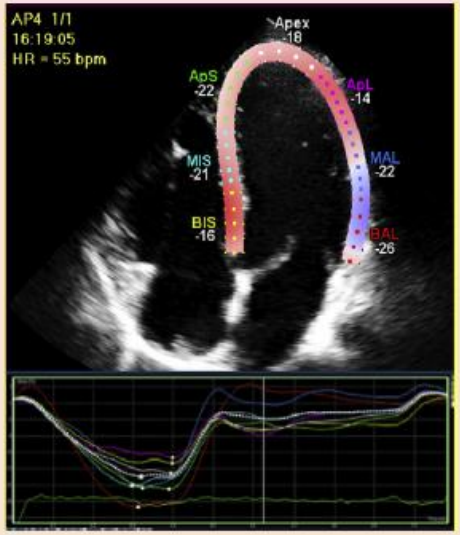
Parameter and method	Technique	Advantages	Limitations
Global Longitudinal Strain. Peak value of 2D longitudinal speckle tracking derived strain (%).		• Angle independent • Established prognostic value	• Vendor dependent

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

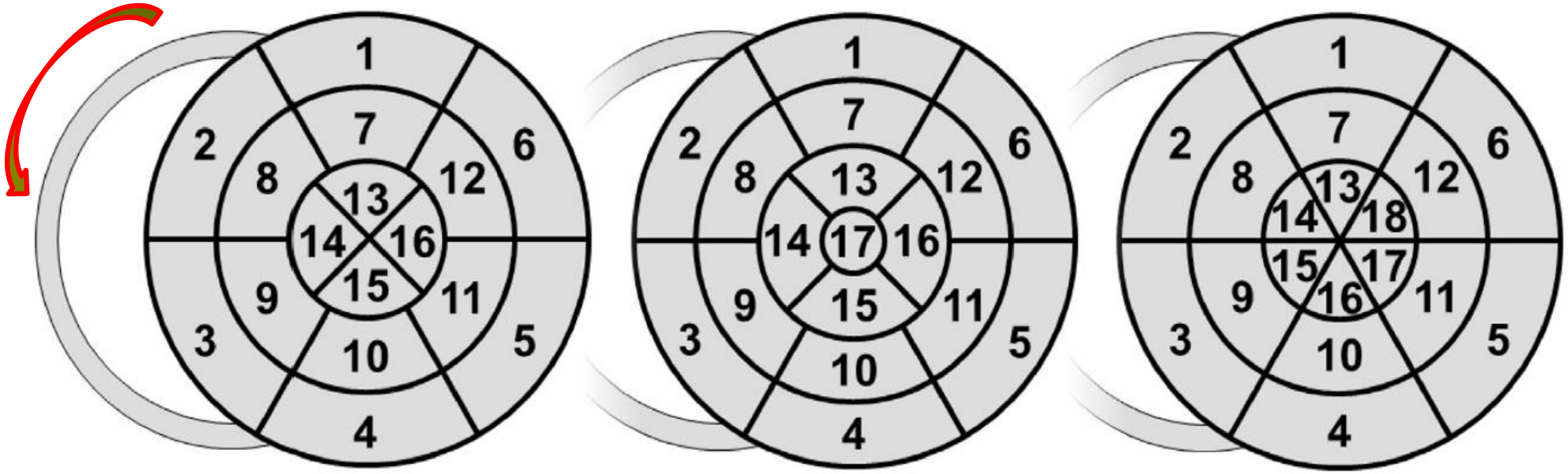
Parameter	Male		Female	
	Mean ± SD	2-SD range	Mean ± SD	2-SD range
LV internal dimension				
Diastolic dimension (mm)	50.2 ± 4.1	42.0–58.4	45.0 ± 3.6	37.8–52.2
Systolic dimension (mm)	32.4 ± 3.7	25.0–39.8	28.2 ± 3.3	21.6–34.8
LV volumes (biplane)				
LV EDV (mL)	106 ± 22	62–150	76 ± 15	46–106
LV ESV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

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

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

Normal values for cardiac chambers by 2D TTE, strain, and 3D were assessed in WASE trial and is going to be presented in ESC 2019 in Paris.

16 segments model, 1995 | 17 segments, 2005 | 18 segments, 2015



all models

1. basal anterior
2. basal anteroseptal
3. basal inferoseptal
4. basal inferior
5. basal inferolateral
6. basal anterolateral
7. mid anterior
8. mid anteroseptal
9. mid inferoseptal
10. mid inferior
11. mid inferolateral
12. mid anterolateral

16 and 17 segment model

13. apical anterior
14. apical septal
15. apical inferior
16. apical lateral

17 segment model only

17. apex

18 segment model only

13. apical anterior
14. apical anteroseptal
15. apical inferoseptal
16. apical inferior
17. apical inferolateral
18. apical anterolateral

Figure 3 Schematic diagram of the different LV segmentation models: 16-segment model (*left*),[36] 17-segment model (*center*),[35] and 18-segment model (*right*). In all diagrams, the outer ring represents the basal segments, the middle ring represents the segments at mid-papillary muscle level, and the inner ring represents the distal level. The anterior insertion of the right ventricular wall into the left ventricle defines the border between the anteroseptal and anterior segments. Starting from this point, the myocardium is subdivided into six equal segments of 60°. The apical myocardium in the 16- and 17-segment models is divided instead into four equal segments of 90°. In the 17-segment model an additional segment (*apical cap*) is added in the center of the bull's-eye. (modified from Voigt *et al*.[24])

17 segments model (TTE views)

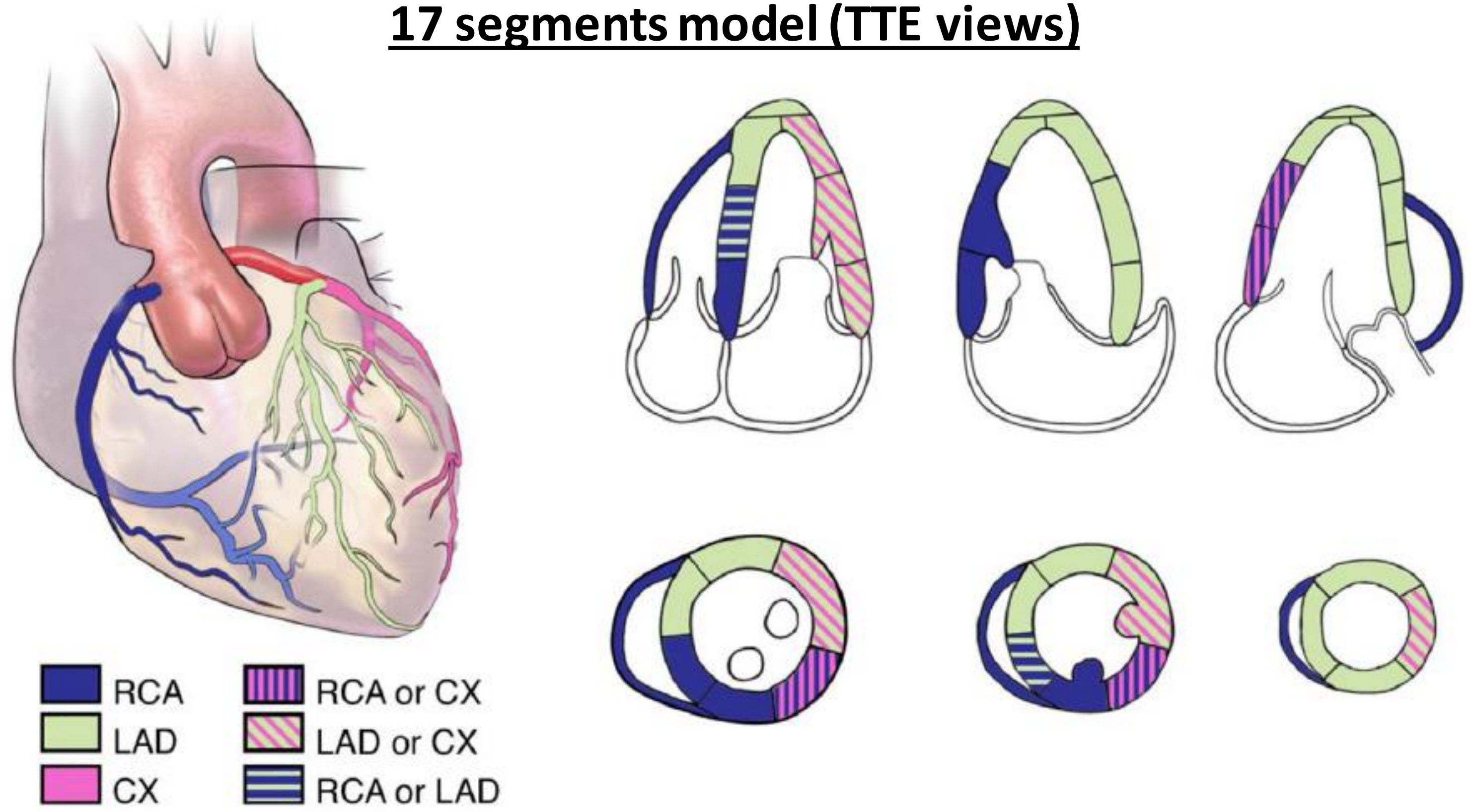


Figure 5 Typical distributions of the right coronary artery (RCA), the left anterior descending coronary artery (LAD), and the circumflex coronary artery (CX). The arterial distribution varies among patients. Some segments have variable coronary perfusion.

18 segments model (TEE views)

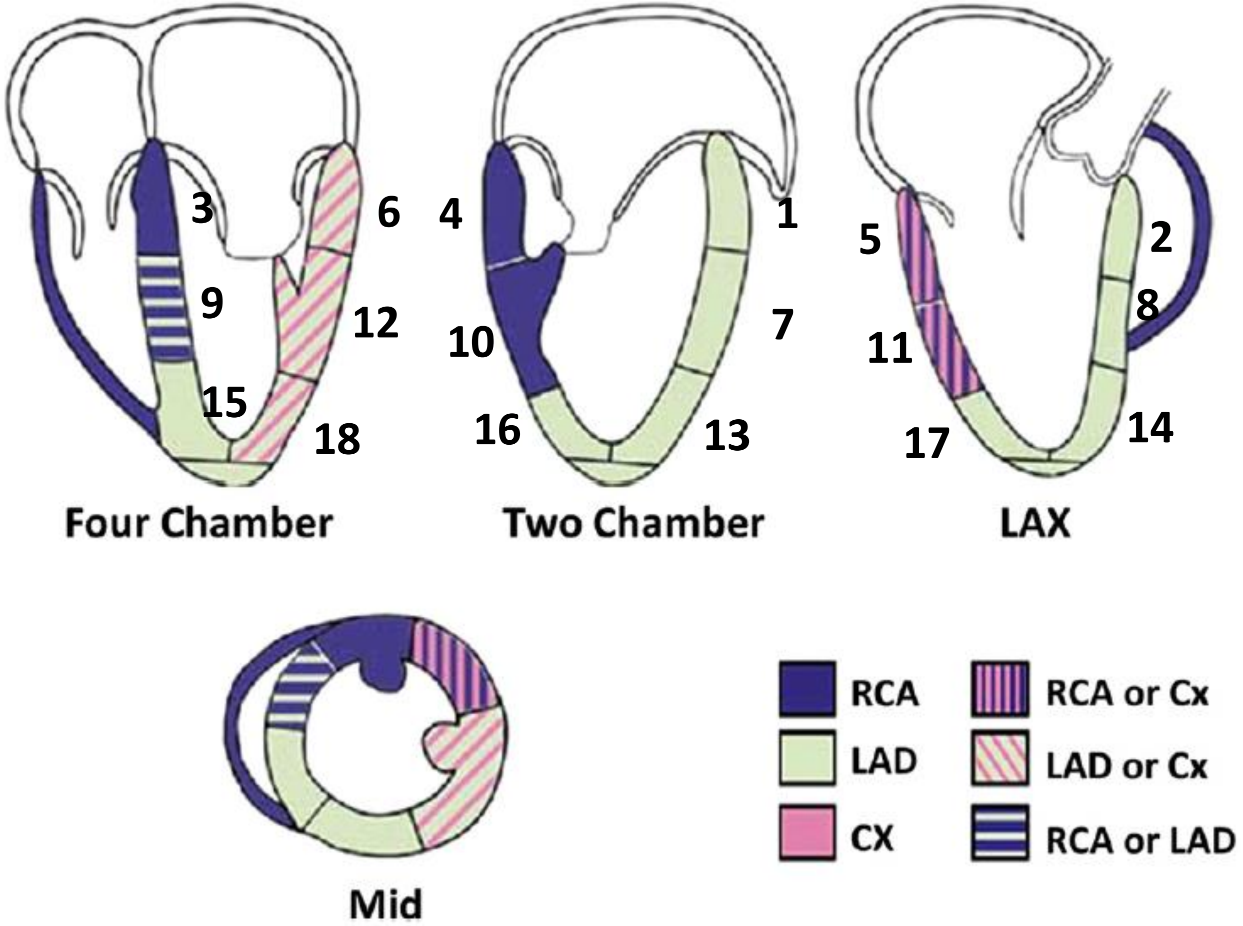
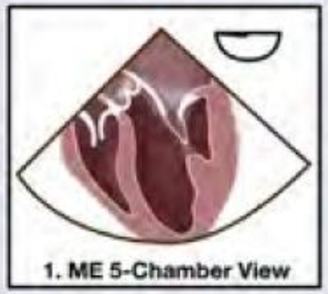
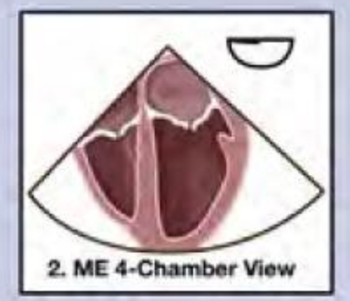
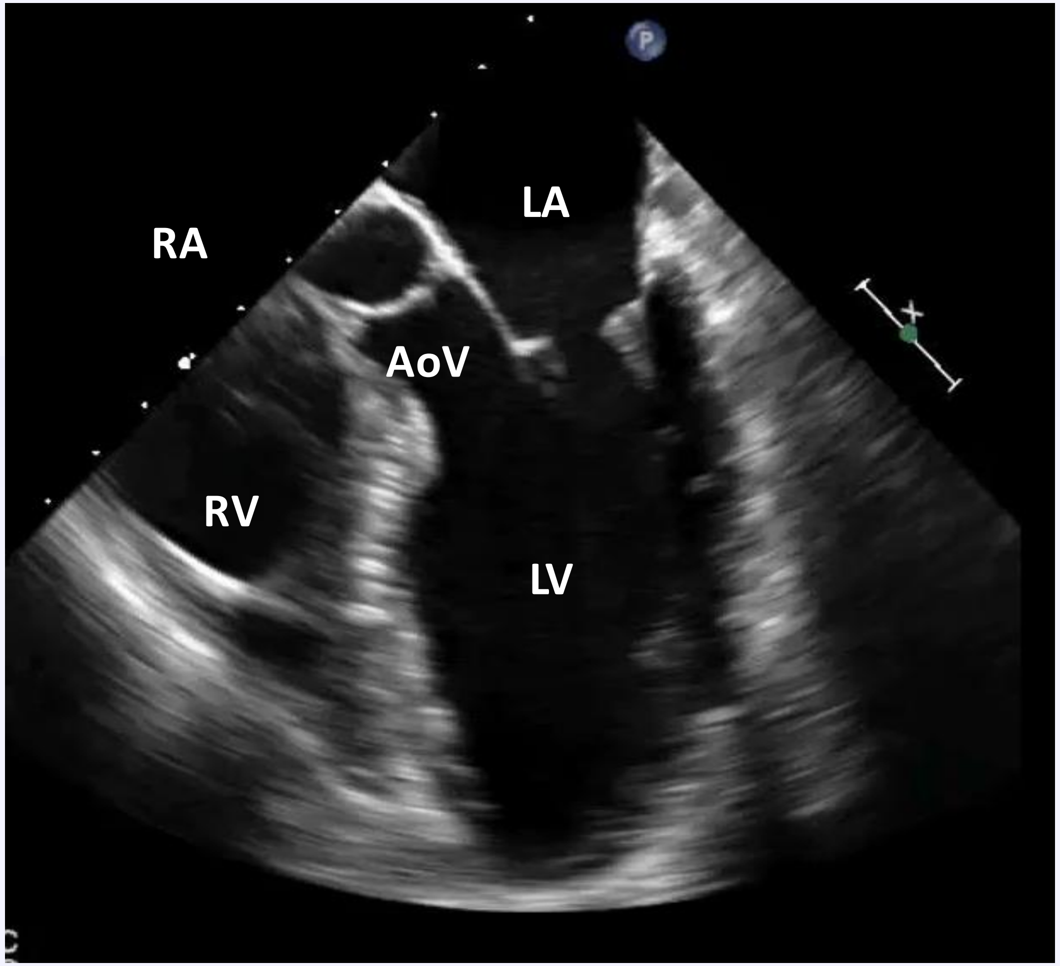


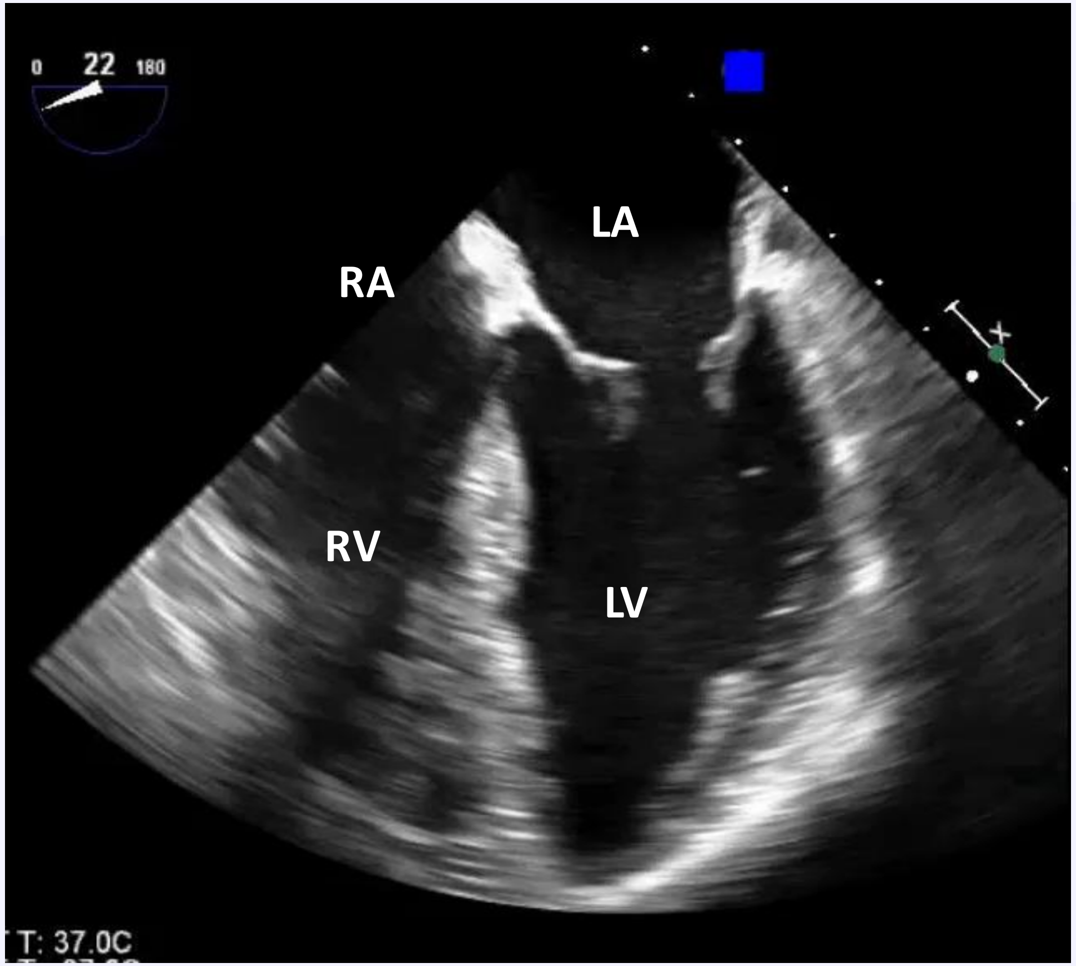
Figure 4 Typical distributions of the RCA, the LAD coronary artery, and the circumflex (CX) coronary artery from transesophageal views of the left ventricle. The arterial distribution varies among patients. Some segments have variable coronary perfusion. Modified with permission from Lang *et al*.[17]

Imaging Plane	3D Model	2D TEE Image	Acquisition Protocol	Structures Imaged
Midesophageal Views				
 1. ME 5-Chamber View			**Transducer Angle:** ~ 0 - 10^0 **Level:** Mid-esophageal **Maneuver** (from prior image): NA	Aortic valve LVOT Left atrium/Right atrium Left ventricle/Right ventricle/IVS Mitral valve (A_2A_1-P_1) Tricuspid valve
 2. ME 4-Chamber View			**Transducer Angle:** ~ 0 - 10^0 **Level:** Mid-esophageal **Maneuver** (from prior image): Advance ± Retroflex	Left atrium/Right atrium IAS Left ventricle/Right ventricle/IVS Mitral valve (A_3A_2-P_2P_1) Tricuspid valve

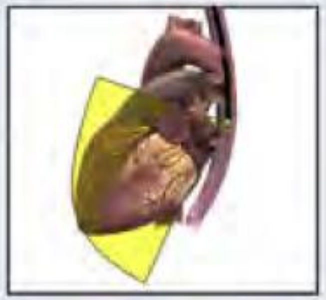
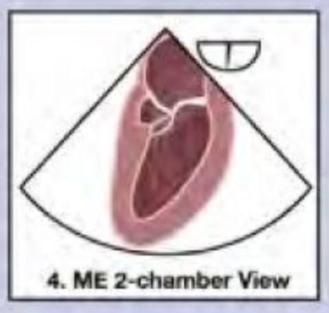
2013 ASE guideline on comprehensive TEE



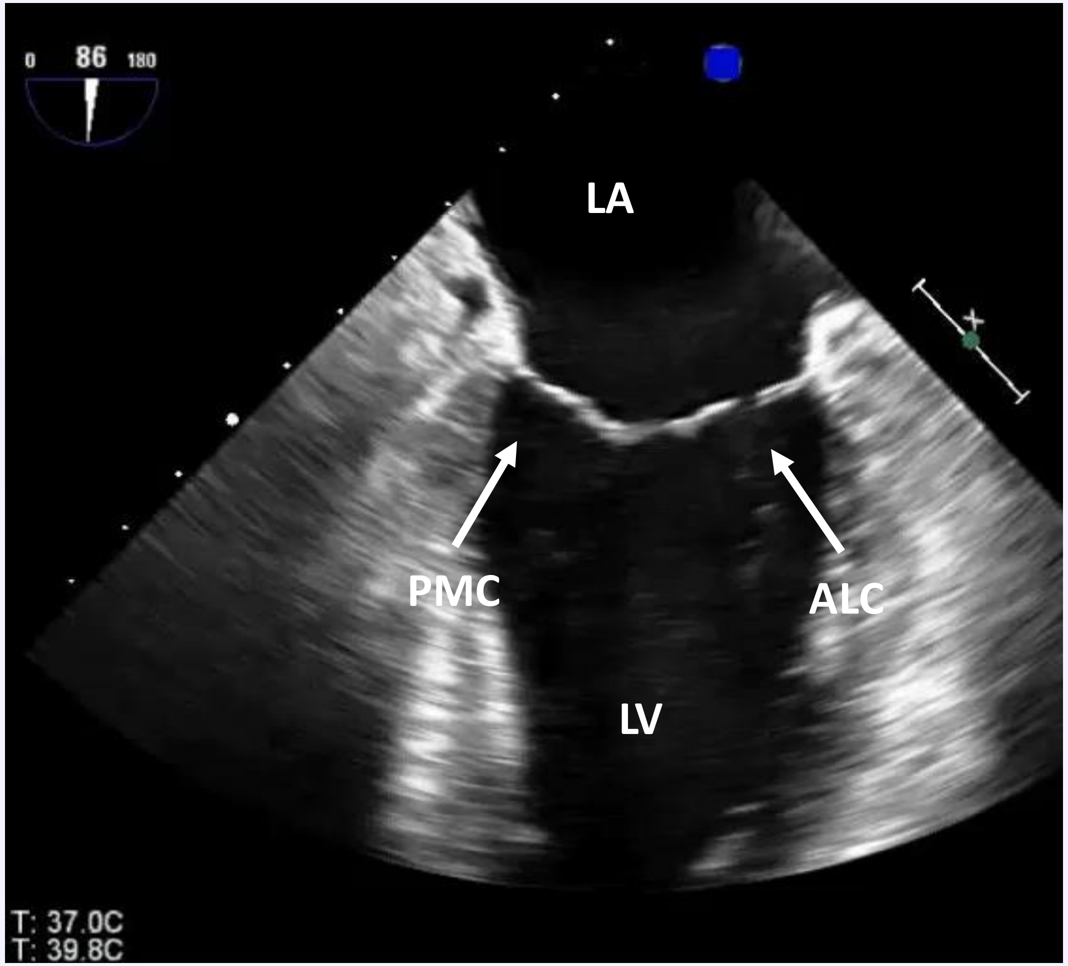
1- ME 5-Chamber View



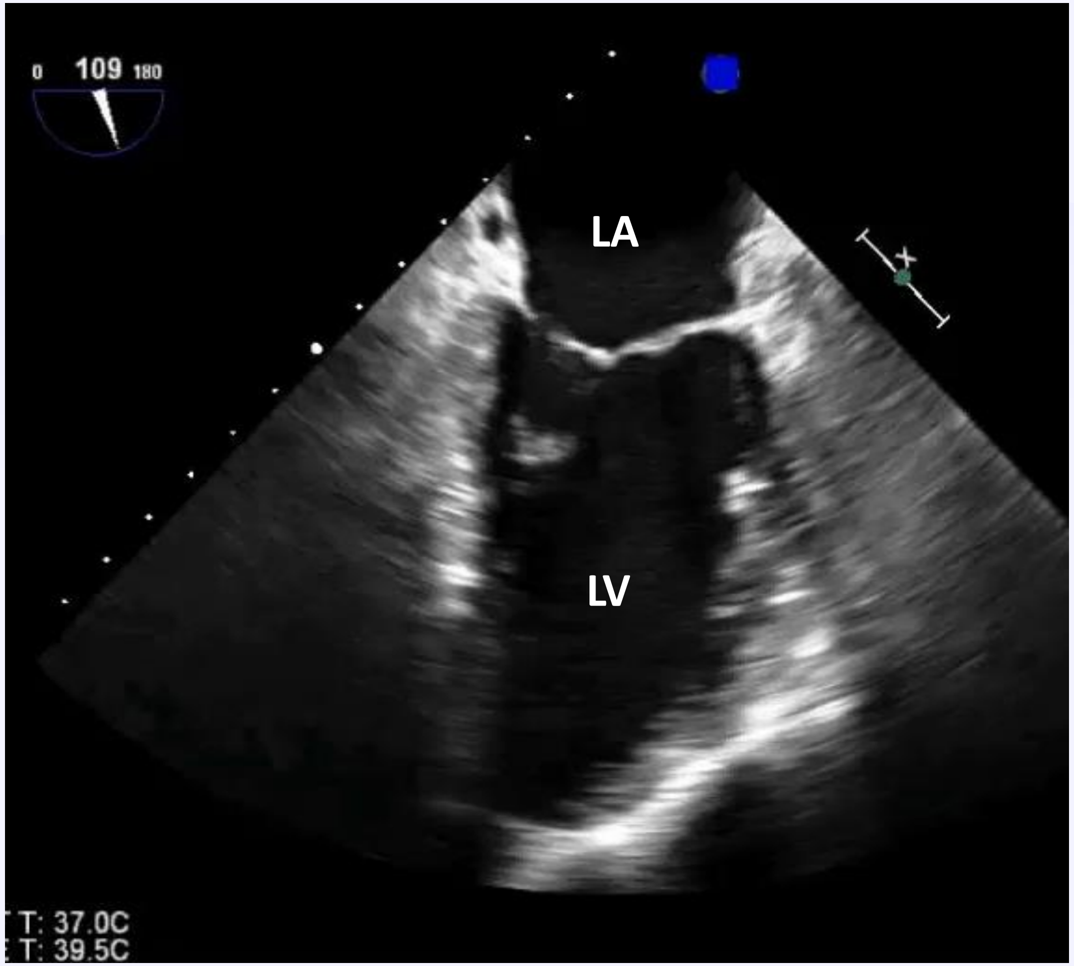
2- ME 4-Chamber View

			**Transducer Angle:** ~ 50 - 70^0 **Level:** Mid-esophageal **Maneuver** (from prior image): NA	Left atrium Coronary Sinus Left ventricle Mitral Valve (P_3- $A_3A_2A_1$ - P_1) Papillary muscles Chordae tendinae
			**Transducer Angle:** ~ 80 - 100^0 **Level:** Mid-esophageal **Maneuver** (from prior image): NA	Left atrium Coronary sinus Left atrial appendage Left ventricle Mitral valve (P_3- $A_3A_2A_1$)

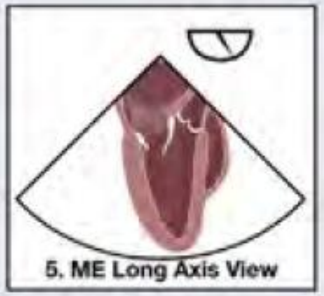
Correction: LAA?

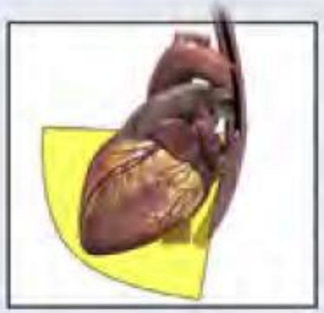


3- ME Mitral Commissural View



★ 4- ME 2-Chamber View



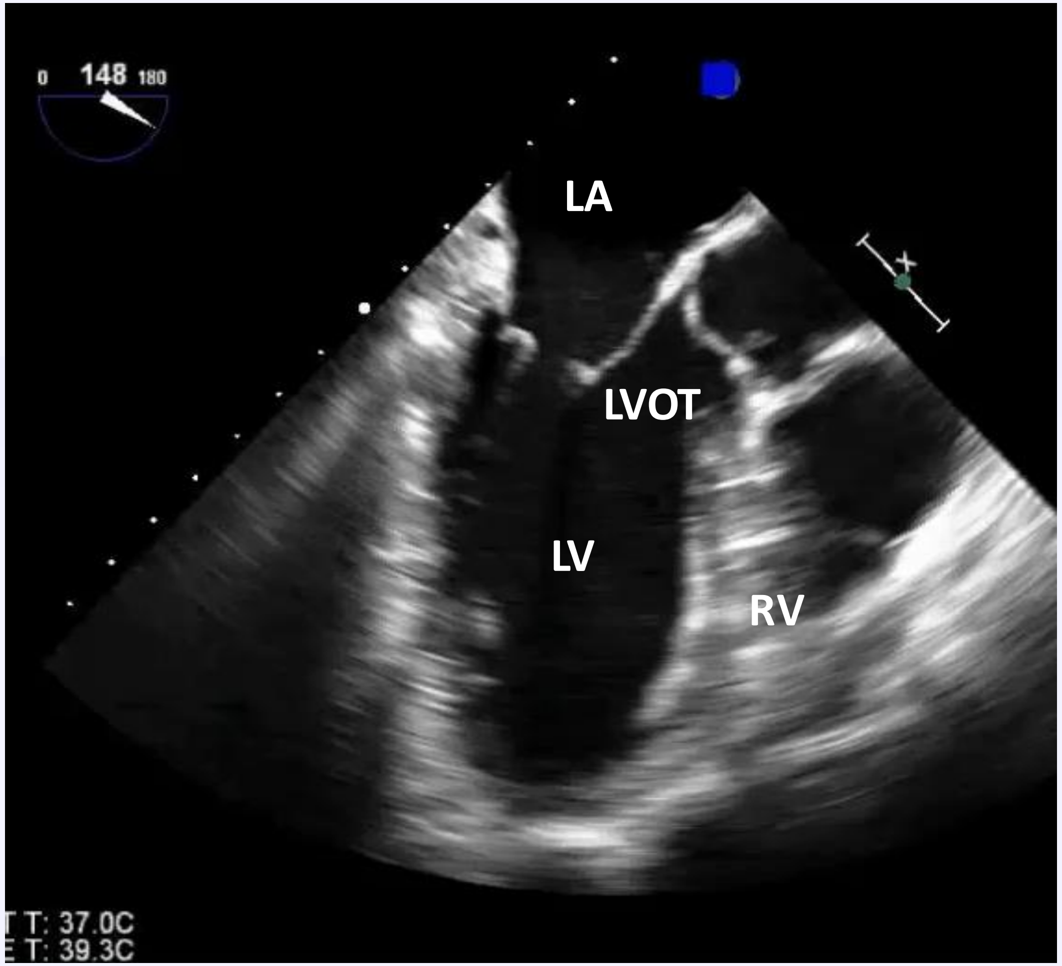


Transducer Angle:
~ 120 - 140^0
Level: Mid-esophageal
Maneuver (from prior image): NA

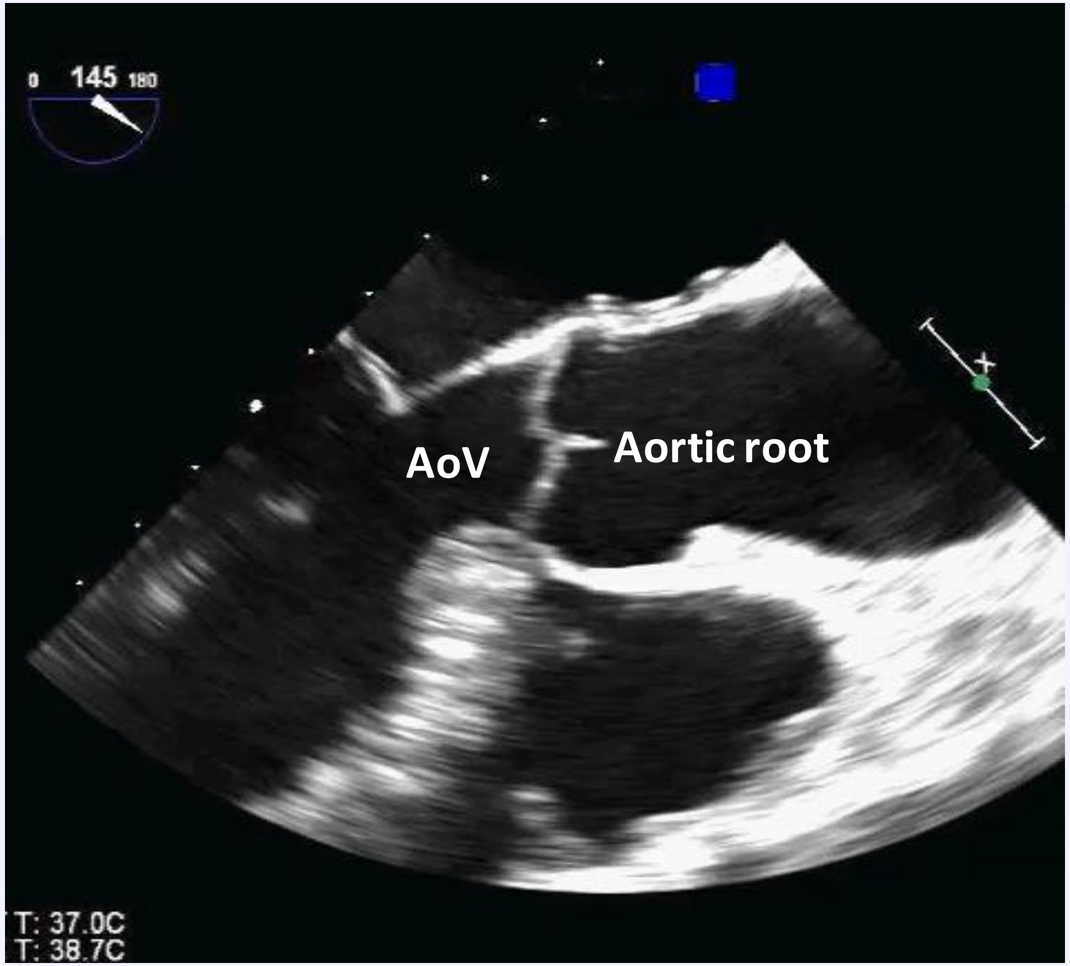
Left atrium
Left ventricle
LVOT
RVOT
Mitral valve (P_2- A_2)
Aortic valve
Proximal ascending aorta

Transducer Angle:
~ 120 - 140^0
Level: Mid-esophageal
Maneuver (from prior image): Withdrawl ± anteflex

Left atrium
LVOT
RVOT
Mitral valve (A_2- P_2)
Aortic valve
Proximal ascending aorta



5- ME Long Axis View



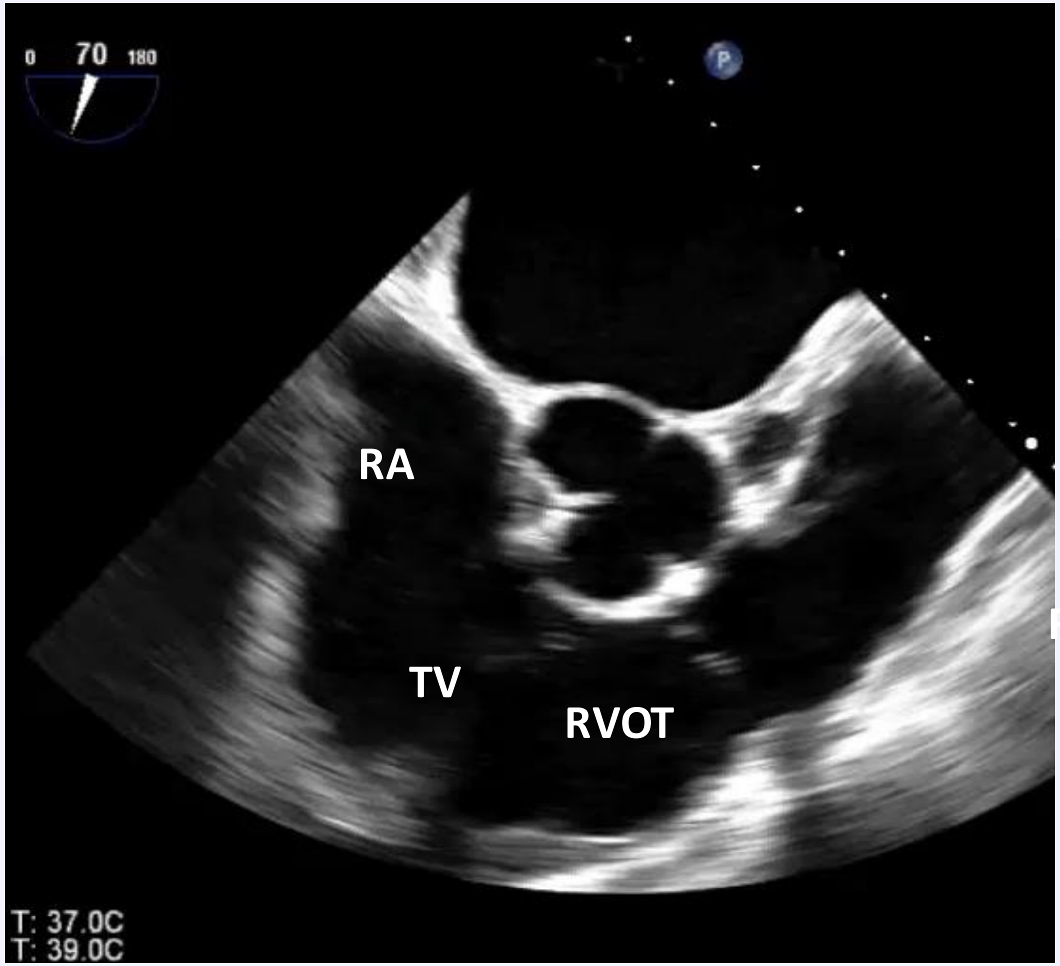
6- ME AV LAX View

Transducer Angle: ~ 50 - 70^0
Level: Mid-esophageal
Maneuver (from prior image): CW, Advance

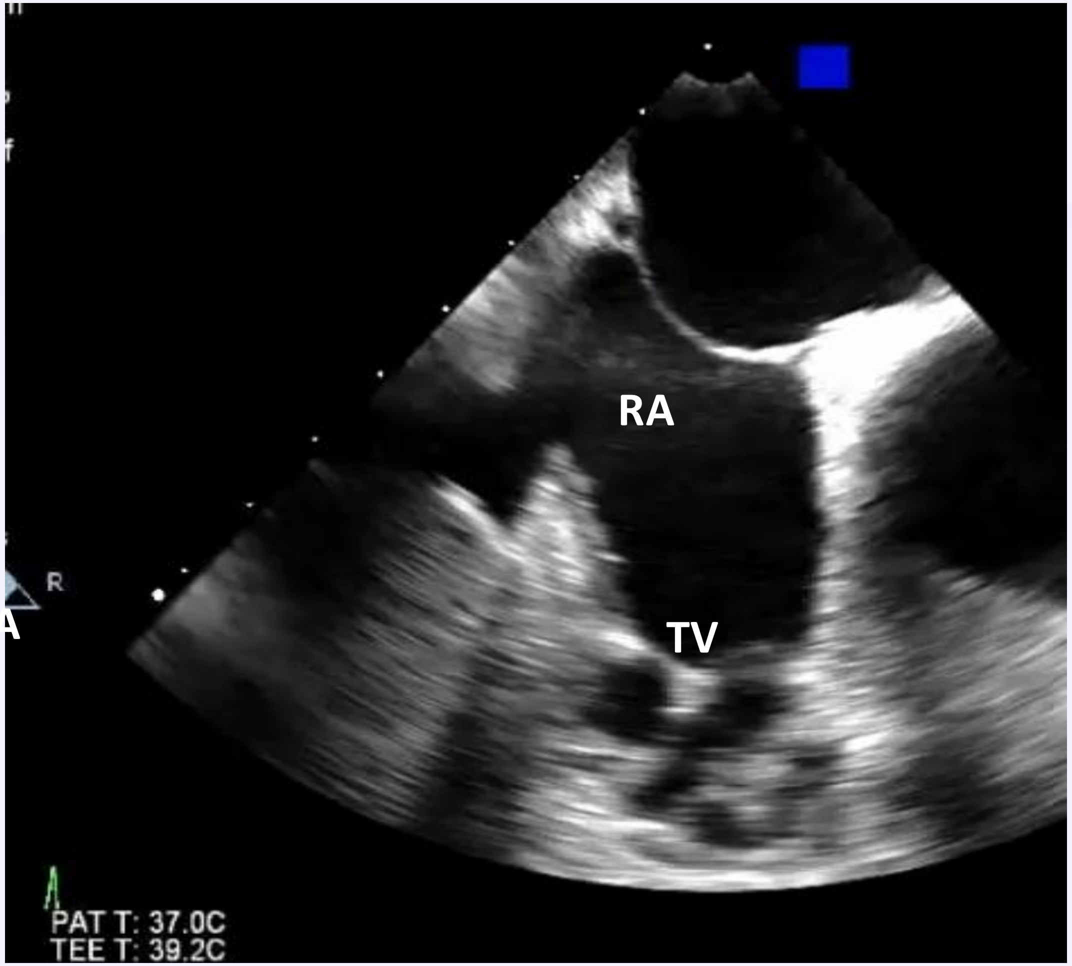
- Aortic valve
- Right atrium
- Left atrium
- Superior IAS
- Tricuspid Valve
- RVOT
- Pulmonary Valve

Transducer Angle: ~ 50 - 70^0
Level: Mid-esophageal
Maneuver (from prior image): CW

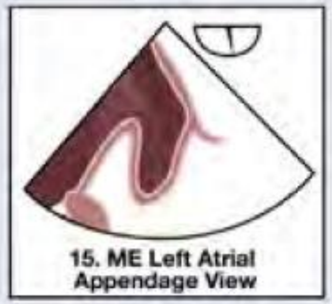
- Right atrium
- Left atrium
- Mid-IAS
- Tricuspid Valve
- Superior vena cava
- Inferior vena cava/coronary sinus



★11- ME RV Inflow-Outflow View



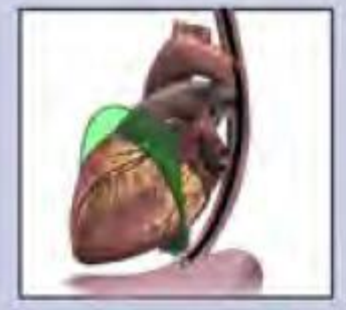
12- ME Modified Bicaval TV View



Transducer Angle: ~90 - 110°
Level: Mid-esophageal
Maneuver (from prior image): Advance

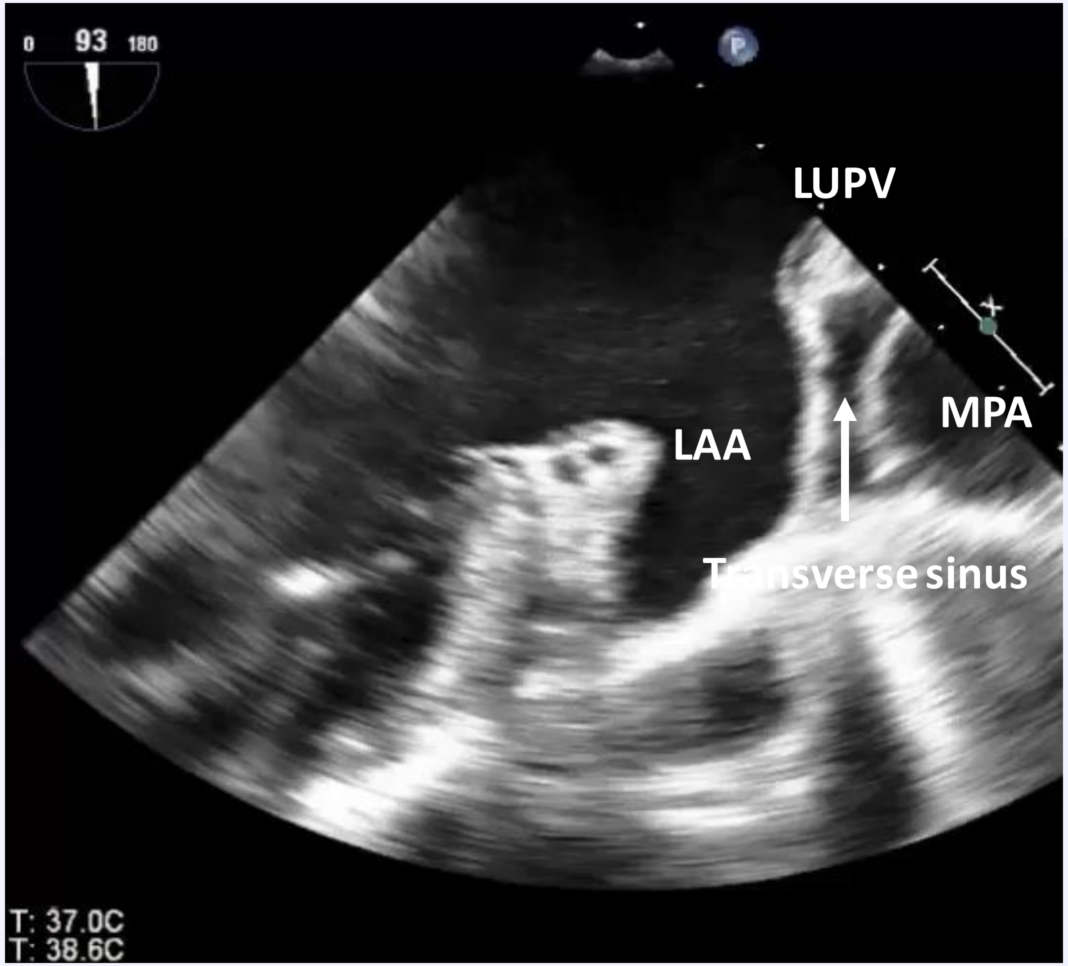
Left atrial appendage
Left upper pulmonary vein

Transgastric Views

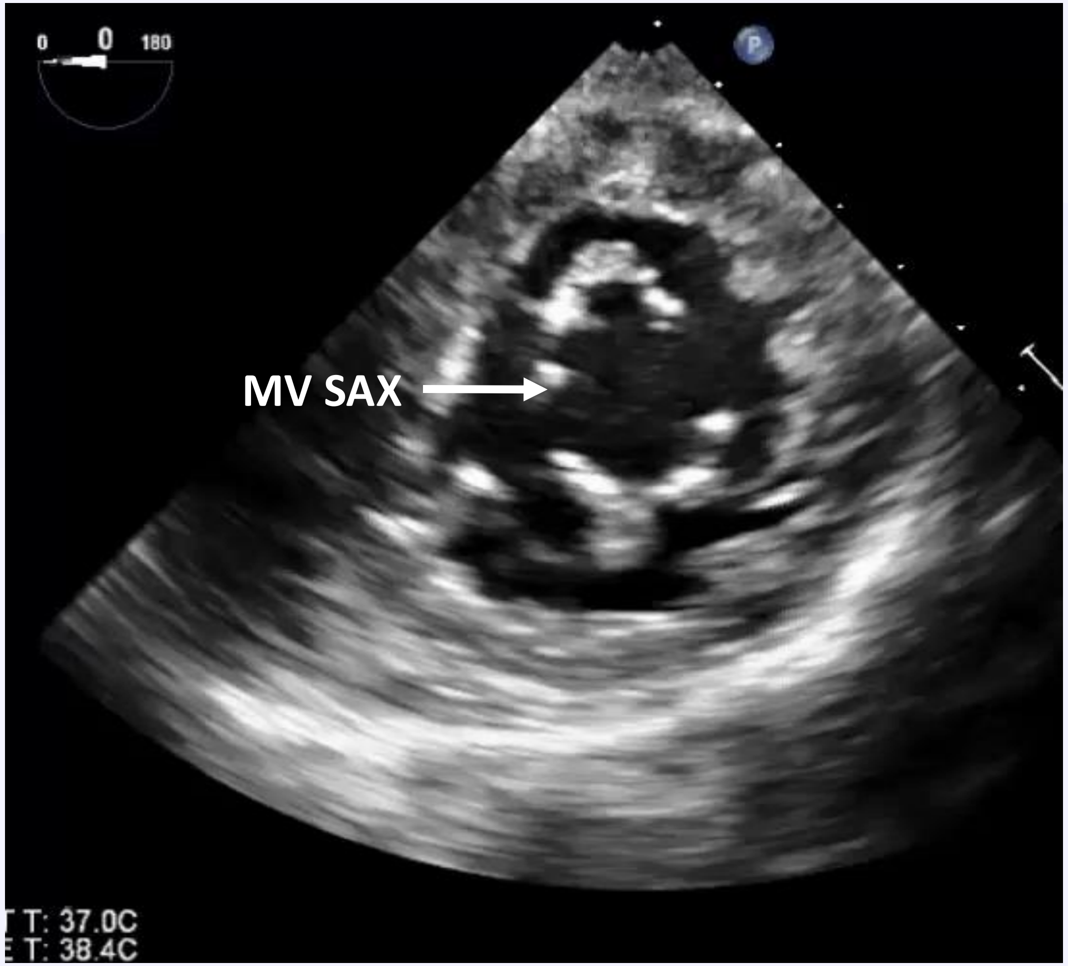


Transducer Angle: ~ 0 - 20°
Level: Transgastric
Maneuver (from prior image): Advance ± Anteflex

Left ventricle (base)
Right ventricle (base)
Mitral valve (SAX)
Tricuspid valve (short-axis)



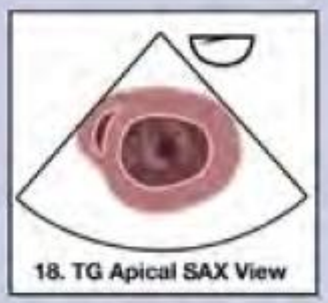
15- ME Left Atrial Appendage View



16- TG Basal SAX View

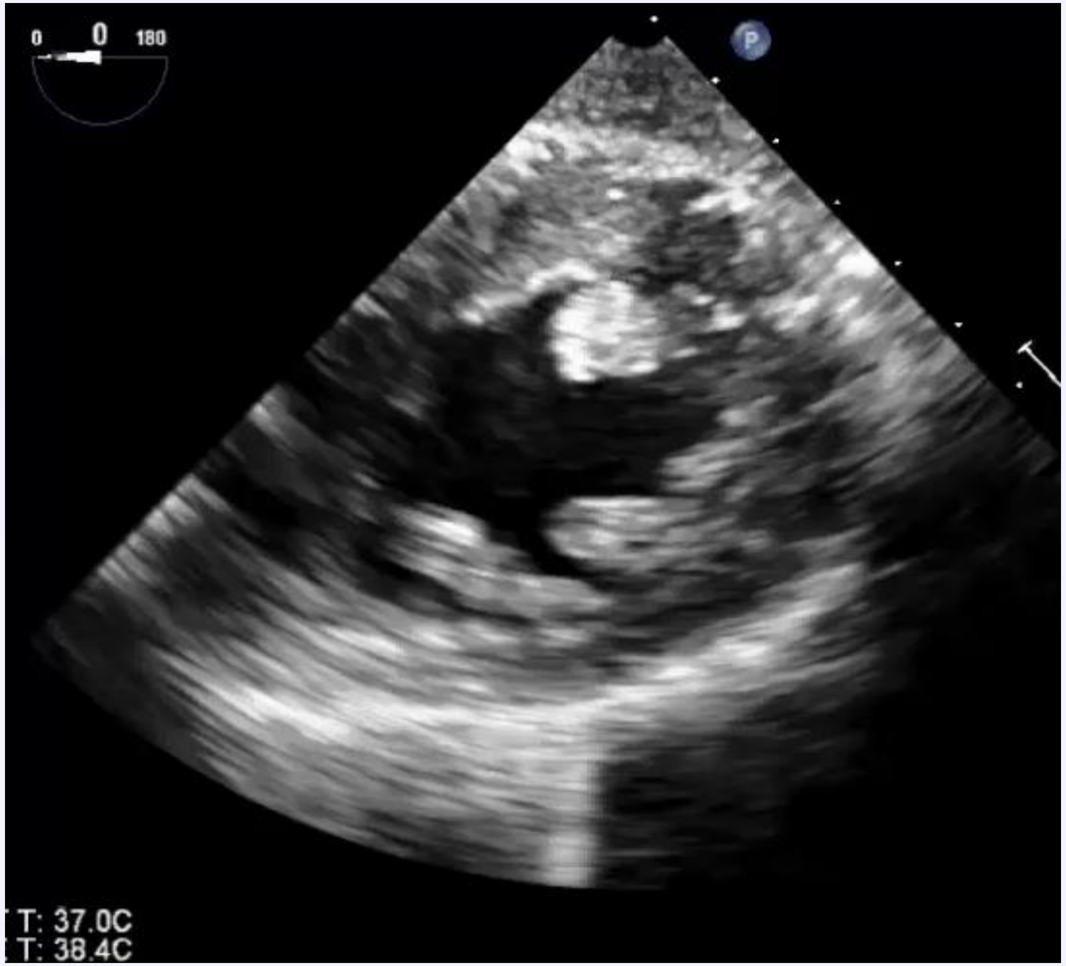

Transducer Angle: ~ 0 - 20^0
Level: Transgastric
Maneuver (from prior image): Advance ± Anteflex

Left ventricle (mid)
Papillary muscles
Right ventricle (mid)




Transducer Angle: ~ 0 - 20^0
Level: Transgastric
Maneuver (from prior image): Advance ± Anteflex

Left ventricle (apex)
Right ventricle (apex)



★★17- TG Mid Papillary SAX View

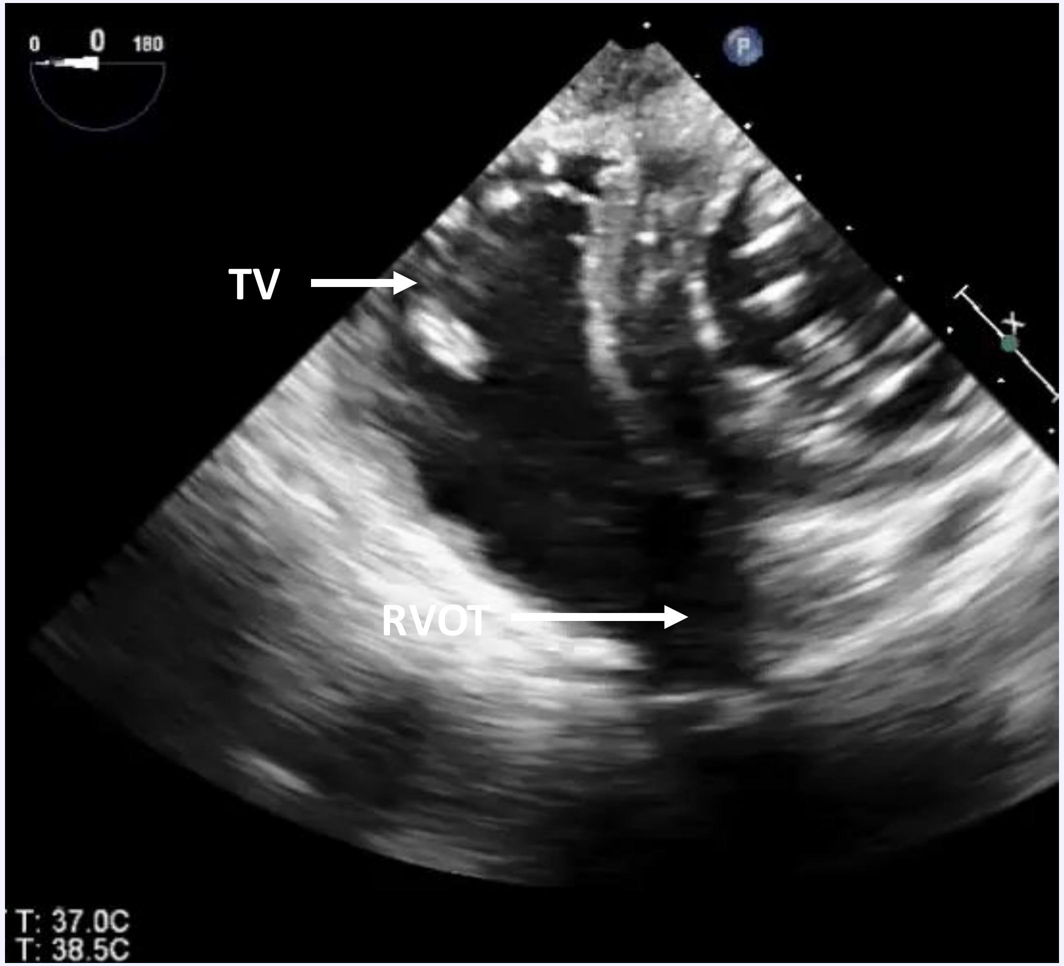
★18- TG Apical SAX View

Transducer Angle: ~ 0 - 20⁰
Level: Transgastric
Maneuver (from prior image): Anteflex

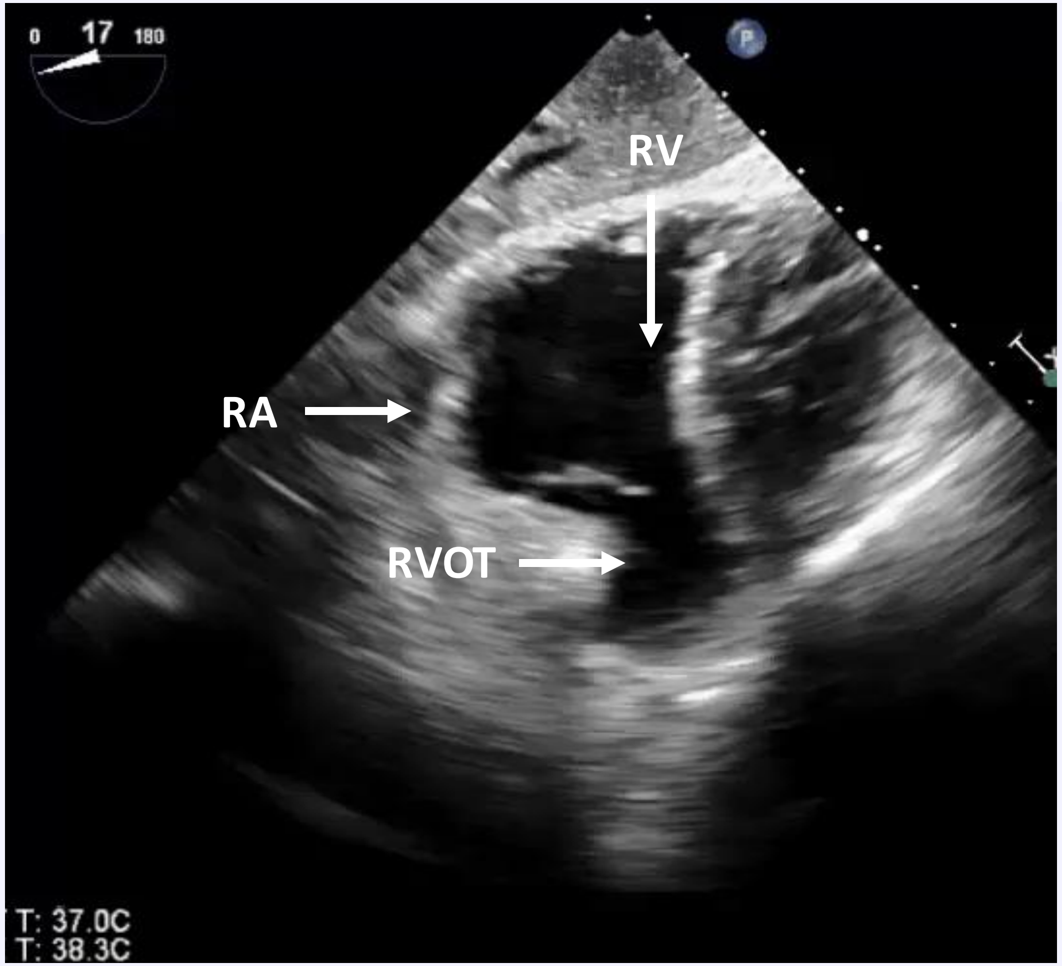
Left ventricle (mid)
Right ventricle (mid)
Right ventricular outflow tract
Tricuspid Valve (SAX)
Pulmonary Valve

Transducer Angle: ~ 0 - 20⁰
Level: Transgastric
Maneuver (from prior image): Right-flex

Right atrium
Right ventricle
Right ventricular outflow tract
Pulmonary valve
Tricuspid Valve



★ 19- TG RV Basal View



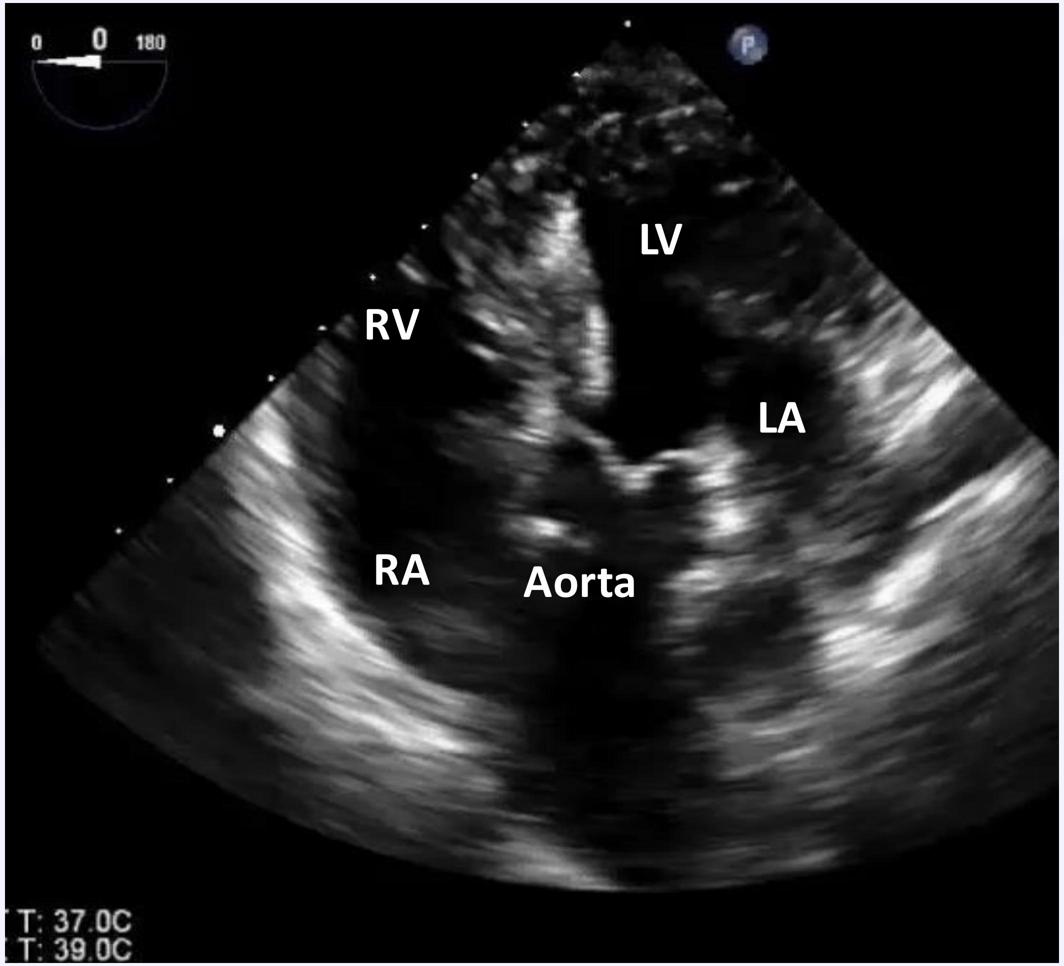
★ 20- TG RV Inflow-Outflow View

Transducer Angle: ~ 0 - 20°
Level: Transgastric
Maneuver (from prior image): Left-flex, Advance, Anteflex

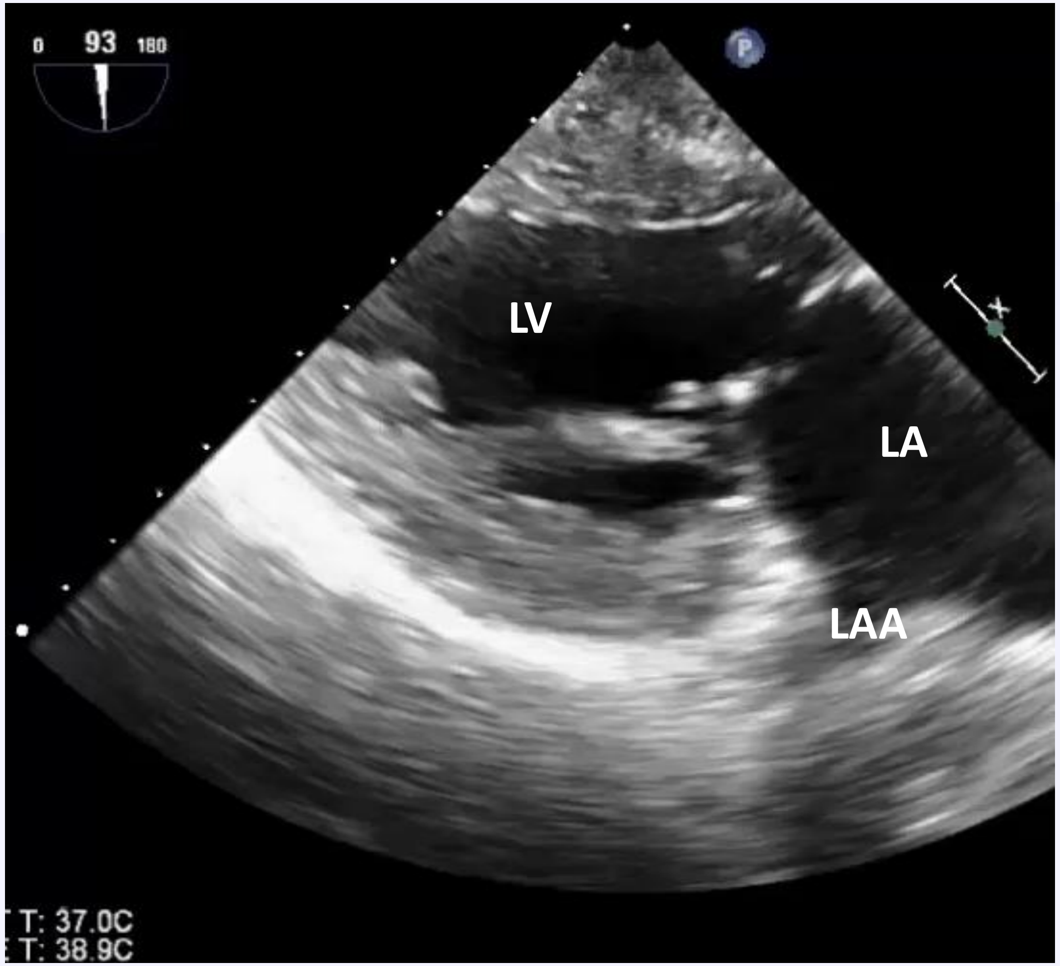
Left ventricle
Left ventricular outflow tract
Right ventricle
Aortic valve
Aortic root
Mitral Valve

Transducer Angle: ~ 90 - 110°
Level: Transgastric
Maneuver (from prior image): Neutral flexion, Withdraw

Left ventricle
Left atrium/appendage
Mitral valve

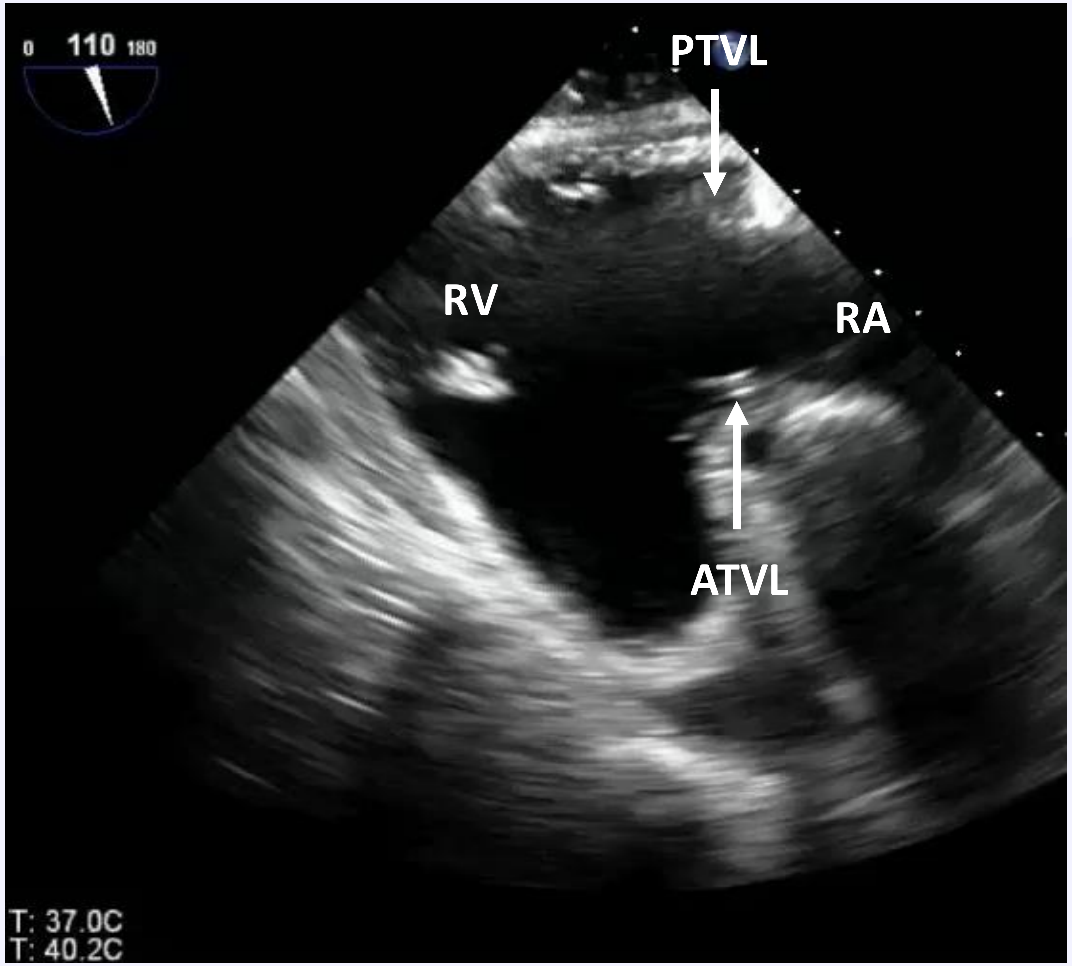


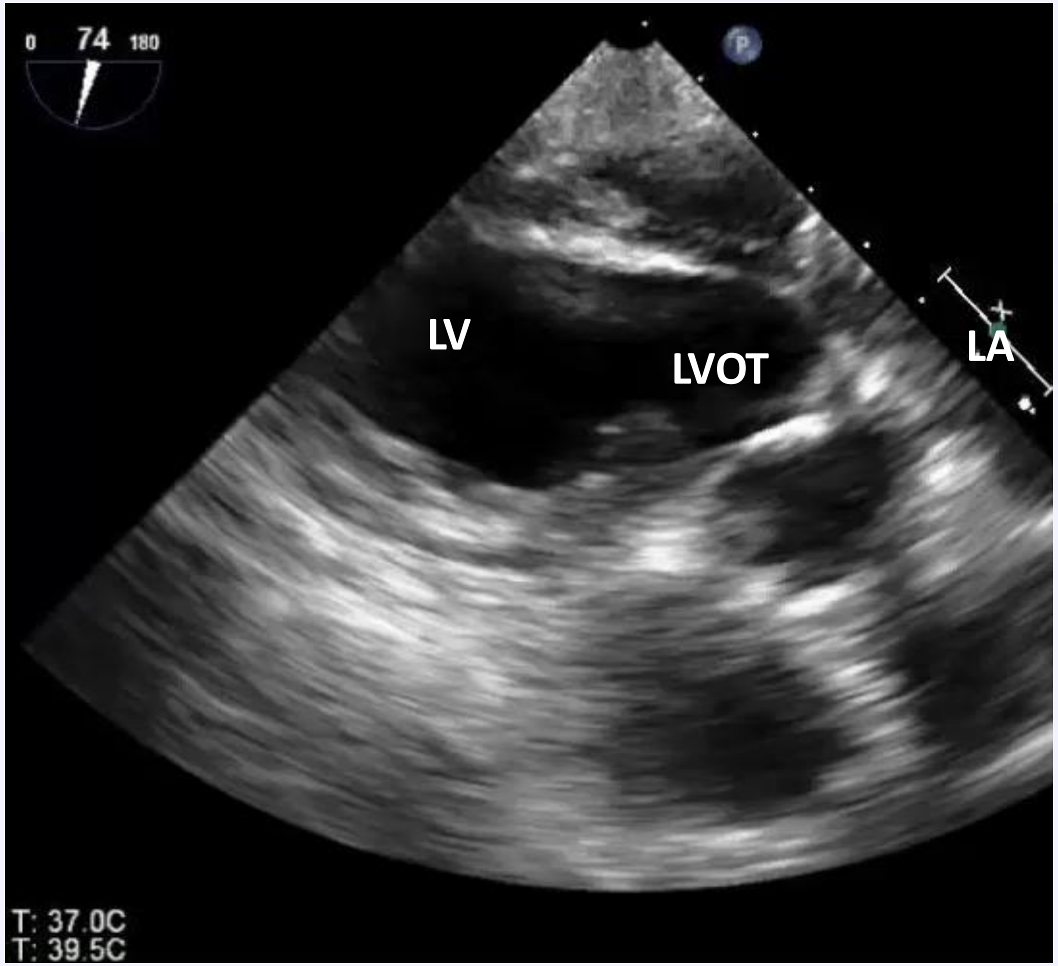
★ 21- Deep TG 5-Chamber View



★★ 22- TG 2-Chamber View

24. TG LV LAX View



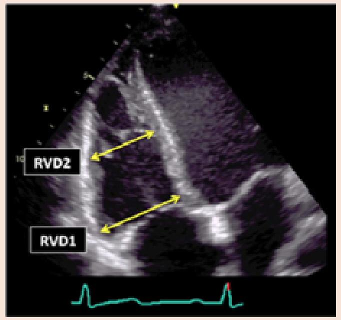
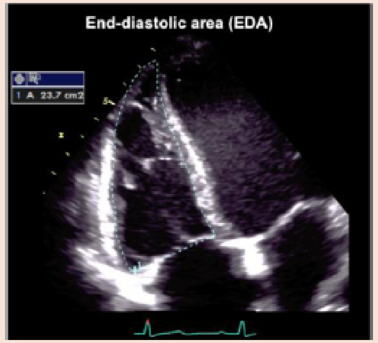


★★ 23- TG RV Inflow View

★ 24- TG LAX View

How to assess RV?

Table 7 Recommendations for the echocardiographic assessment of RV size

Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV linear dimensions (inflow)* 	• Basal RV linear dimension (RVD1) = maximal transversal dimension in the basal one third of RV inflow at end-diastole in the *RV-focused view* • Mid-cavity RV linear dimension (RVD2) = transversal RV diameter in the middle third of RV inflow, approximately halfway between the maximal basal diameter and the apex, at the level of papillary muscles at end-diastole.	• Easily obtainable • Simple • Fast • Wealth of published data	• RV size may be underestimated due to the crescent RV shape • RV linear dimensions are dependent on probe rotation and different RV views; in order to permit inter-study comparison, the echocardiography report should state the window from which the measurement was performed.
RV areas (inflow) 	• Manual tracing of RV endocardial border from the lateral tricuspid annulus along the free wall to the apex and back to medial tricuspid annulus, along the interventricular septum at end-diastole and at end-systole • Trabeculations, papillary muscles and moderator band are included in the cavity area	• Relatively easy to measure	• Challenging in case of suboptimal image quality of RV free wall • Challenging in the presence of trabeculation • RV size underestimation if RV cavity is foreshortened • Due to the LV twisting motion and the crescent RV shape, the end-diastolic RV image may not be in the same tomographic plane as the end-systolic one • May not accurately reflect global RV size (underestimation or overestimation)

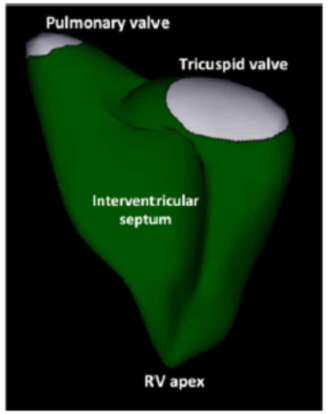
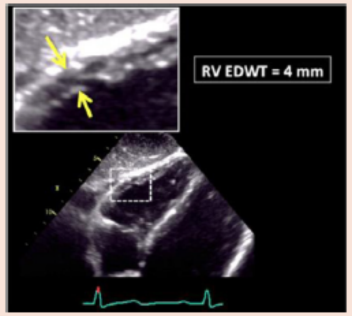
Echocardiographic imaging	Recommended methods	Advantages	Limitations
3DE RV volumes  	• Dedicated multibeat 3D acquisition, with minimal depth and sector angle (for a temporal resolution > 20–25 volumes/sec) that encompasses entire RV cavity • Automatically identified timing of end-diastole and end-systole should be verified • Myocardial trabeculae and moderator band should be included in the cavity	• Unique measures of RV global size that includes inflow, outflow and apical regions • Independent of geometric assumptions • Validated against cardiac magnetic resonance	• Dependent on image quality, regular rhythm, patient cooperation • Needs specific 3D echocardiographic equipment and training • Reference values established in few publications
RV wall thickness  	• Linear measurement of RV free wall thickness (either by M-mode or 2DE) performed at end-diastole, below the tricuspid annulus at a distance approximating the length of anterior tricuspid leaflet, when it is fully open and parallel to the RV free wall. • Trabeculae, papillary muscles and epicardial fat should be excluded • Zoomed imaging with focus on the RV mid-wall and respiratory maneuvers may improve endocardial border definition	• Easy to perform	• Single-site measurement • Harmonic imaging and oblique M-mode sampling may overestimate RV wall thickness • Challenging in case of thickening of visceral pericardium • There is no criterion for defining an abnormally thin RV wall

Table 9 Recommendations for the echocardiographic assessment of RV function

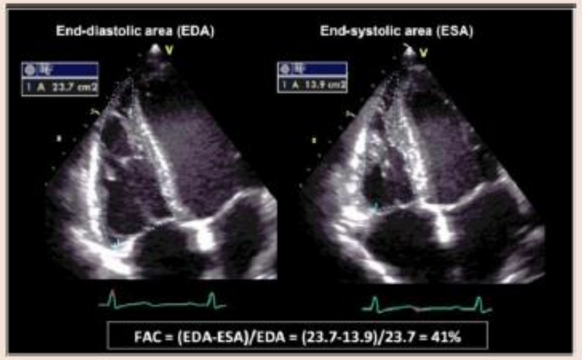
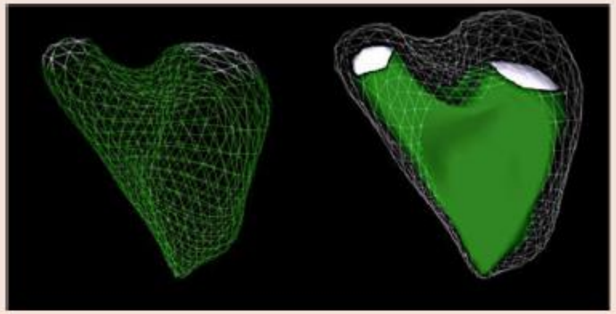
Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV global systolic function			
FAC 	RV FAC in RV-focused apical four-chamber view: RV FAC (%) = 100 × (EDA – ESA)/EDA	• Established prognostic value • Reflects both longitudinal and radial components of RV contraction • Correlates with RV EF by CMR	• Neglects the contribution of RV outflow tract to overall systolic function • Only fair inter-observer reproducibility
EF 	Fractional RV volume change by 3D TTE: RV EF (%) = 100 × (EDV – ESV)/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

Table 9 Recommendations for the echocardiographic assessment of RV function **Cont.**

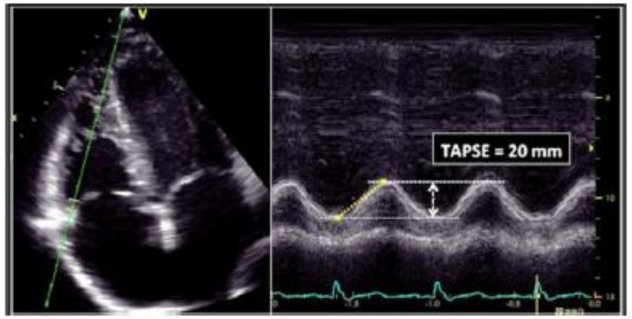
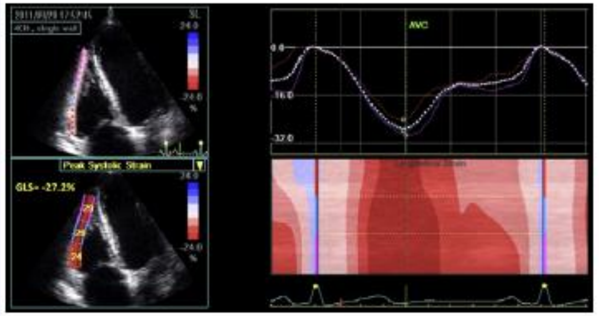
Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV longitudinal systolic function TAPSE  	• Tricuspid annular longitudinal excursion by M-mode (mm), measured between end-diastole and peak systole • Proper alignment of M-mode cursor with the direction of RV longitudinal excursion should be achieved from the apical approach.	• Established prognostic value • Validated against radionuclide EF	• Angle dependency • Partially representative of RV global function*
 	• Peak value of 2D longitudinal speckle tracking derived strain, averaged over the three segments of the RV free wall in RV-focused apical four-chamber view (%)	• Angle independent • Established prognostic value	• Vendor dependent

Table 10 Normal values for parameters of RV function

Parameter	Mean ± SD	Abnormality threshold
TAPSE (mm)	24 ± 3.5	<17
Pulsed Doppler S wave (cm/sec)	14.1 ± 2.3	<9.5
Color Doppler S wave (cm/sec)	9.7 ± 1.85	<6.0
RV fractional area change (%)	49 ± 7	<35
RV free wall 2D strain* (%)	–29 ± 4.5	>–20 (<20 in magnitude with the negative sign)
RV 3D EF (%)	58 ± 6.5	<45
Pulsed Doppler MPI	0.26 ± 0.085	>0.43
Tissue Doppler MPI	0.38 ± 0.08	>0.54
E wave deceleration time (msec)	180 ± 31	<119 or >242
E/A	1.4 ± 0.3	<0.8 or >2.0
e′/a′	1.18 ± 0.33	<0.52
e′	14.0 ± 3.1	<7.8
E/e′	4.0 ± 1.0	>6.0

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e′/a′	1.18 ± 0.33	<0.52
e′	14.0 ± 3.1	<7.8
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Case 1

17-year-old boy presented with fatigue and mild cyanosis

Suggested reading materials

1. Recommendations for cardiac chamber quantification by echocardiography in adults. JASE, 2015.

Questions

Question 1

Which of the following statements about LV anatomy is CORRECT?

A. LV wall thickness is about 3 times more than RV
B. LV internal dimensions and volume are larger in women but ejection fraction are more in men
C. LV apex is the thickest segment in the LV
D. Endocardial layer of the LV has coarse trabeculation

Question 2

Which of the following statements about function of the LV and RV is CORRECT?

A. Basal LV rotates in counter-clockwise rotation
B. LV net twist is the difference between LV apex and base rotation
C. RV function is more dependent to circumferential contraction of the RV muscle
D. During systole LV apex moves towards the base to create longitudinal contraction

Question 3

All of the following statements about TEE assessment of LV function are correct EXCEPT

A. In ME 2-chamber view LV anterior wall and inferior wall can be assessed
B. In TG SAX view of the LV, the wall below the image is anterior wall
C. In ME LAX view, LV anterolateral wall can be assessed
D. TG RV inflow view the best view to measure TAPSE

Question 4

All of the following statements about echocardiographic assessment of LV function are correct EXCEPT

A. Normal cut off value of LV global longitudinal strain in women is more than men (absolute number)
B. Normal cut off value of RV global longitudinal strain is more than LV (absolute number)
C. Normal cut off value of LV EF is less than RV
D. LV volume in a normal person will decrease in older age

Question 5

Which of the following statements about RV anatomy and function is CORRECT?

A. In normal person apex of the heart is part of RV
B. Normal TAPSE is more than 24 mm
C. Normal RV free wall thickness is about 7-11 mm
D. Normal E/e’ ratio in RV should be less than 6.0

Correct Answers

1- A
2- B
3- C
4- C
5- D


Toronto
Thank you.