Ins and Outs of the Atria

San Antonio Echocardiography Society

July 2007

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Atrial Echo: The Ins and Outs

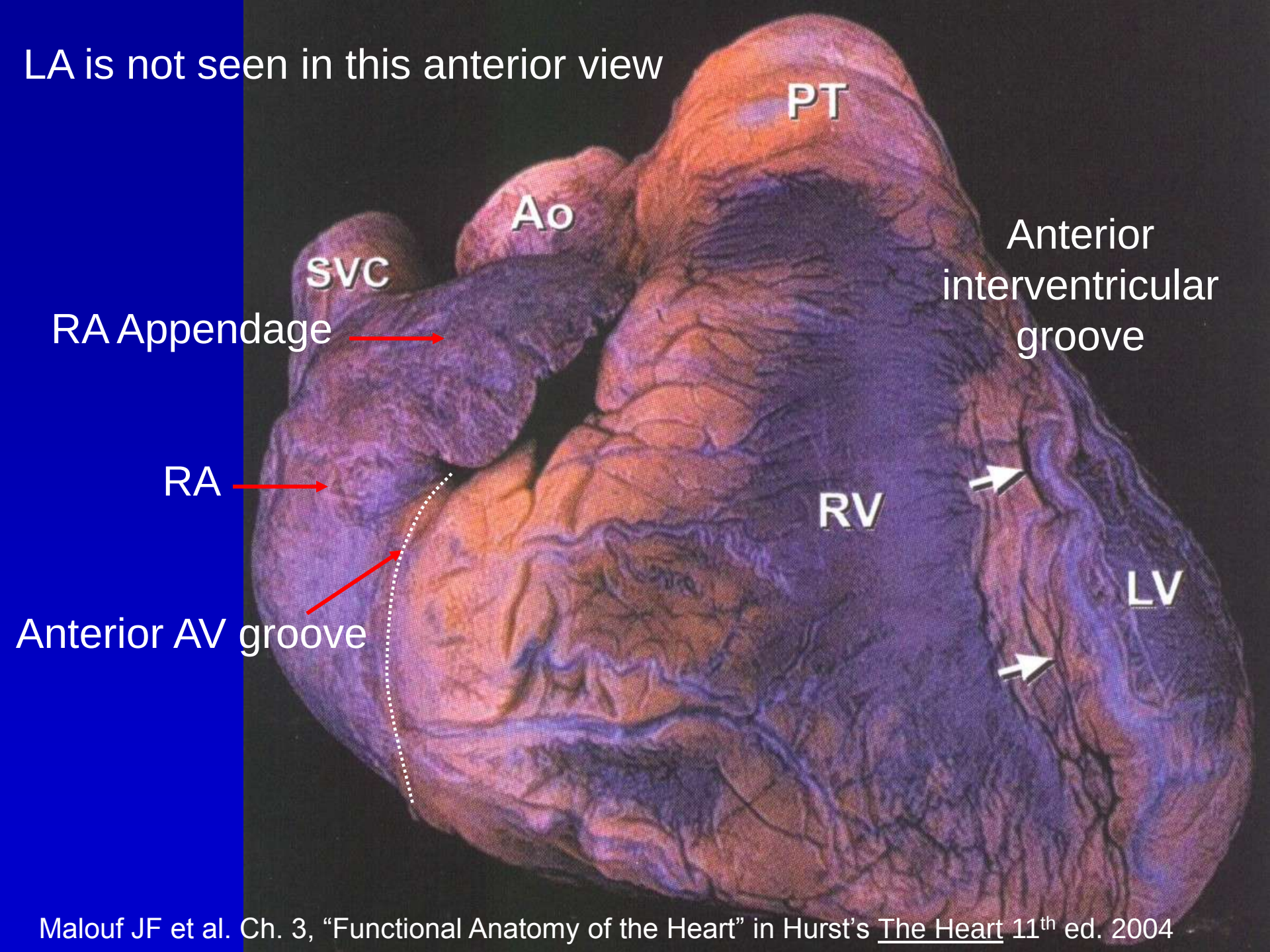
- Atrial Anatomic review
- Atrial size
- Atrial function by echo
- Inflow and outflow

Atrial Anatomy

Connections of Atria

	Right atrium	Interatrial septum	Left atrium
IN	• IVC • SVC • Coronary sinus • Thebesian veins • (ASD)		• Four pulmonary veins • (ASD)
OUT	• Tricuspid Valve		• Mitral Valve

LA is not seen in this anterior view



Malouf JF et al. Ch. 3, “Functional Anatomy of the Heart” in Hurst’s The Heart 11th ed. 2004

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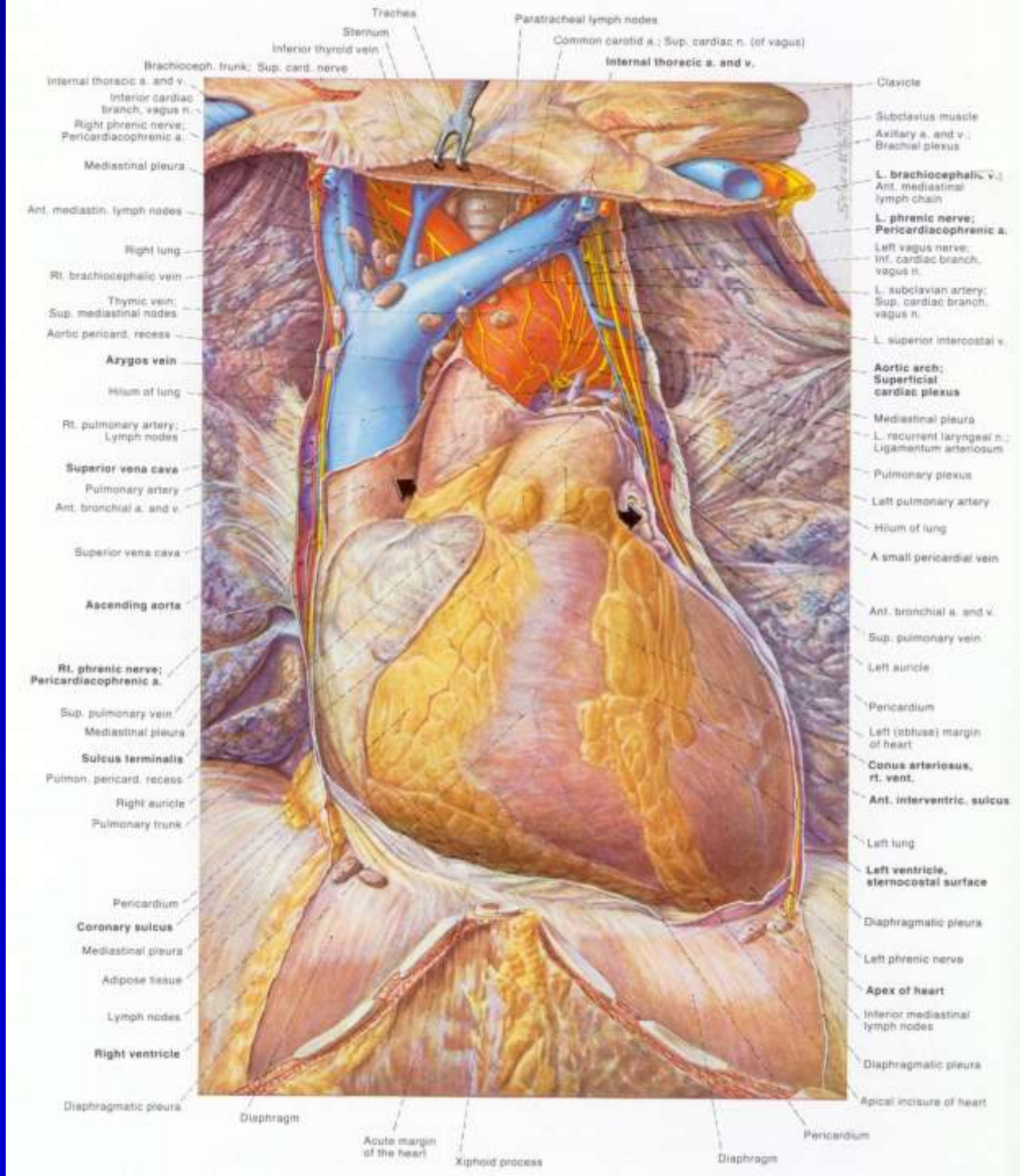
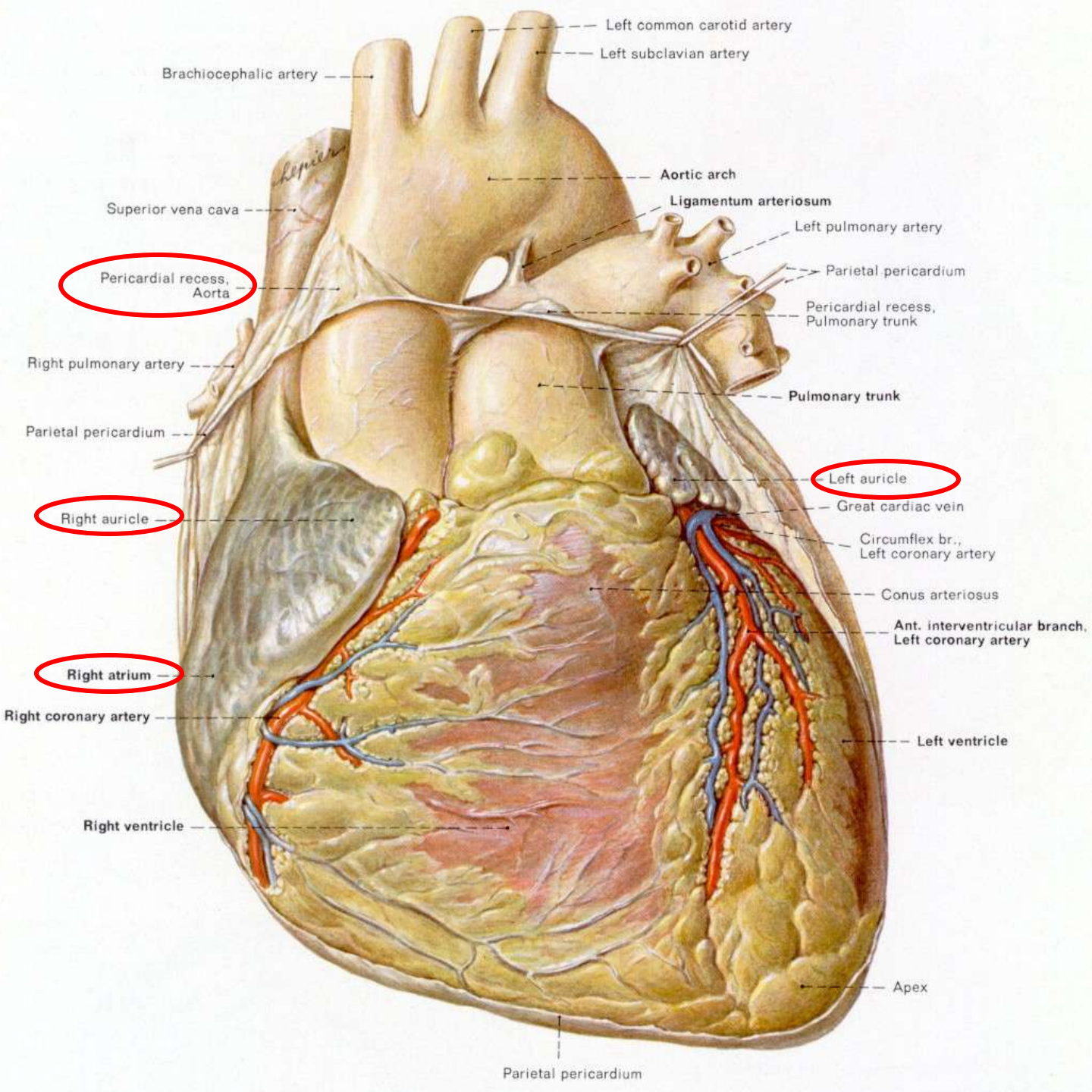


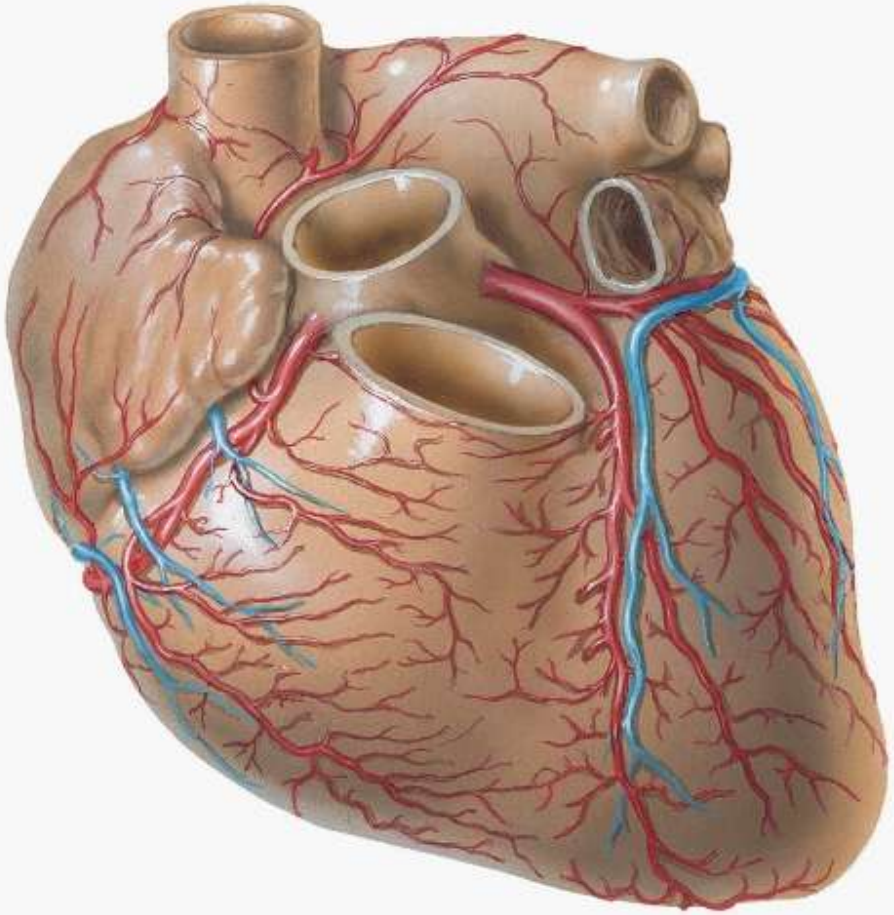
Clemente CD. Anatomy
3rd Ed, 1987, fig 188.



Clemente CD. Anatomy
3rd Ed, 1987, fig 194.

Coronary Arteries and Cardiac Veins

Sternocostal Surface



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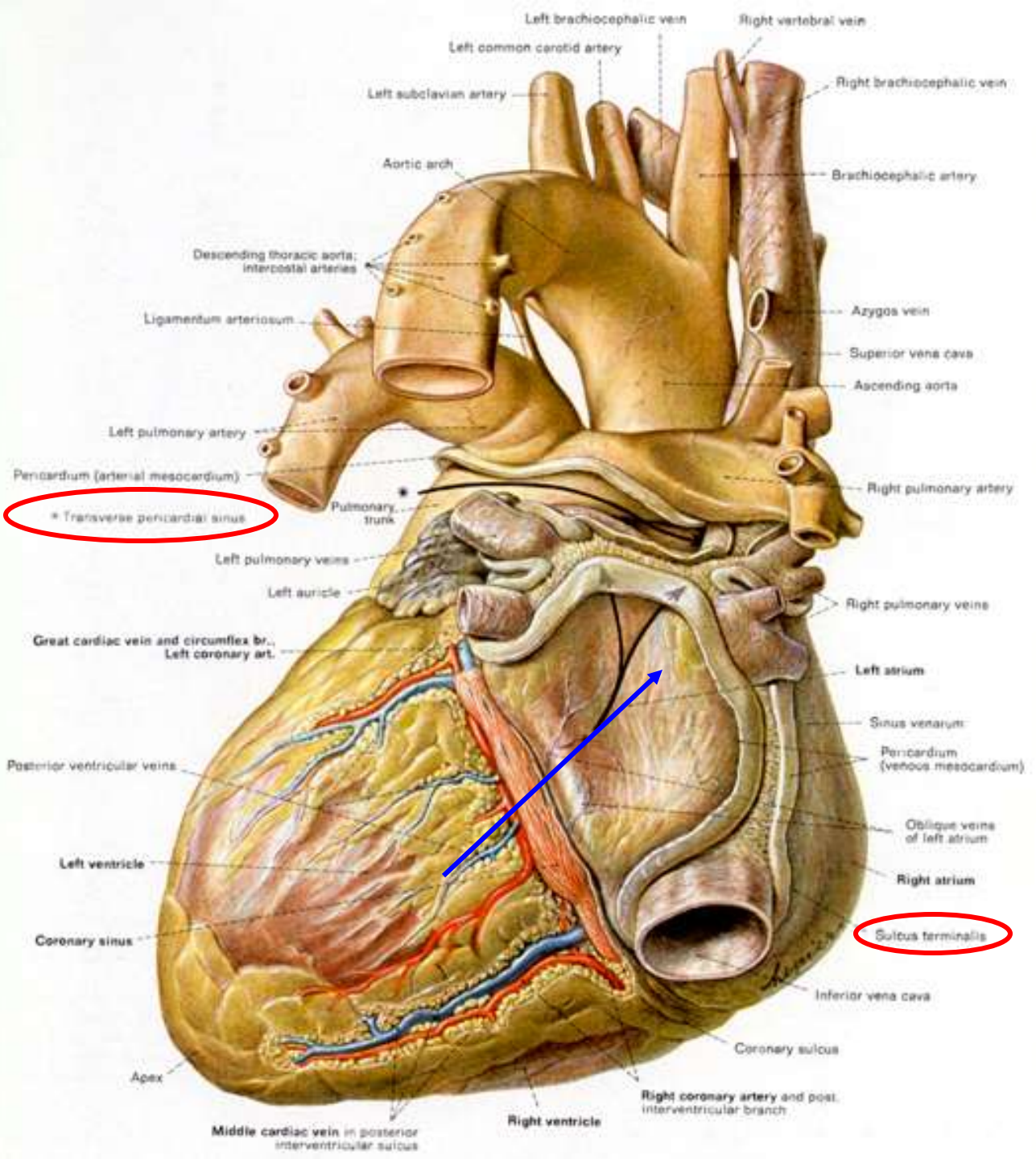
The Heart, Posterior View

Veins

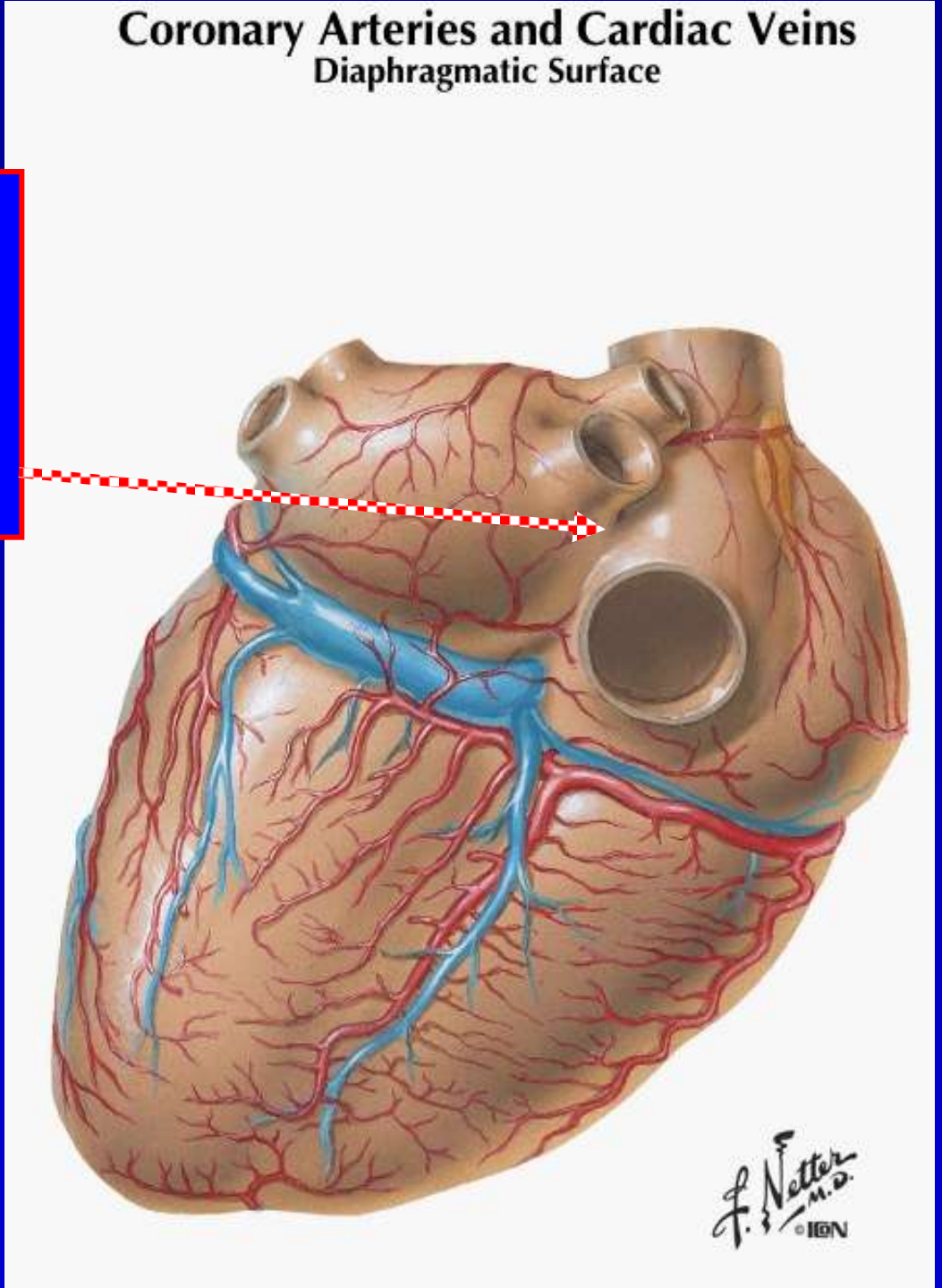
Oblique pericardial sinus

Clemente CD. Anatomy
3rd Ed, 1987, fig 195.

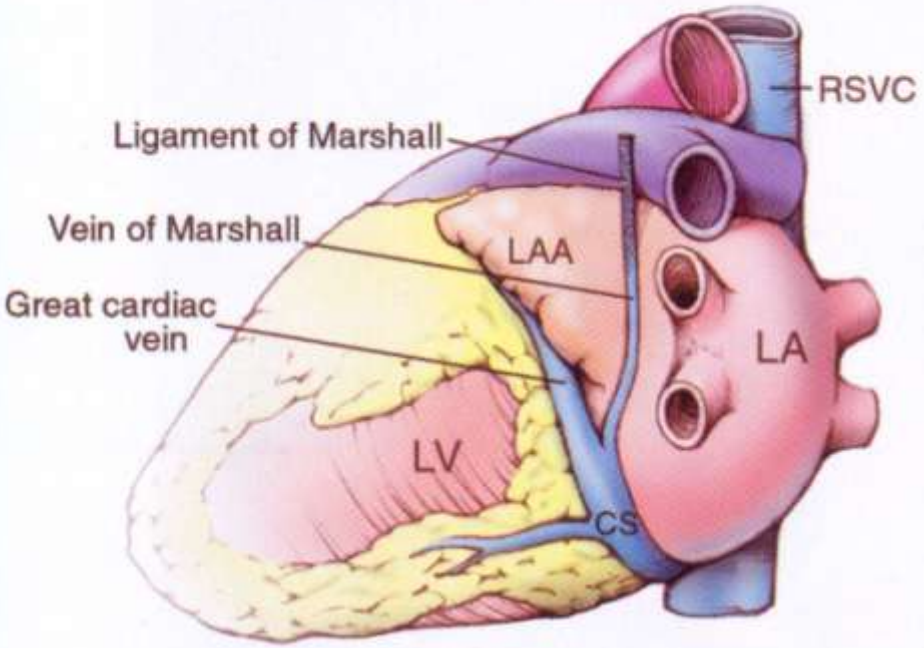
Sobotta Atlas, 13th Ed, 2000, vol 2, p. 77



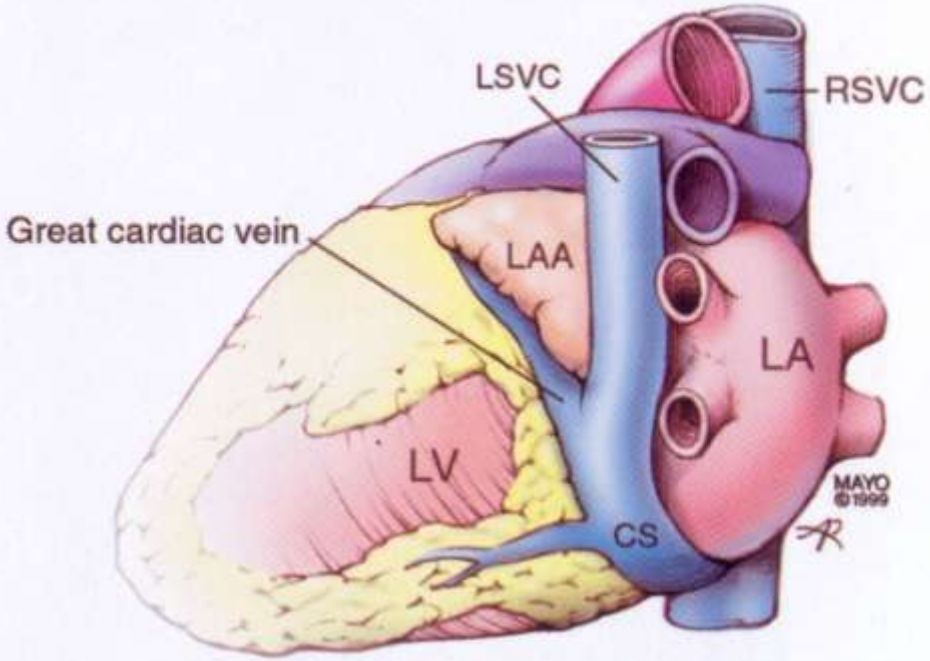
Sondegaard's Groove, Waterston's groove, interatrial groove



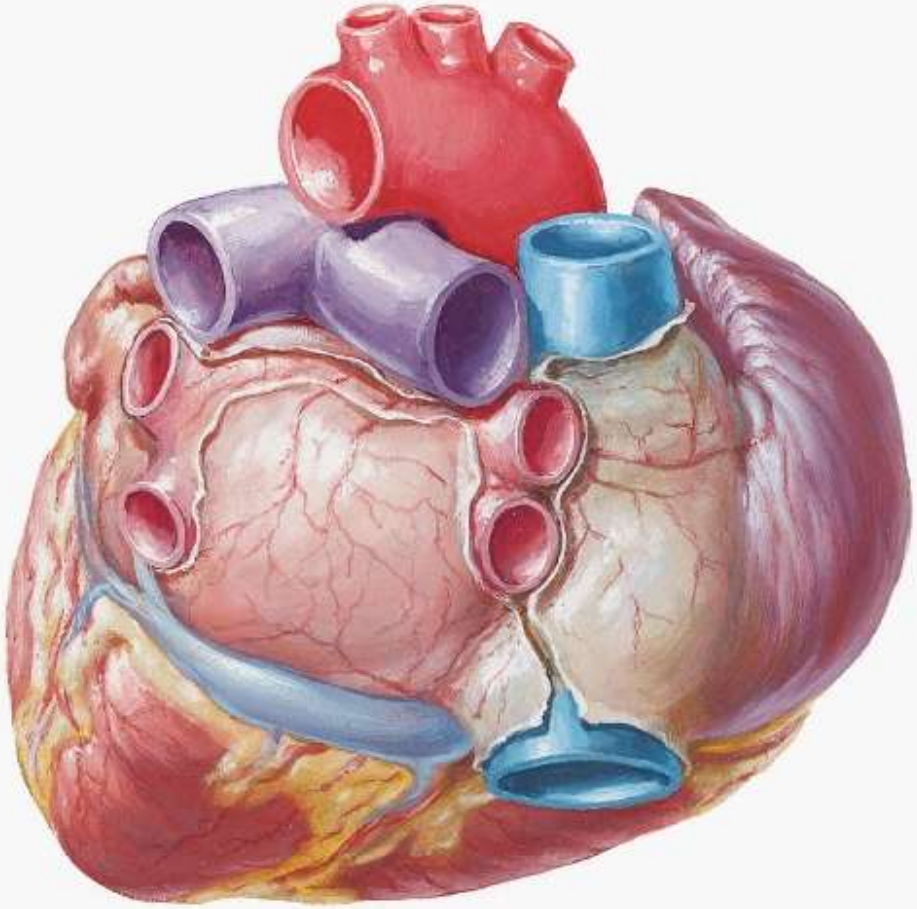
NORMAL HEART



PERSISTENT LSVC



Base of Heart
Posterior View



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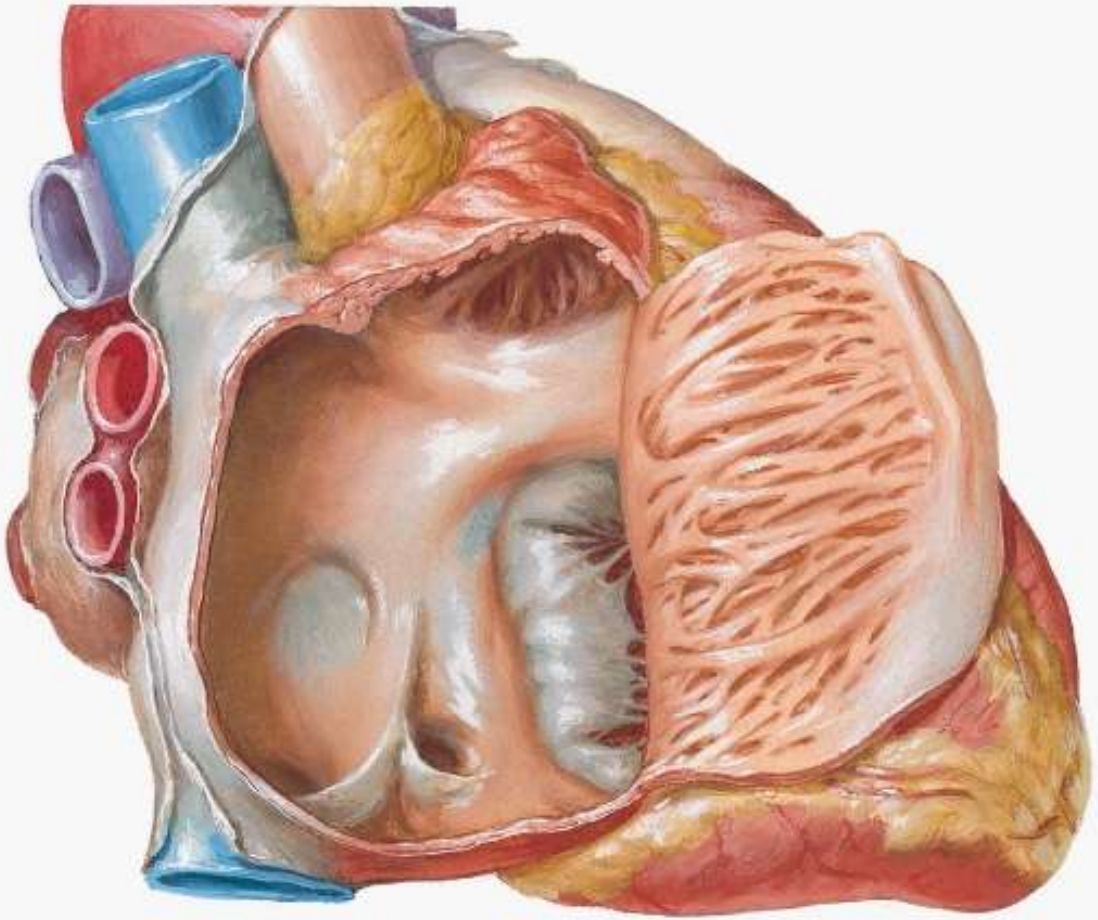
Opened Right Atrium

Right Lateral View



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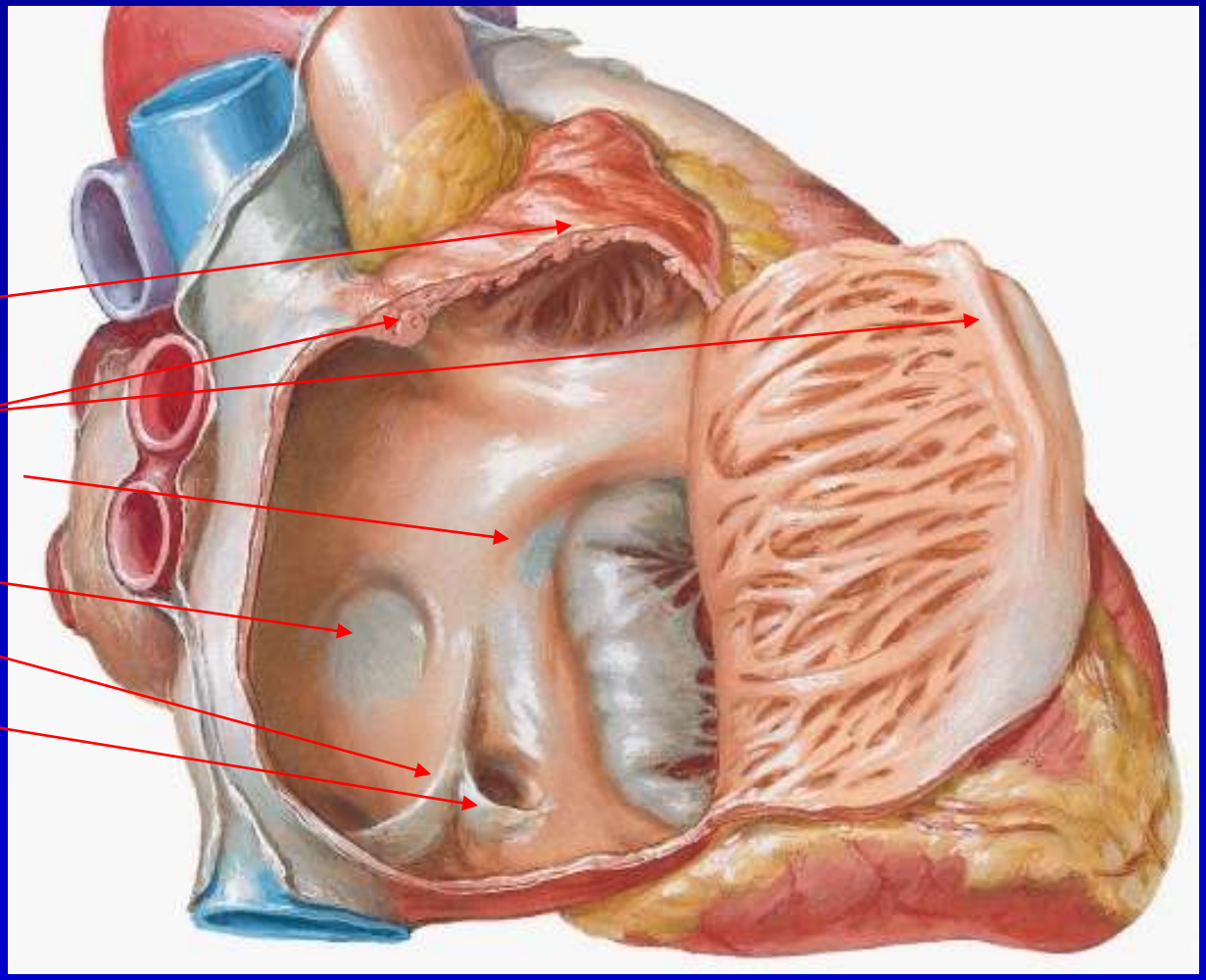
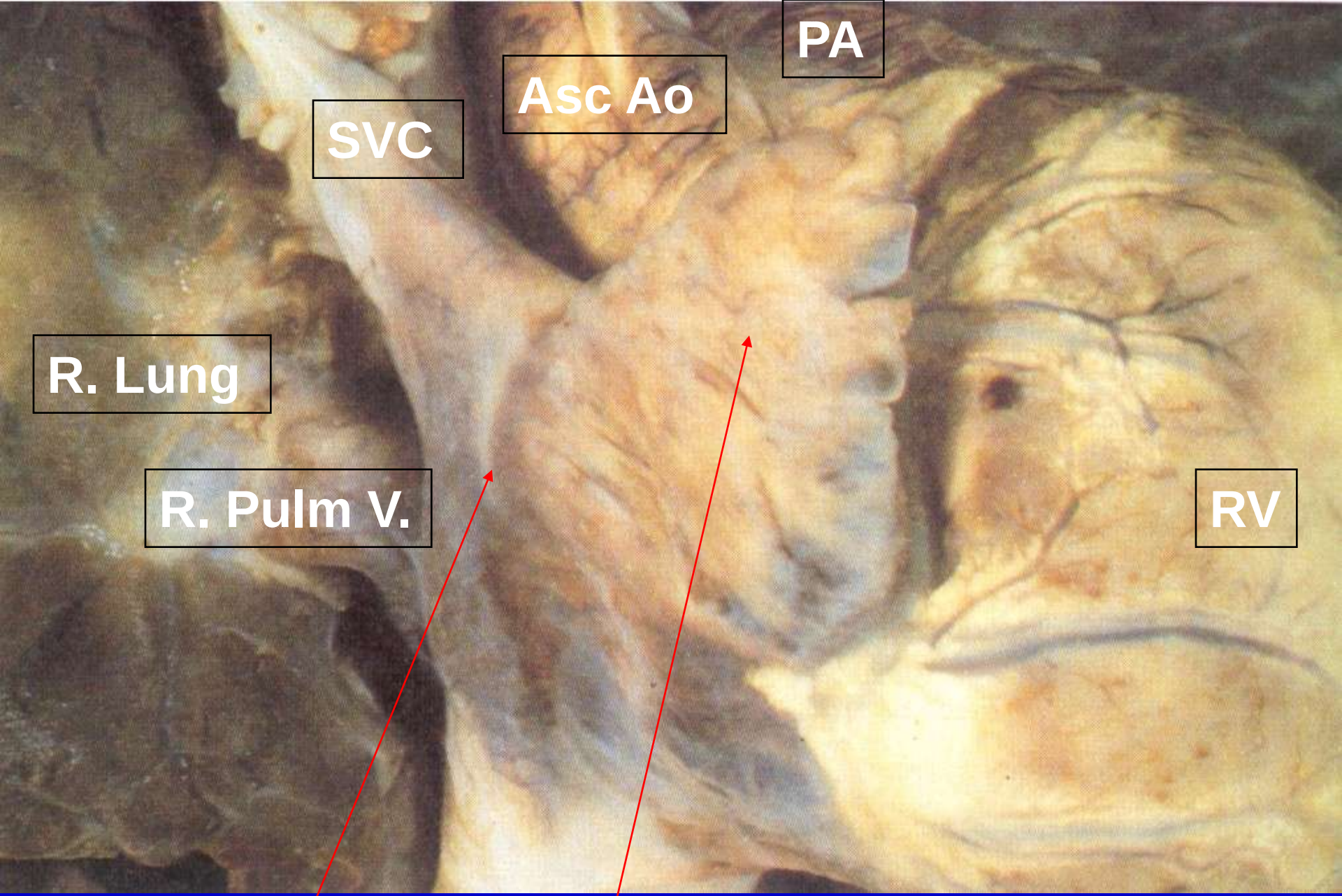
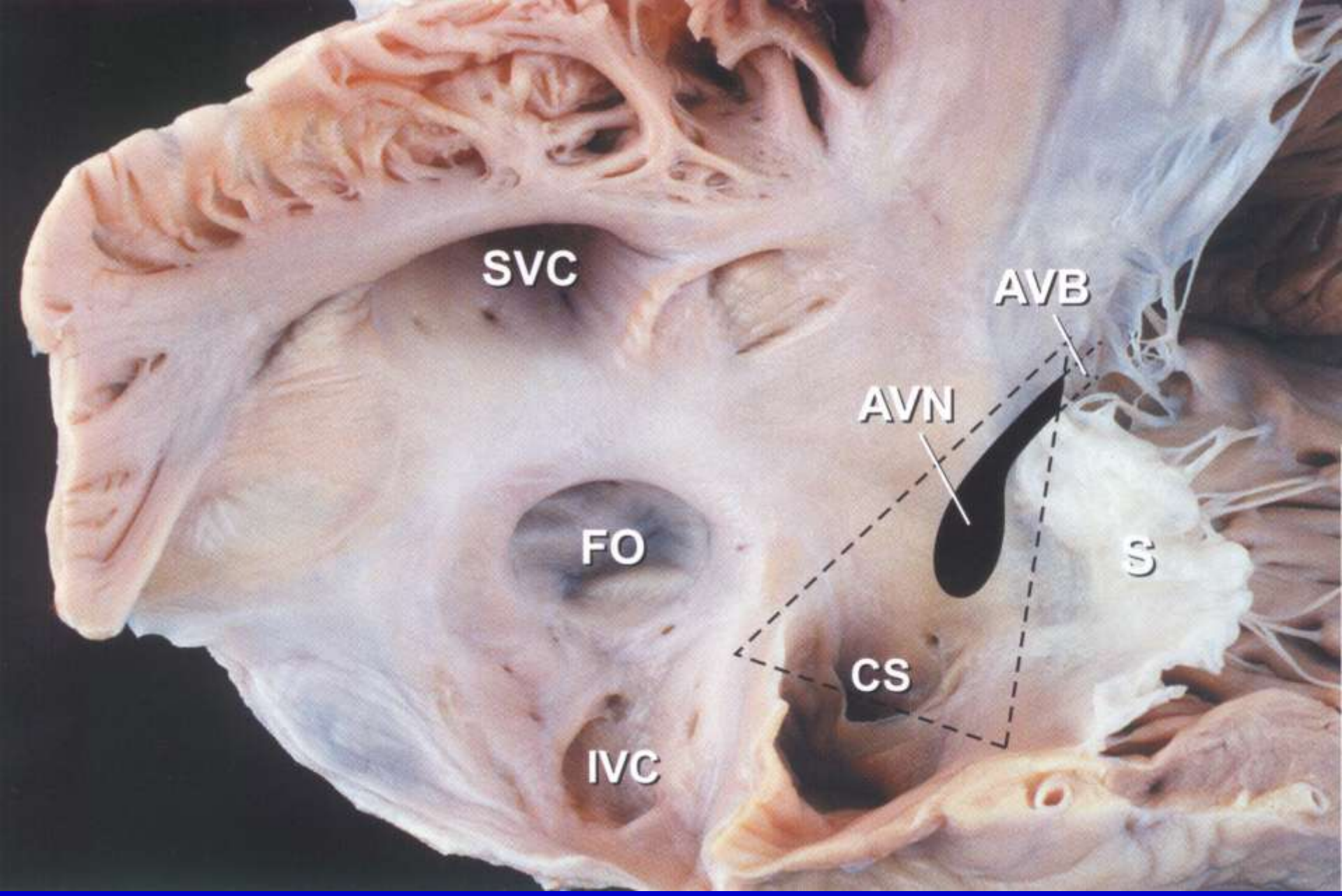
Right Atrial Structures

RA appendage
Christa Terminalis
Membranous Septum
Fossa ovalis
Eustachian valve
Thebesian valve





sulcus terminalis and RA Appendage



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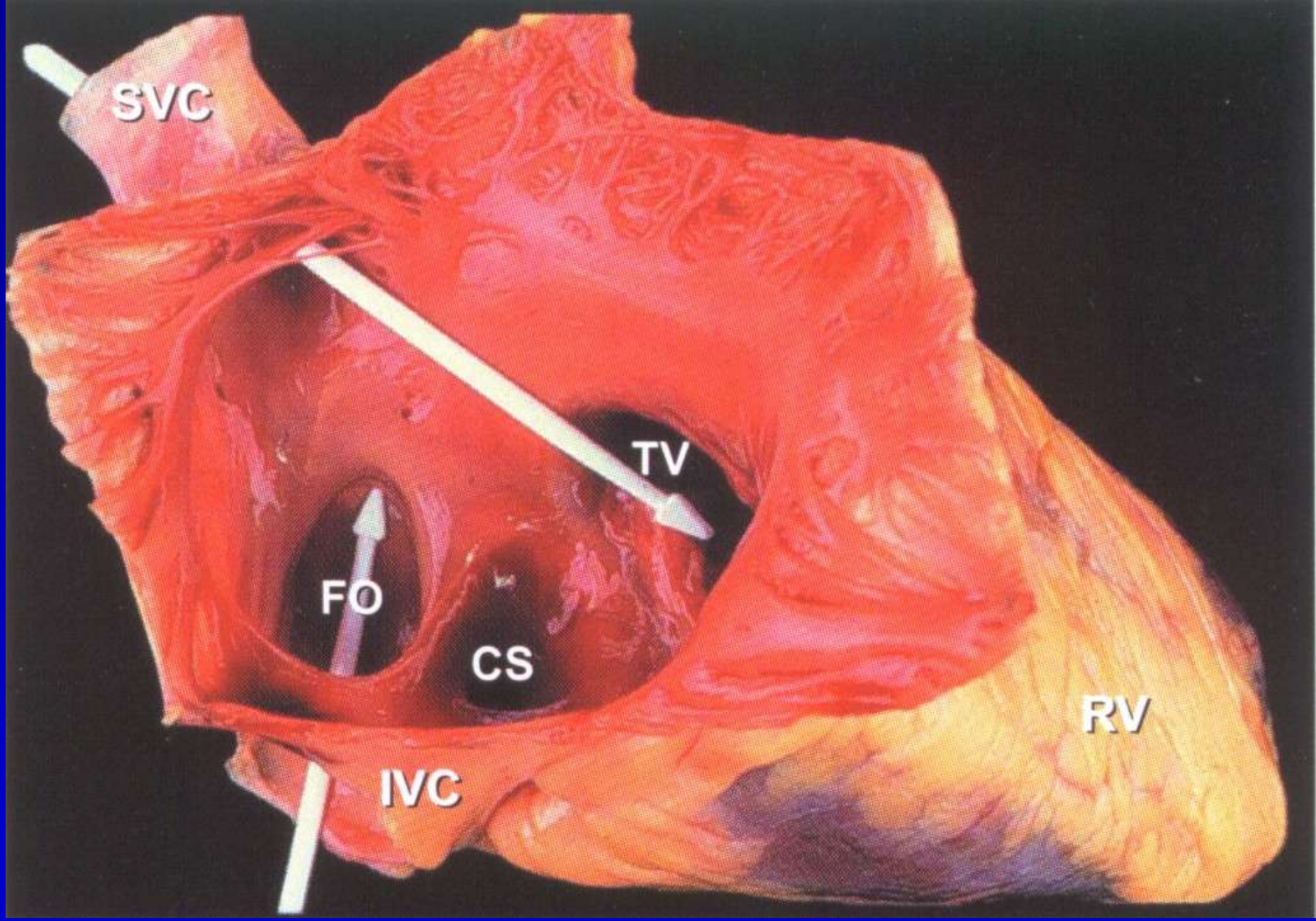

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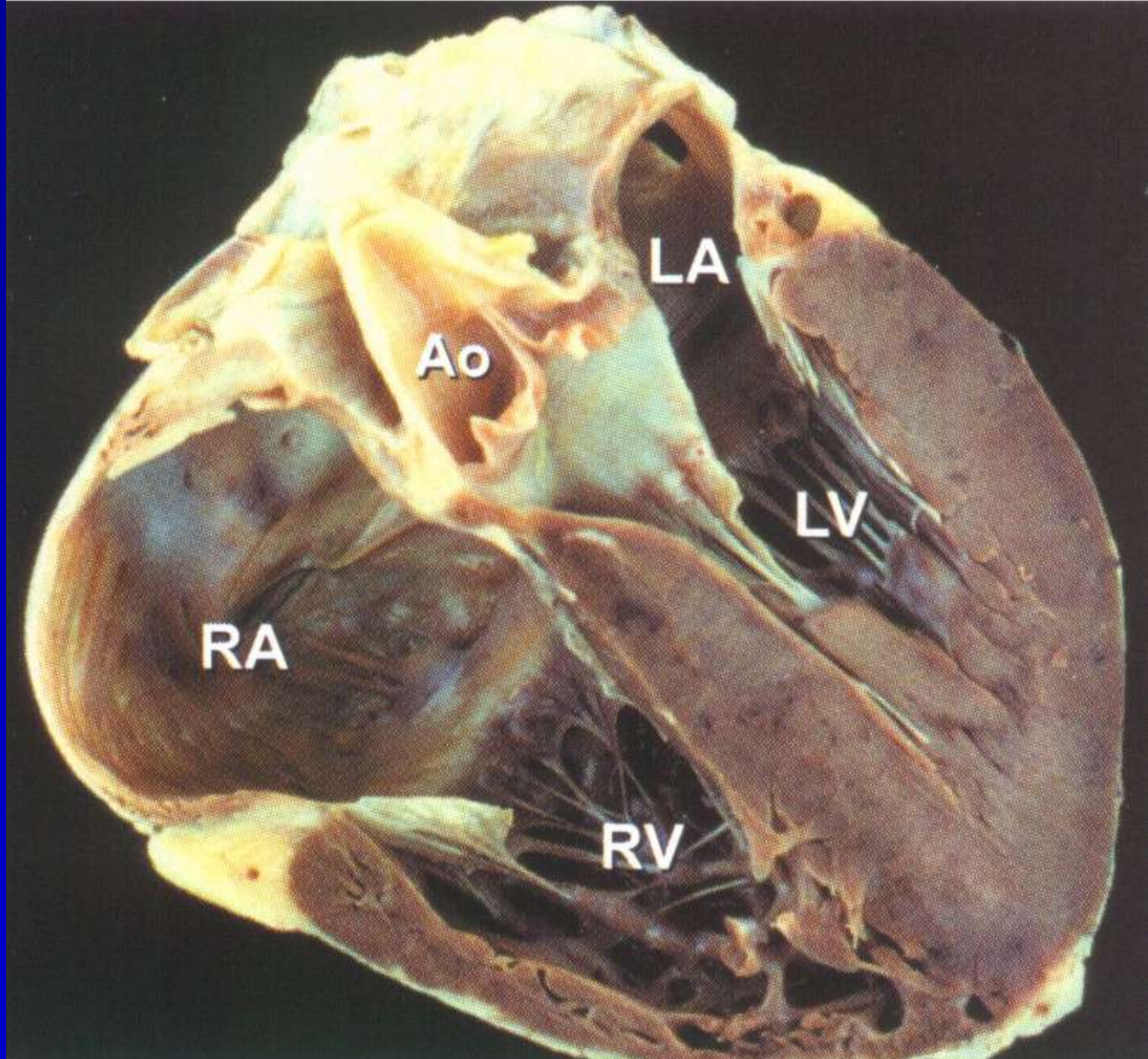

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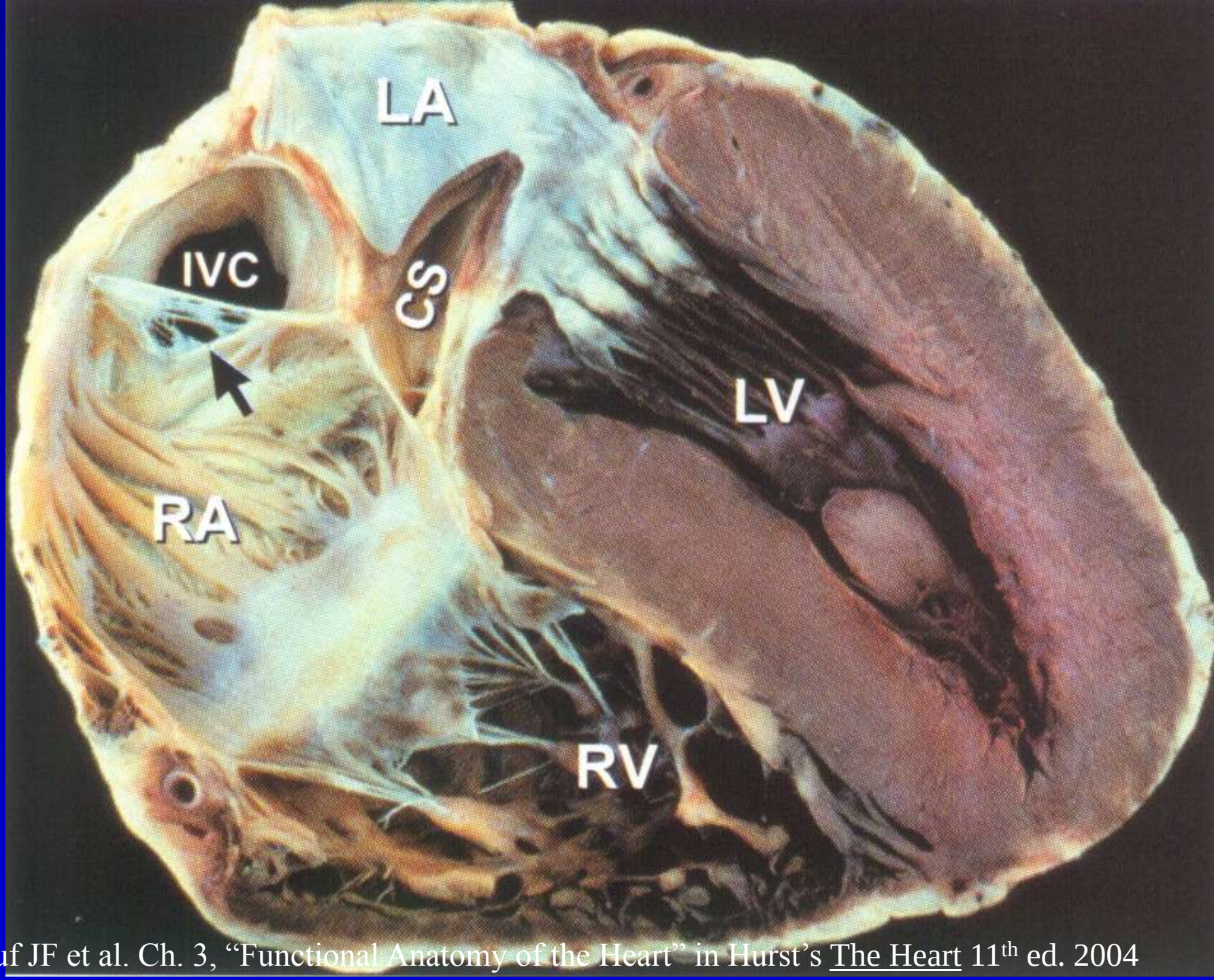

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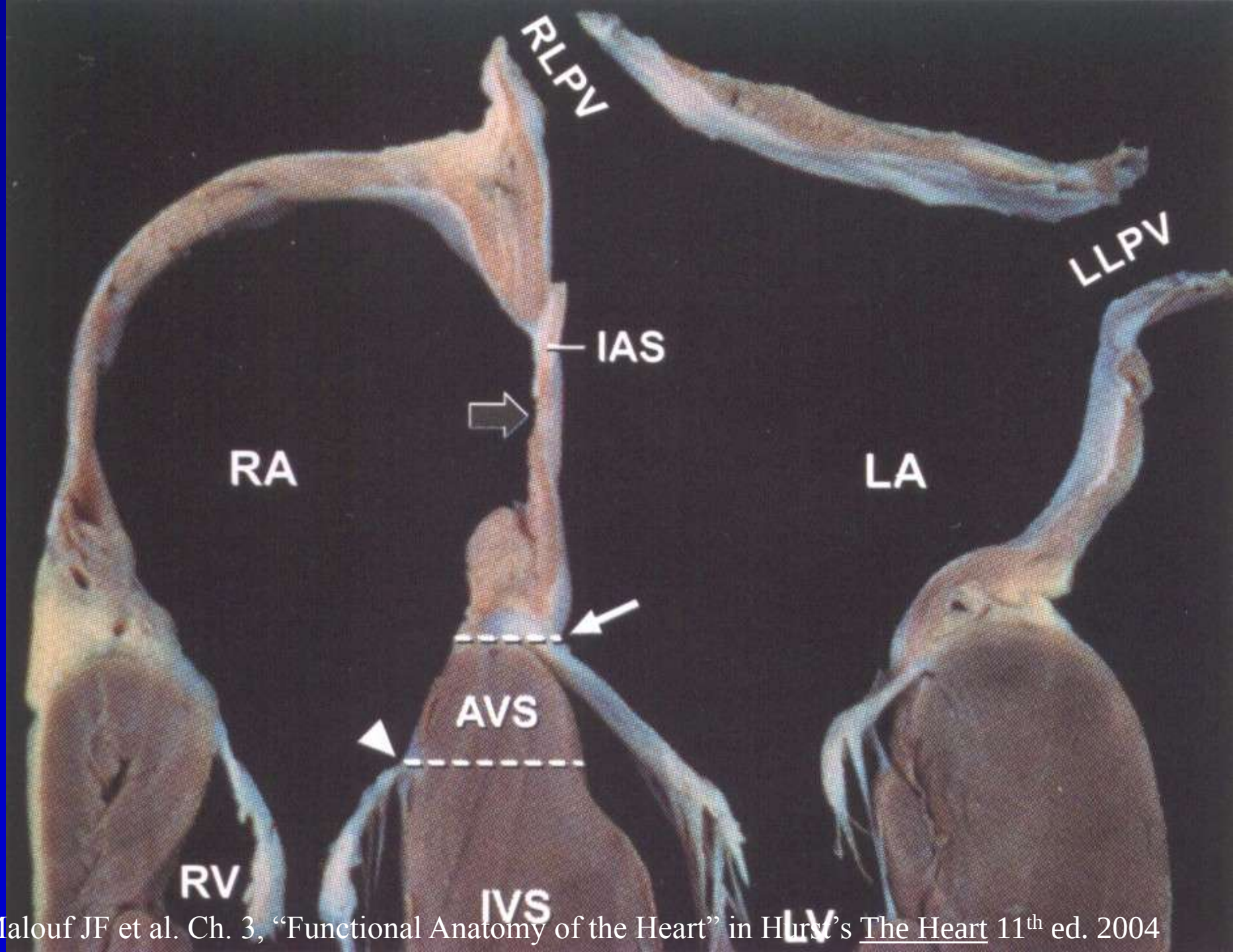

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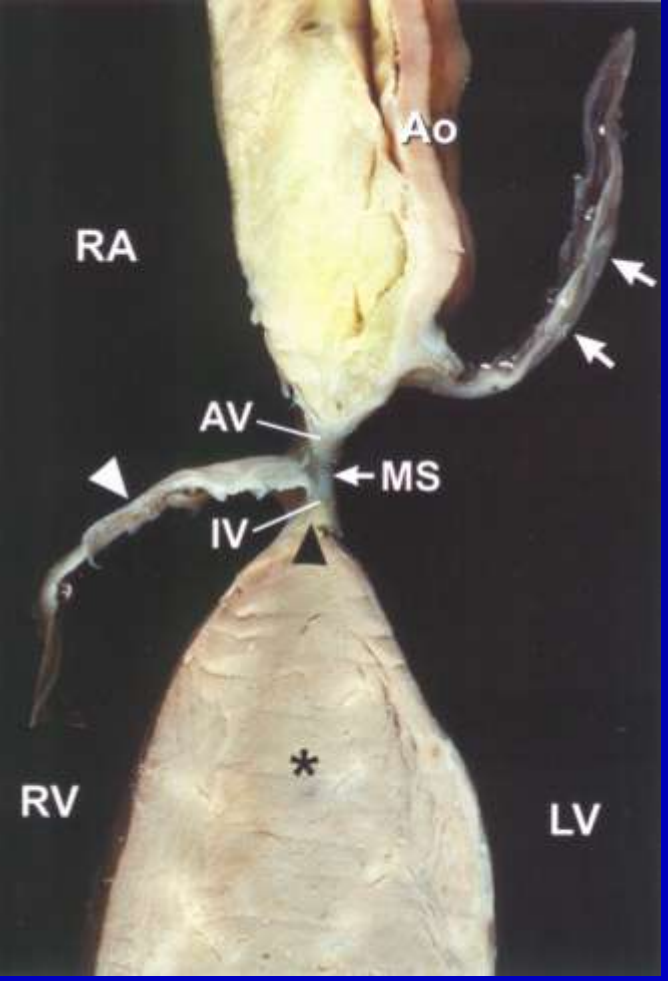

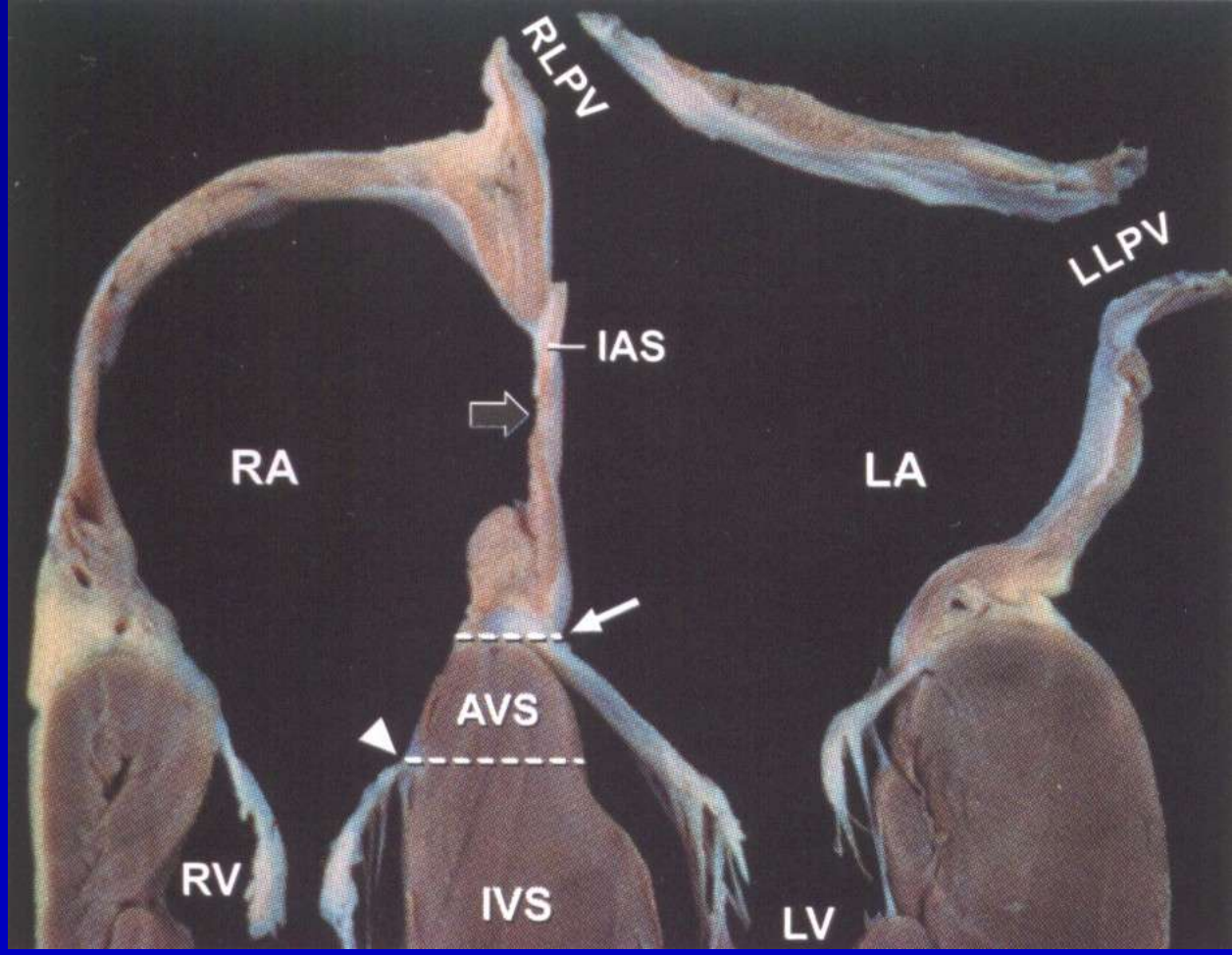

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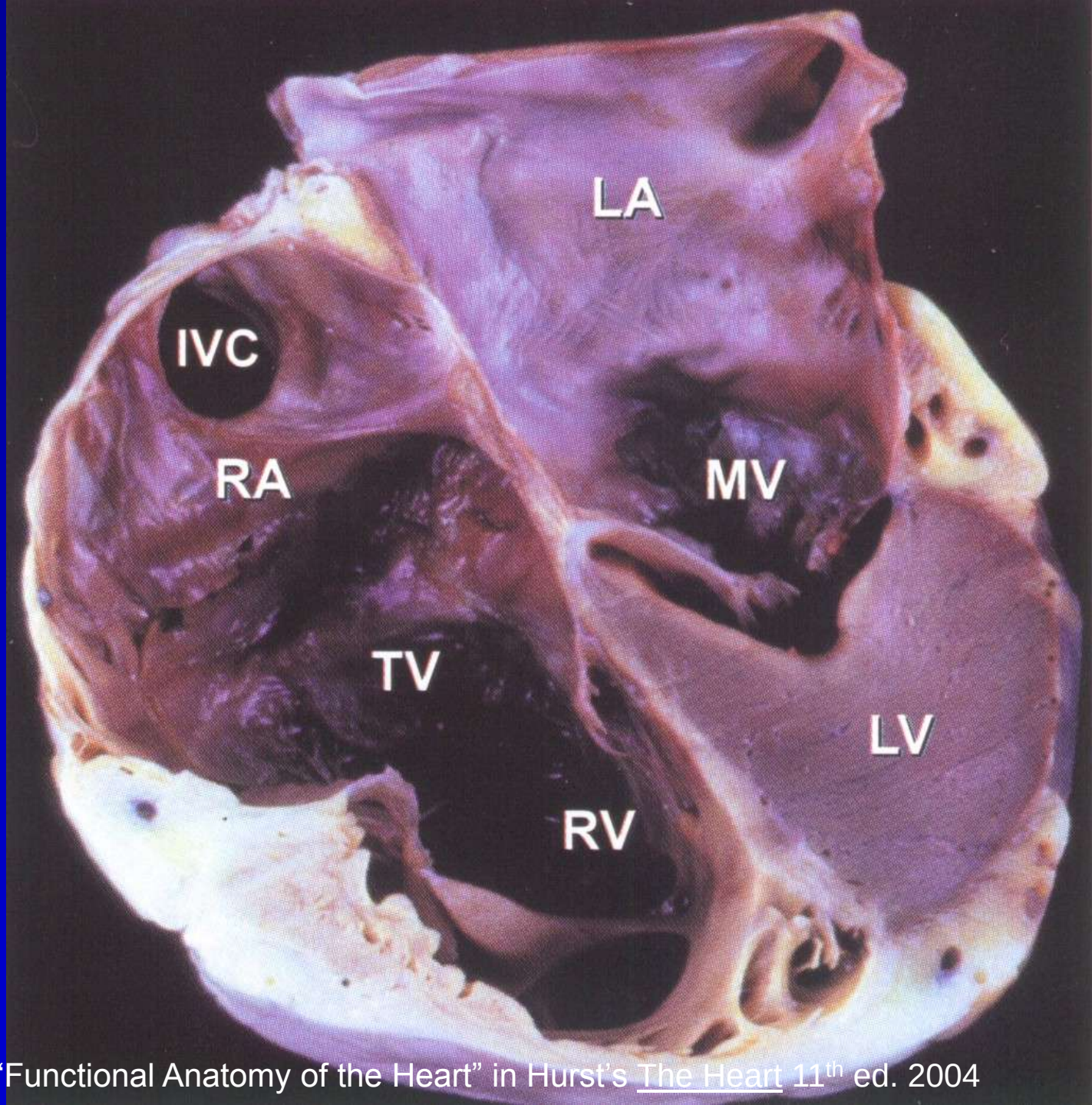

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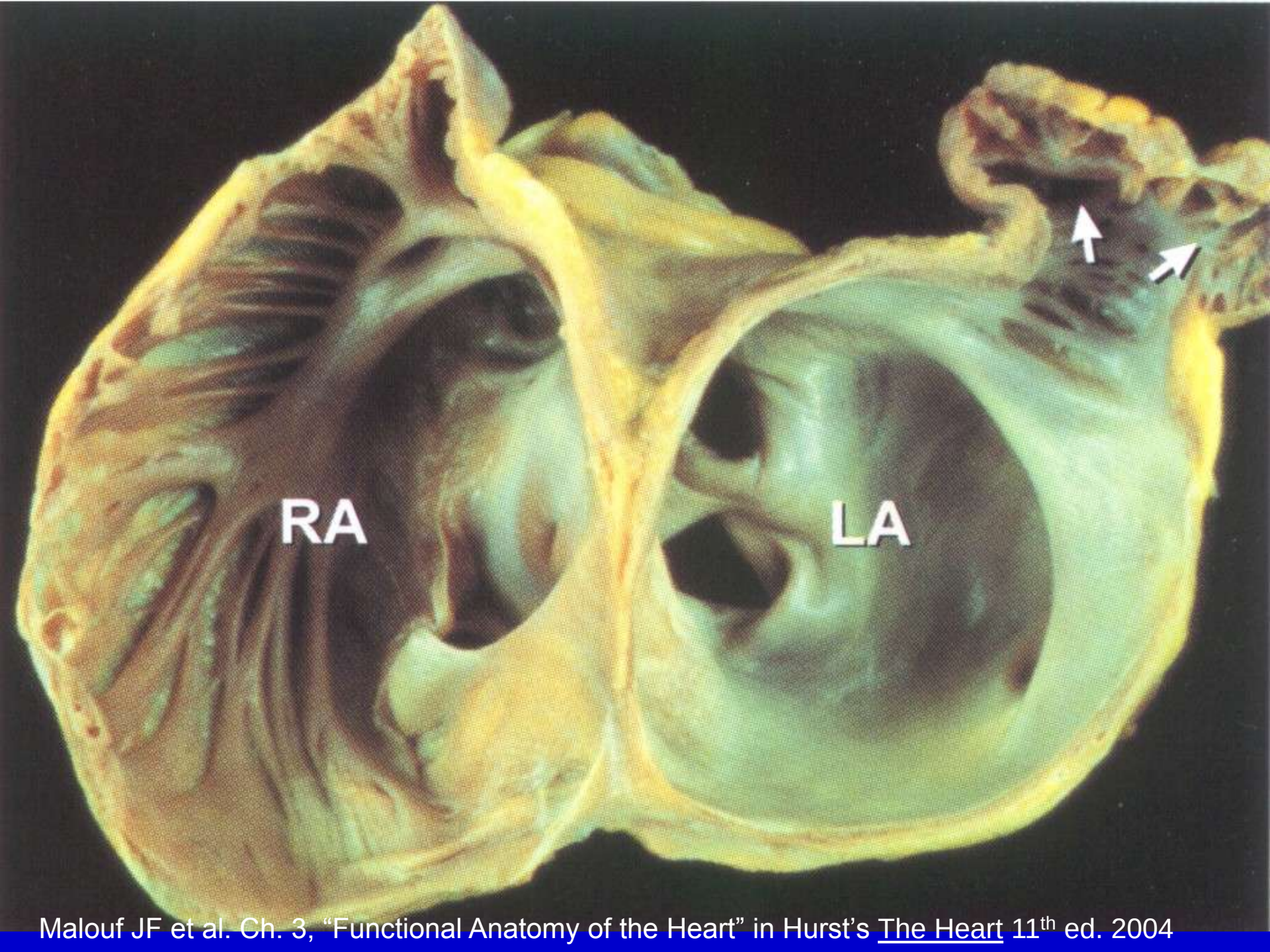

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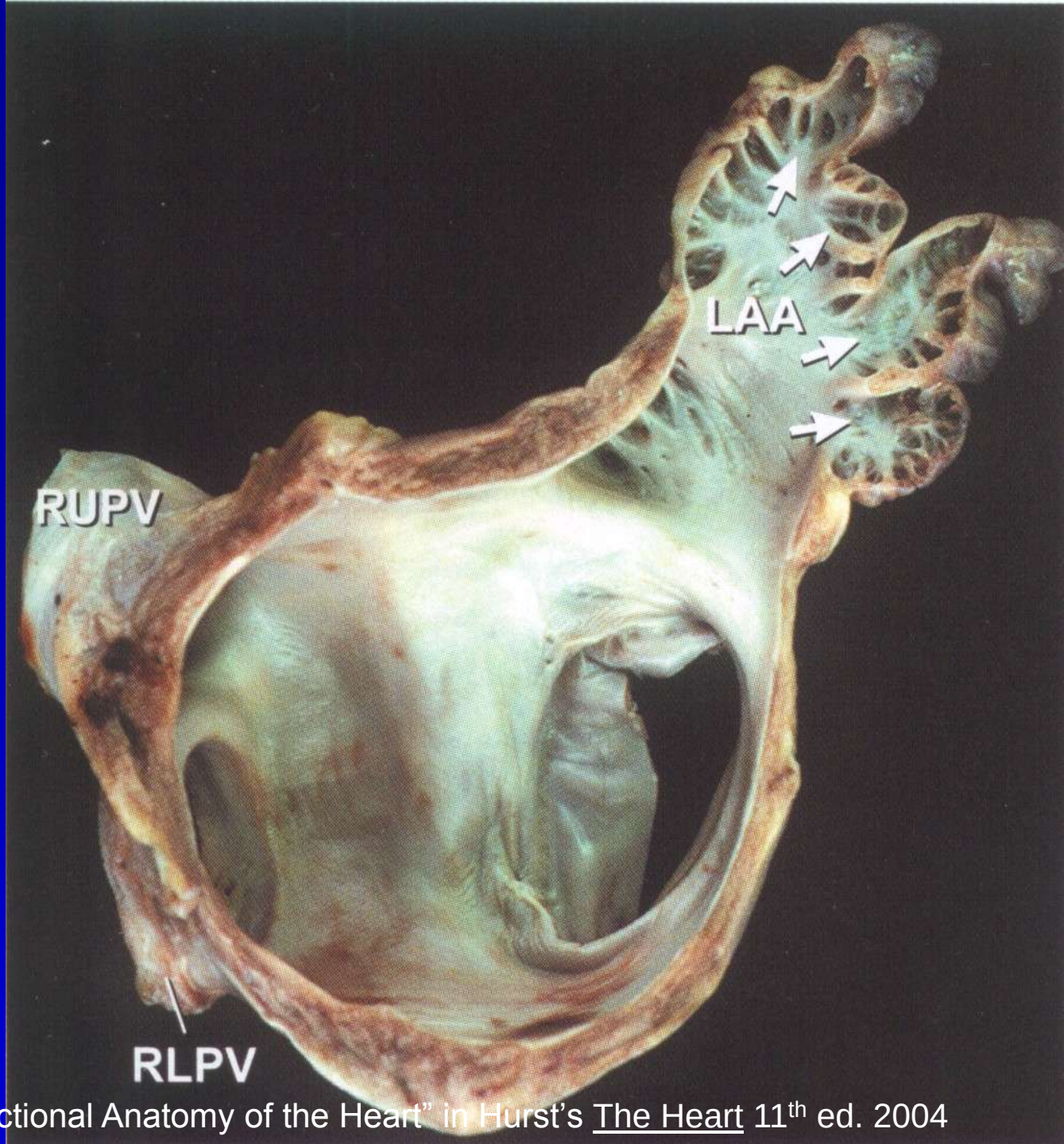
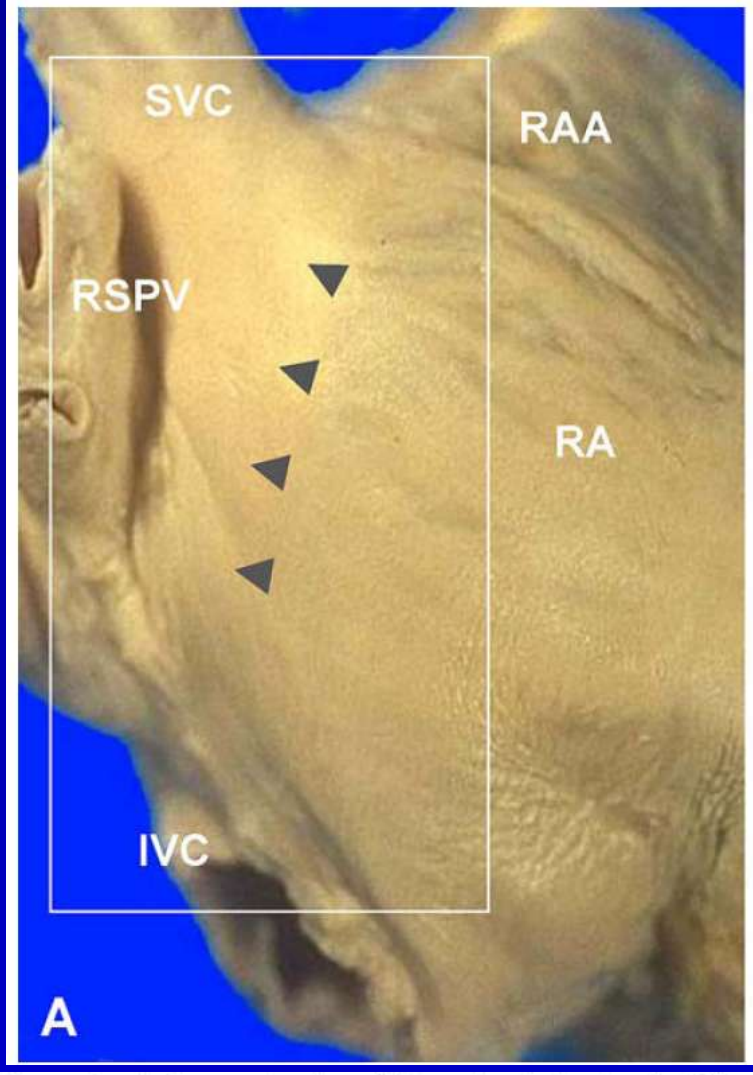


Malouf JF et al. Ch. 3, “Functional Anatomy of the Heart” in Hurst’s The Heart 11th ed. 2004

Interatrial septum: Waterston’s groove

Right Atrium

Arrowheads indicate sulcus terminalis, the outside corresponding to the crista terminalis on the inside



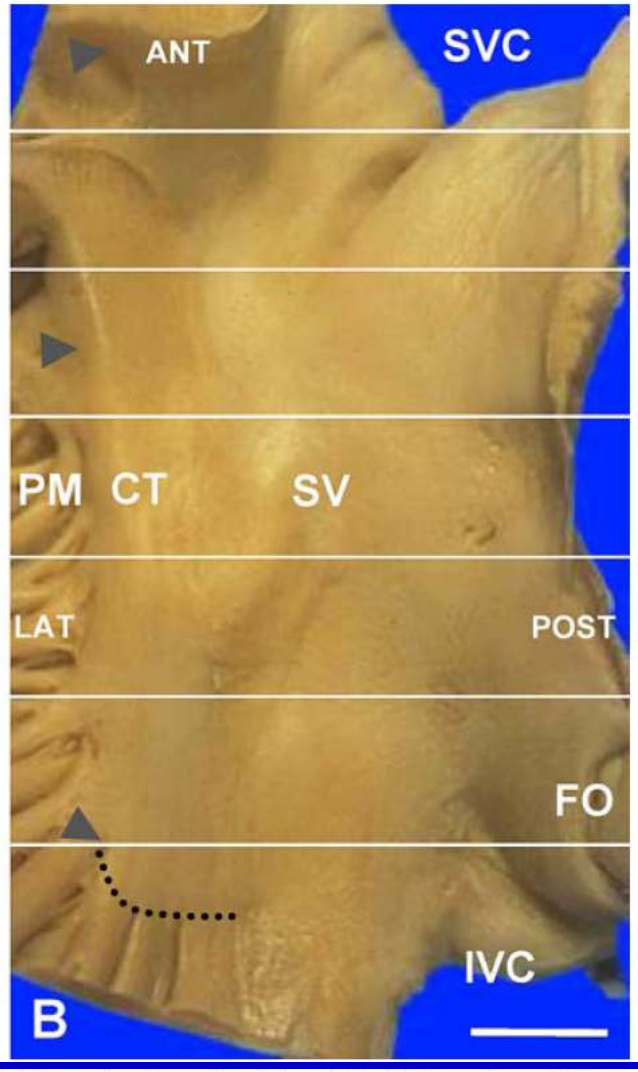


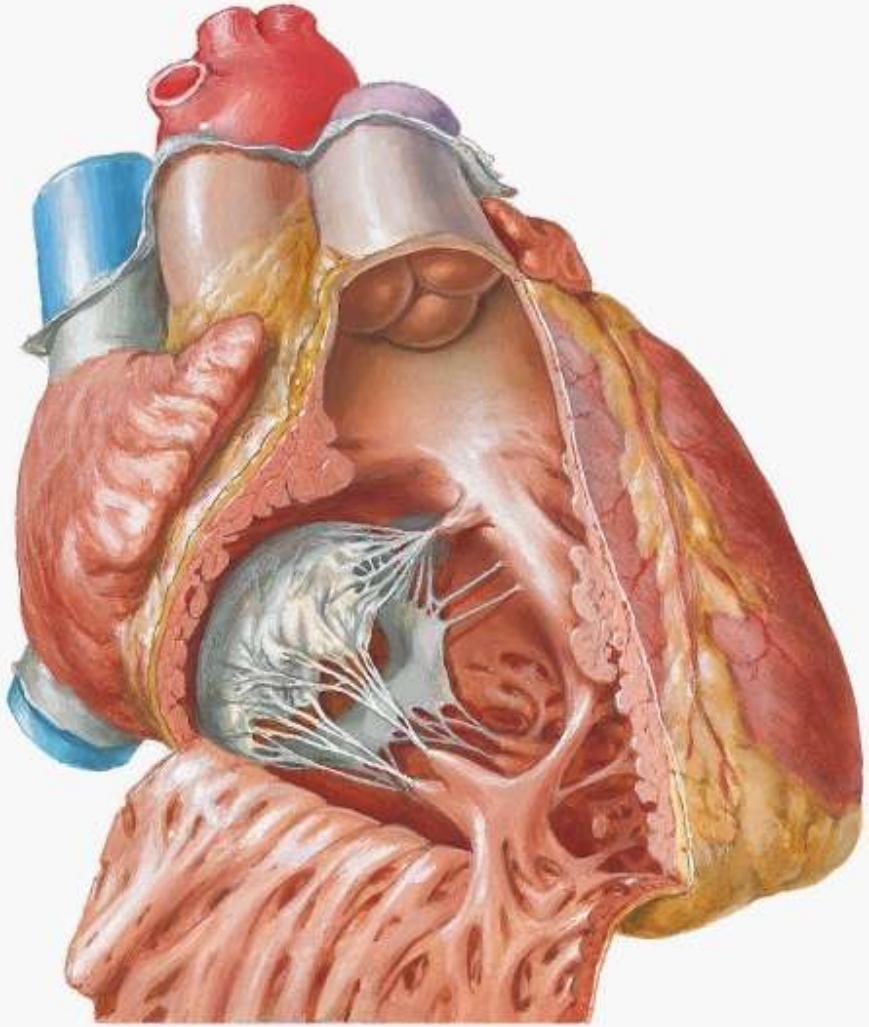
Figure 1 A. Panoramic view of the posterolateral wall of the right atrium based on the right oblique view of the fluoroscope (Heart 2). Arrowheads indicate the sulcus terminalis, the probable junction between the sinoatrial node and the sinus venosus. The frame containing the SVC, IVC, and the posterolateral free wall indicates the subject area of this study and is the area of the right atrium removed for tissue preparation. B. Endocardial aspect of the excised tissue based on the left oblique view of the fluoroscope. The crista terminalis is unfolded from its originally curved shape. The entire crista terminalis (arrowheads) lies between the pectinate muscles and the sinus venosus. The crista terminalis and its adjacent musculature were cut into sections 10-mm thick and perpendicular to the longitudinal axis, as shown. Because the inferior border of the crista terminalis was unclear in some cases, we defined it as the first bifurcation from the main trunk (dotted line). ANT = anterior, CT = crista terminalis, FO = foramen ovale, IVC = inferior vena cava, LAT = lateral, PM = pectinate muscle, POST = posterior, RA = right atrium, RAA = right atrial appendage, RSPV = right superior pulmonary vein, SVC = superior vena cava, SV = sinus venosus. Bar = 10 mm.

Matsuyama T et al. Europace 2004;6:307.

Left atrial appendage under the pulmonary artery and in front of pulmonary veins and over the LV

Opened Right Ventricle

Anterior View



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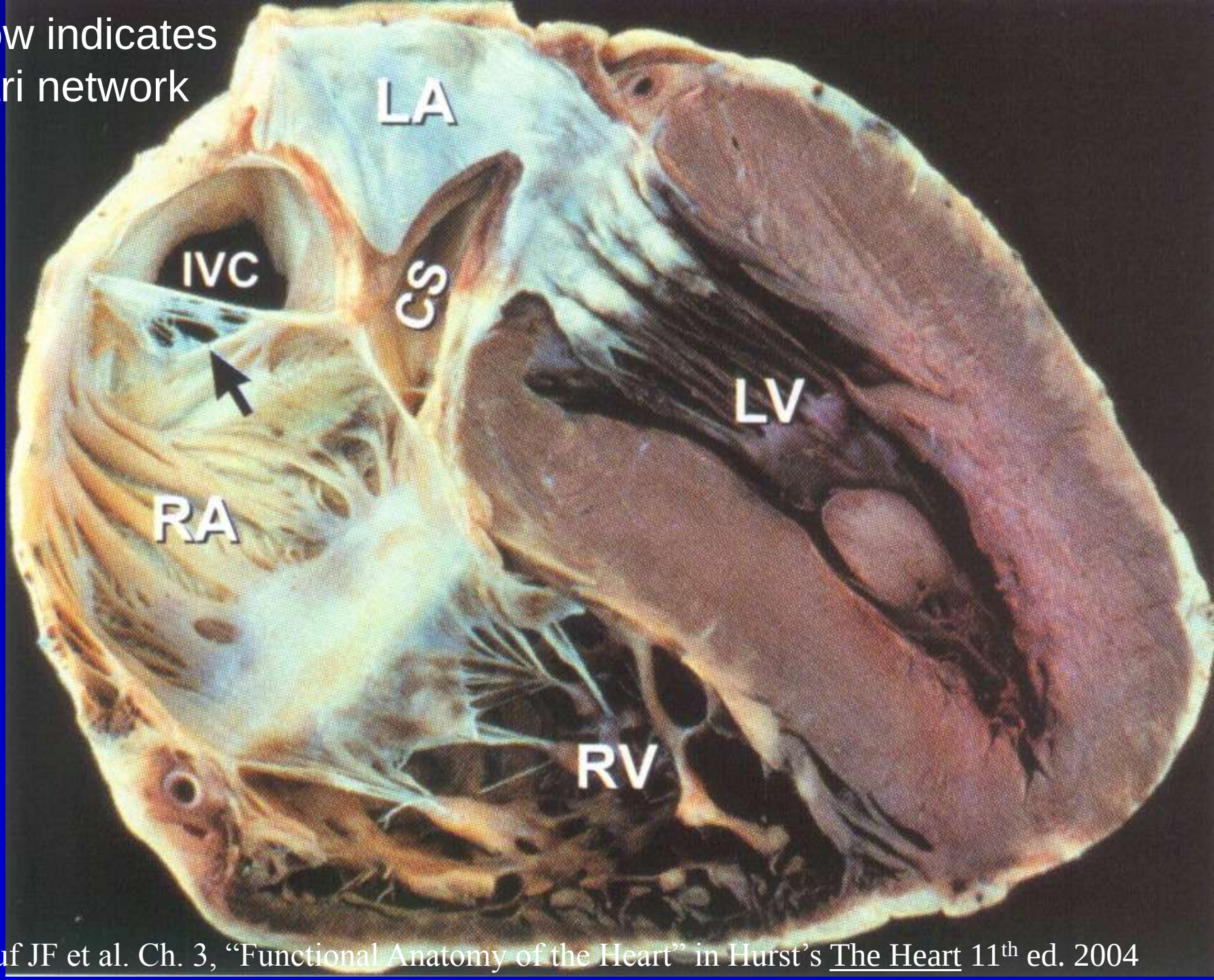
Arrow indicates chiari network



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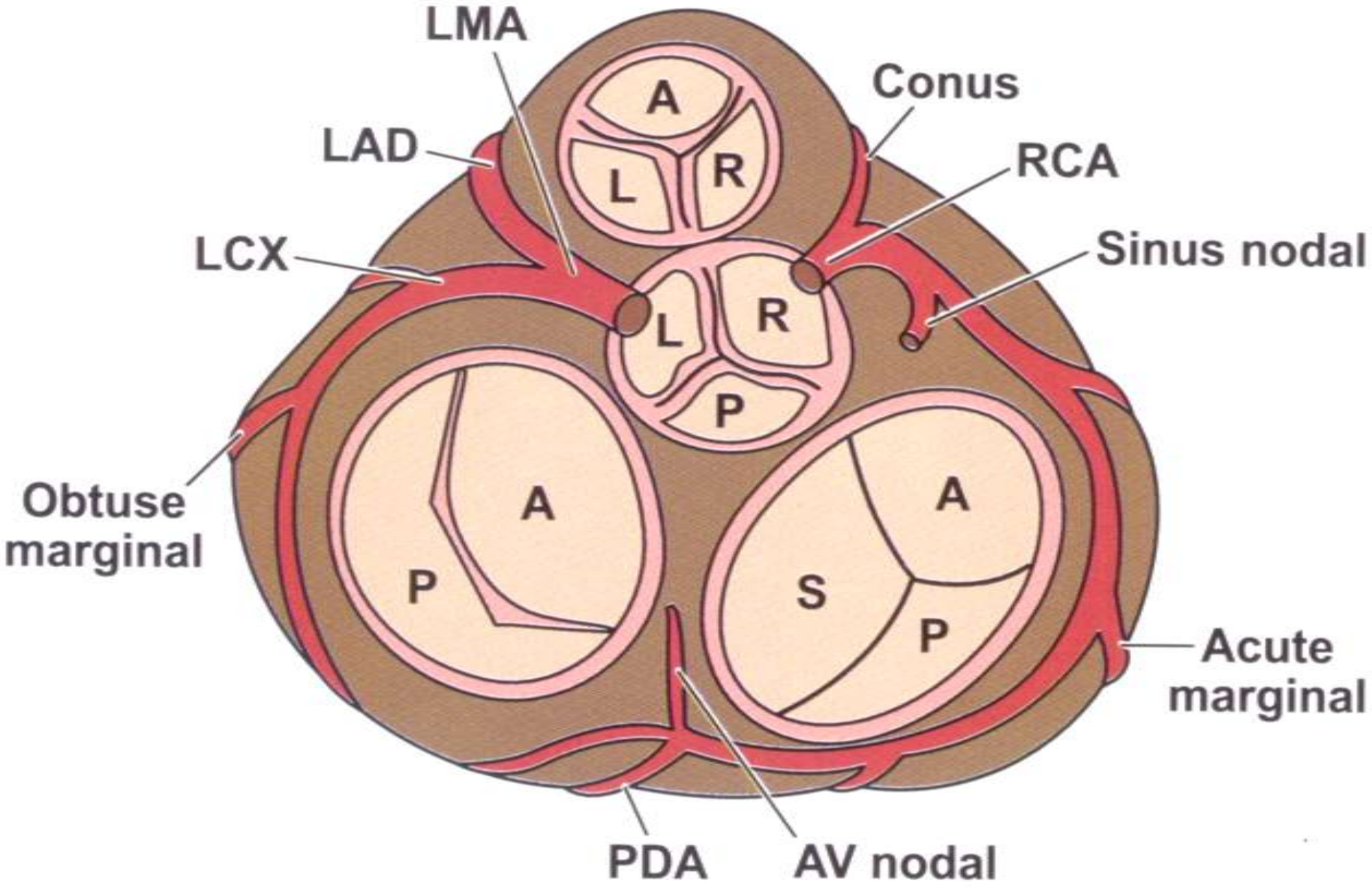
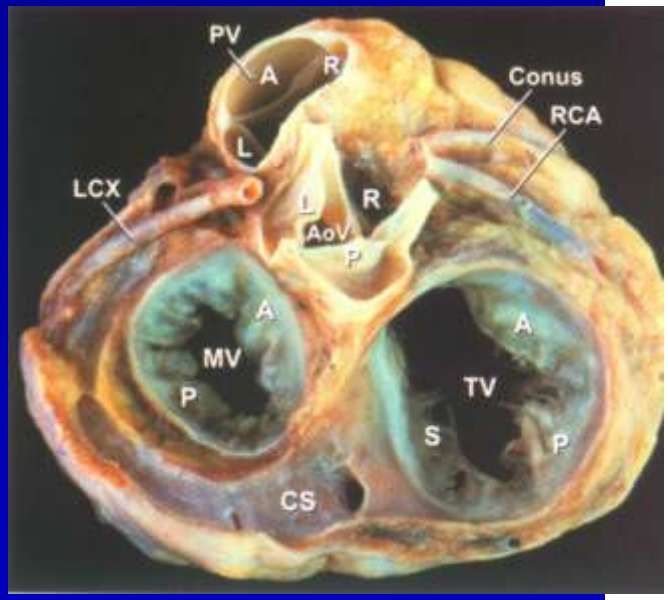
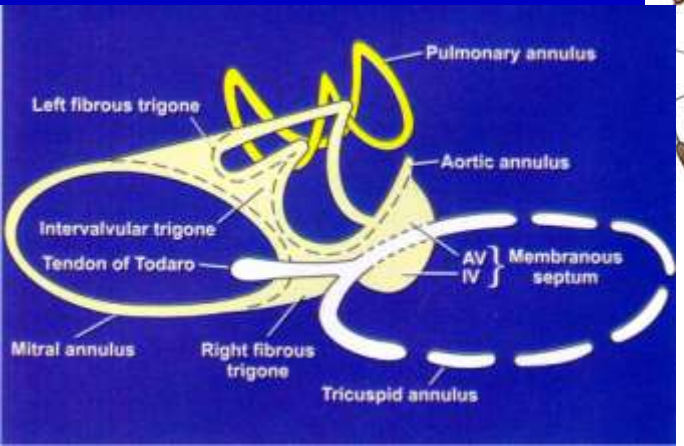
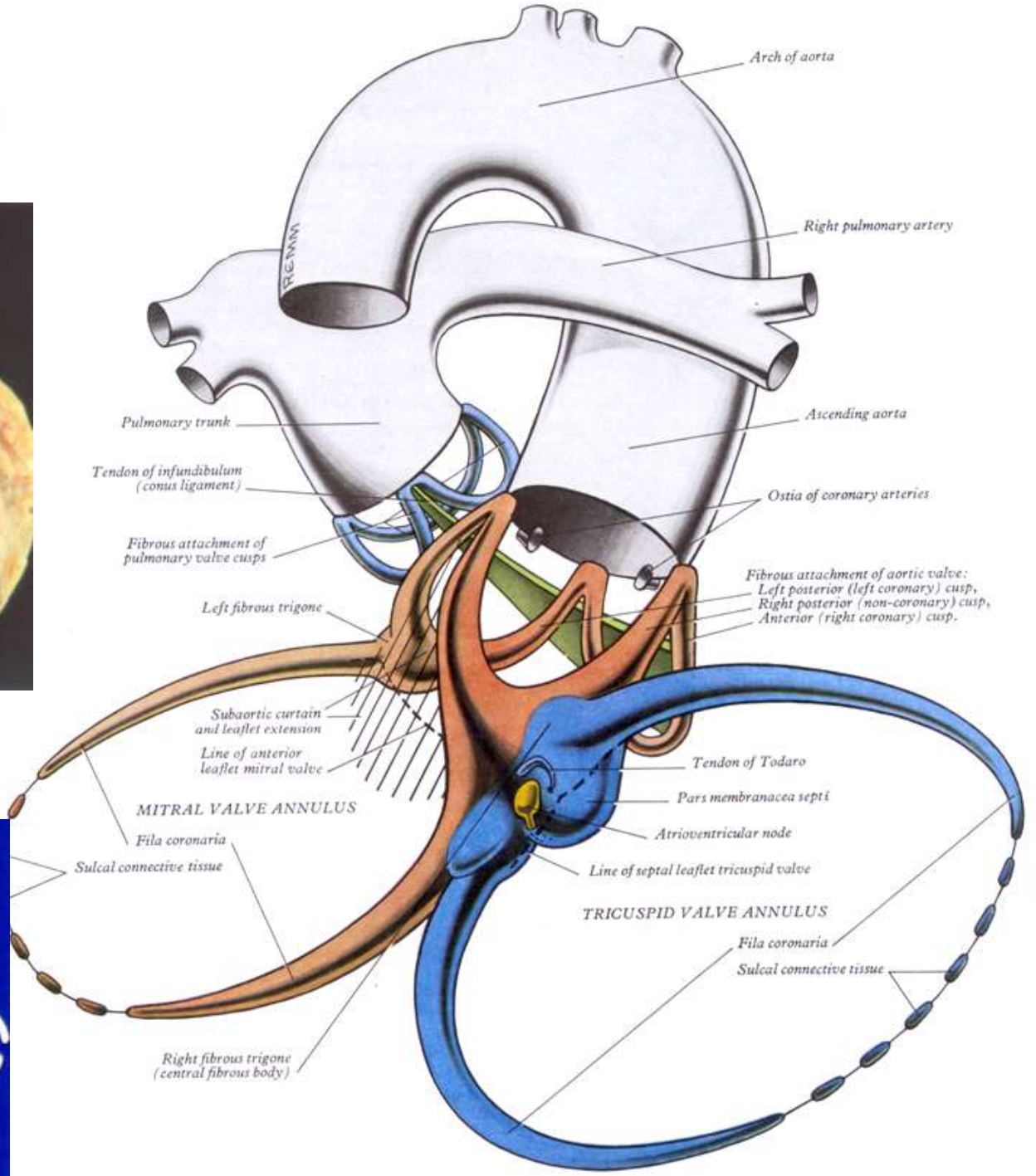

LMA
Conus
LAD
RCA
LCX
Sinus nodal
A
L
R
L
R
P
Obtuse
marginal
A
P
A
S
P
Acute
marginal
PDA
AV nodal

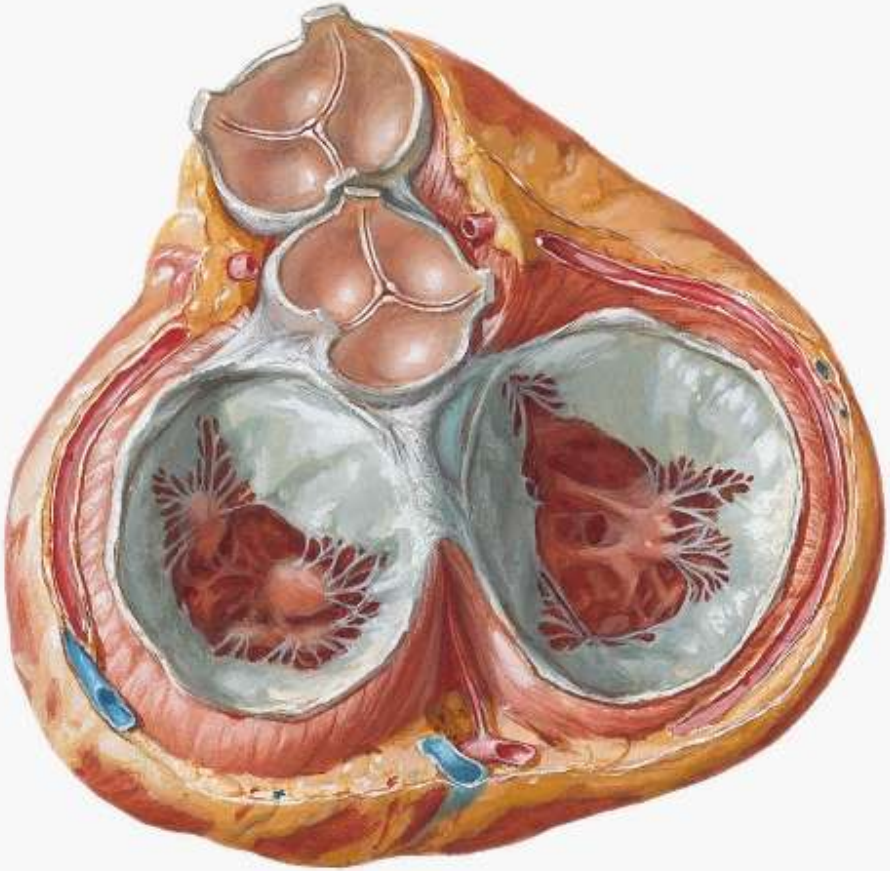
Fibrous Skeleton of the Heart







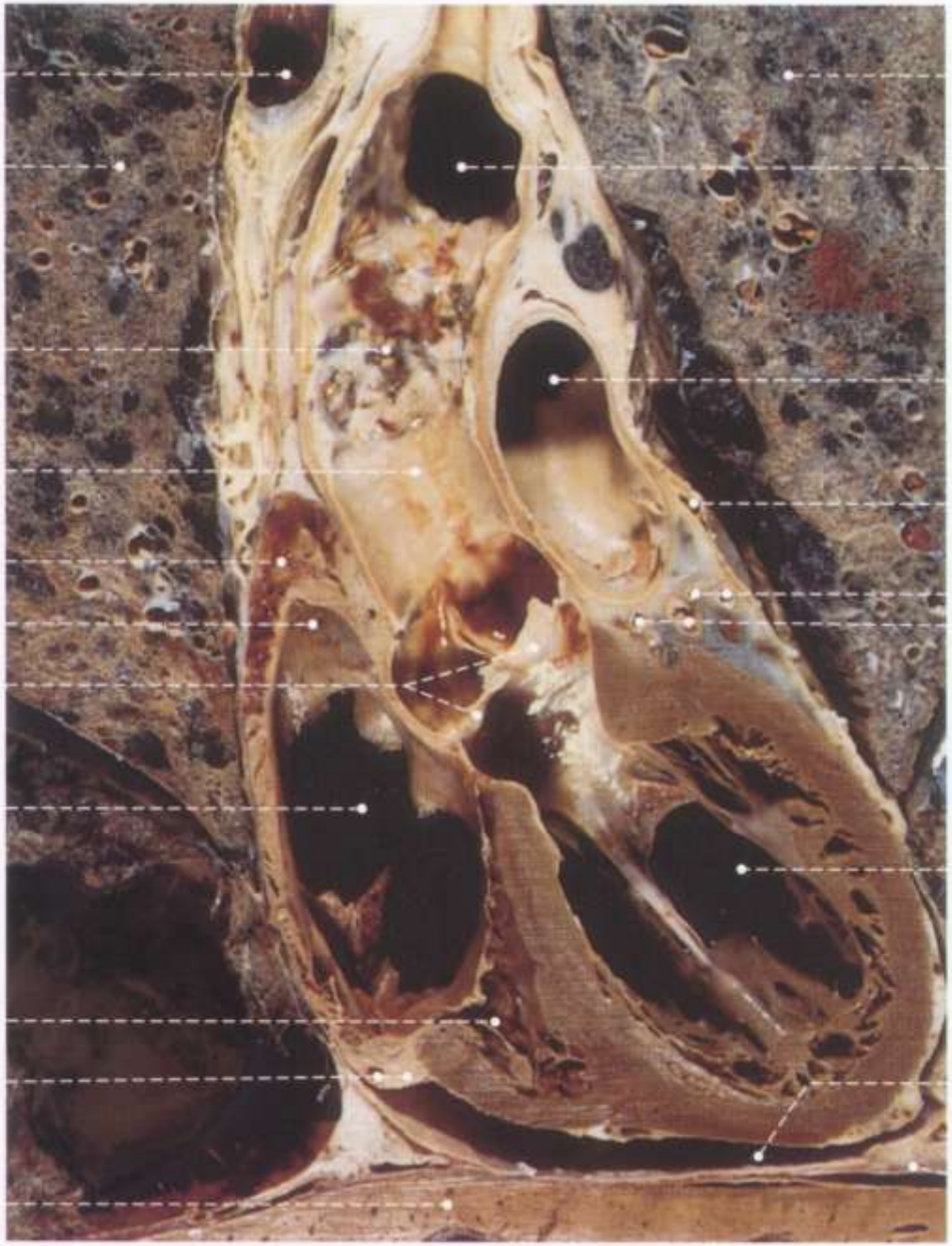
Valves of Heart in Diastole



b


Right brachiocephalic vein
Right lung
Arch of aorta
Right auricle
Right atrium
Diaphragm
Liver
Left lung
Pulmonary trunk
Aortic valve
Circumflex branch of left coronary artery
Left ventricle
Right ventricle
Fundus of stomach

b



Right brachiocephalic vein

Right lung

(Atherosclerotic plaque)

Ascending aorta

Right auricle

Superior vena cava

Semilunar cusps of aortic valve

Right atrium

Right ventricle

Right coronary artery, Small cardiac vein

Liver

Left lung

Arch of aorta

Pulmonary trunk

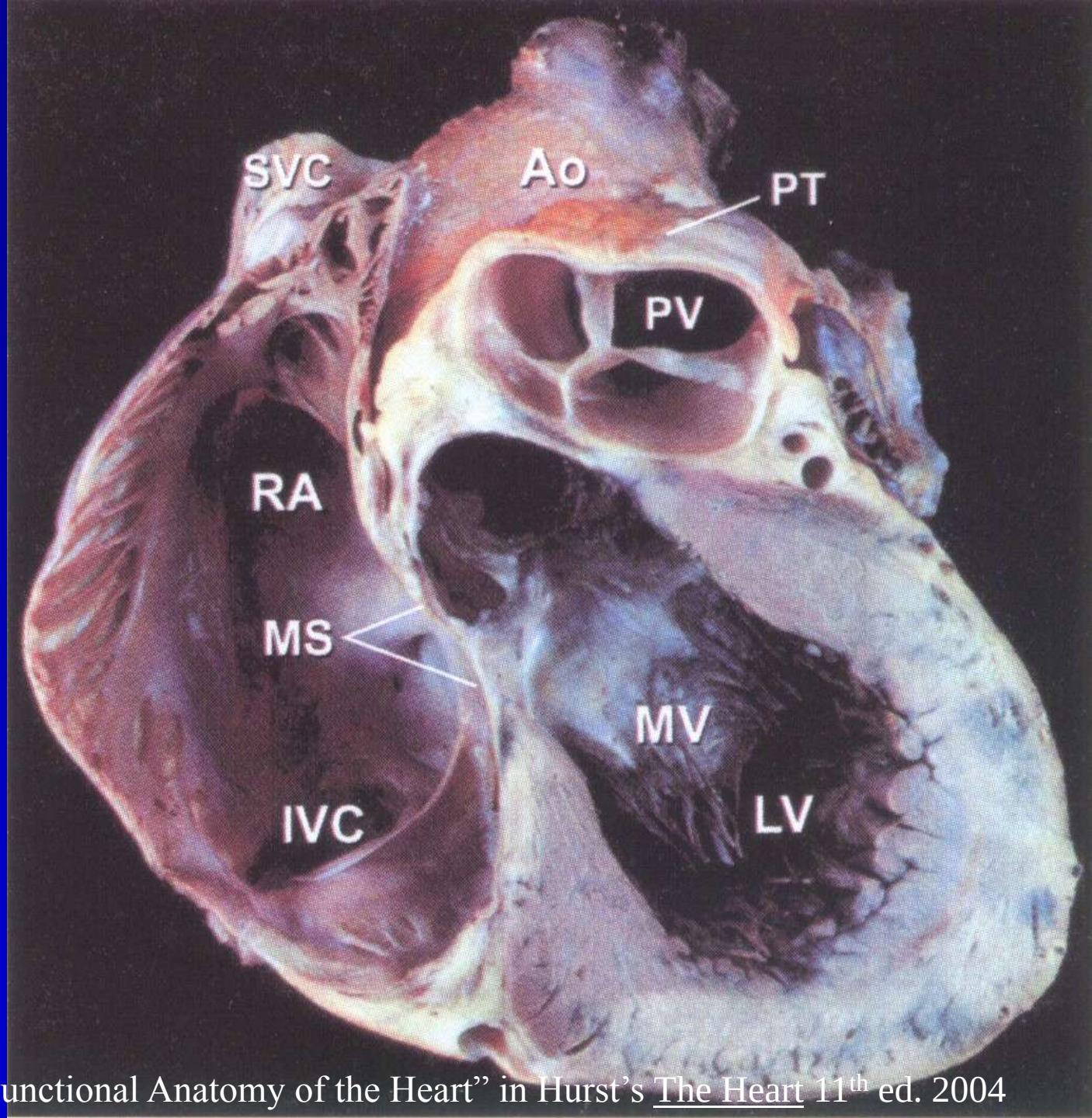
Left auricle

Left coronary artery, Great cardiac vein
– Circumflex branches
– Anterior interventricular branches

Left ventricle

Pericardial cavity (extended)

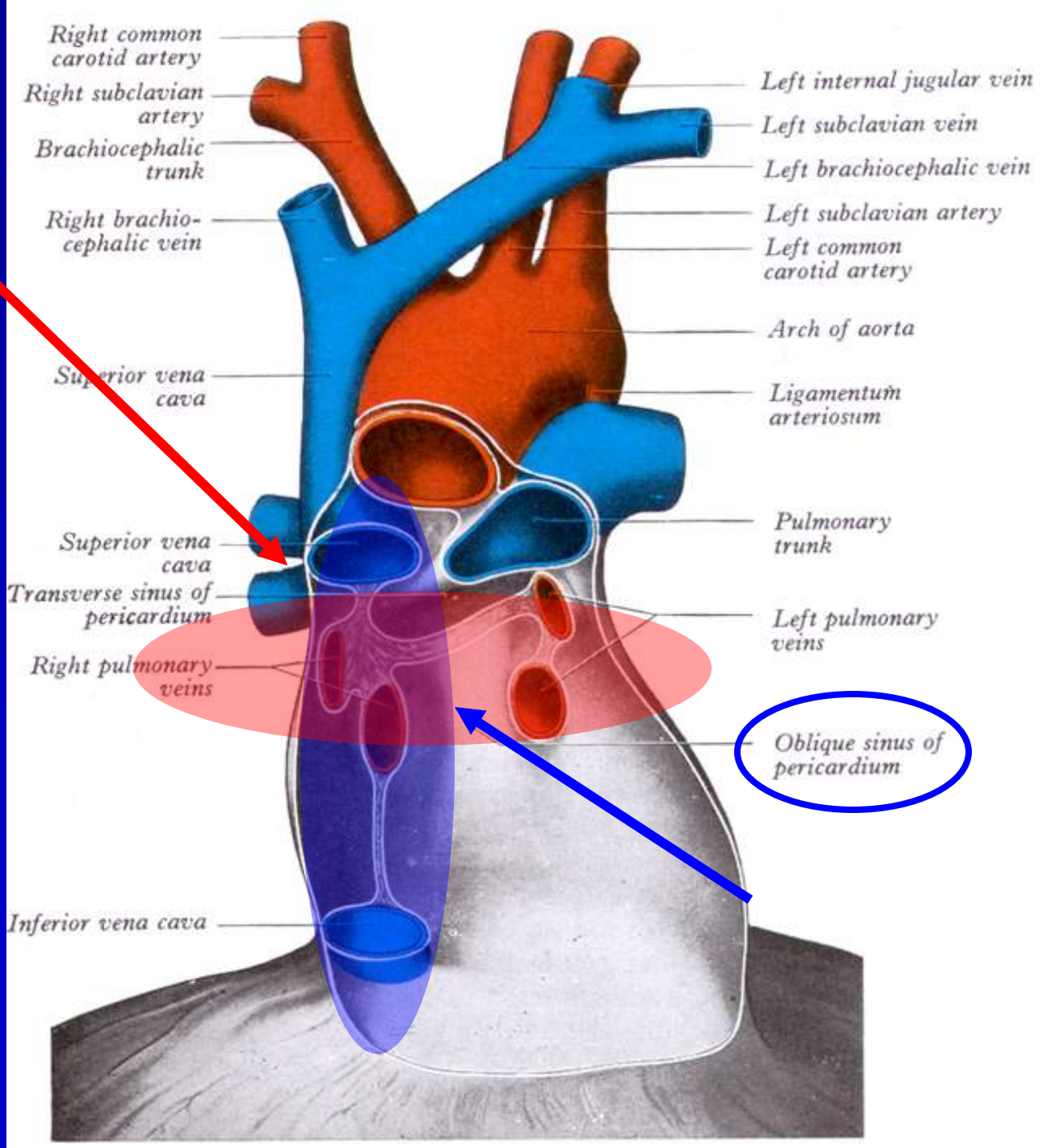
Diaphragm



Malouf JF et al. Ch. 3, "Functional Anatomy of the Heart" in Hurst's The Heart 11th ed. 2004

"Venous Cross"

<u>Westberg's space</u>: the space between the pericardium and the beginning of the aorta (Dorland's Medical Dictionary)



Echocardiography of the Atria

Technical Aspects of Digital Echo

Red = volume

Blue = imaging

Table 2 Sample acquisition protocol

PLAx*	Ap5Ch (AV zoom)*
PLAx (MV/AV zoom)*	Ap2Ch*
RV inflow*	ApLAx*
RV outflow*	ApLAx (MV/AV zoom)*
PSAx (AV)*	SCLAx*
PSAx (MV)*	SCSAx
PSAx (LV)	SSAoArch*
PSAx (Apex)	PW: MV, LVOT, TV
Ap4Ch*	RVOT, PV, HV
Ap4Ch (MV zoom)*	CW: MV, AV, TV, PV
Ap4Ch (TV zoom)*	M-Mode sweeps

A total of 33 loops (15:1 JPEG ≈1.5 MB) + 10 stills (RLE, 200 kB); 50-MB/study × 180 studies/day = 9 GB/day = 2 terabytes/year.

AV, Aortic valve; Ap2Ch, apical 2-chamber; Ap4Ch, apical 4-chamber; Ap5Ch, apical 5-chamber; ApLAx, apical long axis; CW, continuous-wave; HV, hepatic veins; LV, left ventricle; LVOT, left ventricular outflow tract; MV, mitral valve; PLAx indicates parasternal long axis; PSAx, parasternal short axis; PV, pulmonic valve; PW, pulsed-wave; RV, right ventricle; RVOT, right ventricular outflow tract; SSAoArch, suprasternal notch aortic arch; SCLAx, subcostal long axis; SCSAx, subcostal short axis; and TV, tricuspid valve.

*2D + color.

ASE Recommendations for Digital Echocardiography. Thomas JD et al. J Am Soc Echocardiogr. 2005;18:287.

Technical Aspects of Chamber Size Quantitation

- Reviews the technical aspects on how to perform quantitative chamber measurements
- Not intended to describe the standard of care of which measurements should be performed in individual clinical studies.
- However, evaluation of chamber size and function is a component of every complete echocardiographic examination and these measurements may have an impact on clinical management.

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Technical Aspects of Chamber Size Quantitation

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Table 1 Elements of image acquisition and measurement for 2-dimensional quantitation

Aim	Method
Minimize translational motion	Quiet or suspended respiration (at endexpiration)
Maximize image resolution	Image at minimum depth necessary
	Highest possible transducer frequency
	Adjust gains, dynamic range, transmit, and lateral gain controls appropriately
	Frame rate ≥ 30/s
	Harmonic imaging
	B-color imaging
Avoid apical foreshortening	Steep lateral decubitus position
	Cut-out mattress
	Avoid reliance on palpable apical impulse
Maximize endocardial border	Contrast enhancement delineation
Identify end diastole and end systole	Mitral valve motion and cavity size rather than reliance on ECG

ECG, Electrocardiogram.

Reporting Chamber Size

- LA: Normal, Mild, moderate, severe dilation, elongation, volume or dimensions
- RA: Normal, Mild, moderate, marked enlargement, or small
- Summary echo report should include:
  - Answer to the clinical question
  - Emphasis of abnormal findings
  - Comparison to prior studies if available or relevant

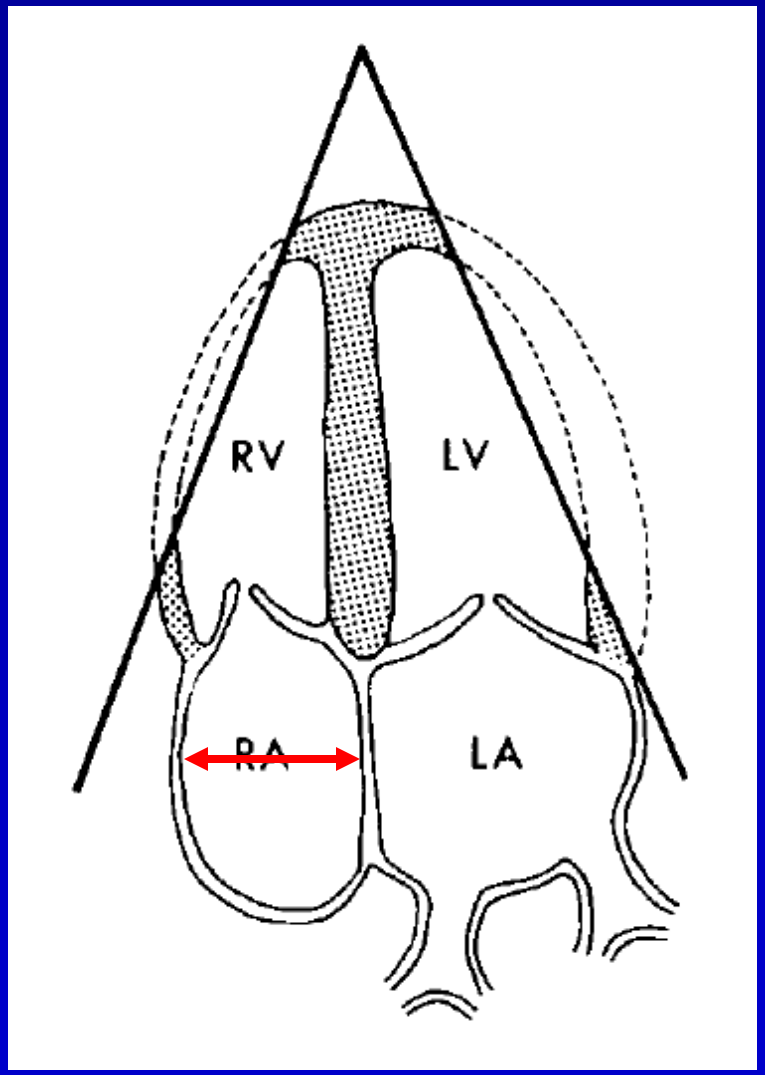
ASE Recommendations for Standardized Report. Gardin JM et al. J Am Soc Echocardiogr. 2002;15:275.

Right Atrium – Size

- Quantification of RA size is most commonly performed from A4C. The minor-axis dimension should be taken in a plane perpendicular to the long axis of the RA and extends from the lateral border of the RA to the interatrial septum. Although RA dimension may vary by sex, no separate male and female reference values can be recommended at this time.

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Right Atrial Size



Report of the ASE Committee on Nomenclature and Standards in Two-dimensional echocardiography

Right Atrium – Volume

- There are no standard orthogonal RA views to use an apical biplane calculation, so the single plane area-length and method of disks formulas have been applied to RA volume determination in several small studies. There is too little peer-reviewed validated literature to recommend normal RA volumetric values at this time. However, limited data on a small number of healthy individuals revealed that indexed RA volumes are similar to LA normal values in men (21 mL/m^2) but appear to be slightly smaller in women.

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Values for Right Atrial Enlargement

Normal	Mild	Moderate	Severe
1.7-2.5	2.6-2.8	2.9-3.1	≥3.2

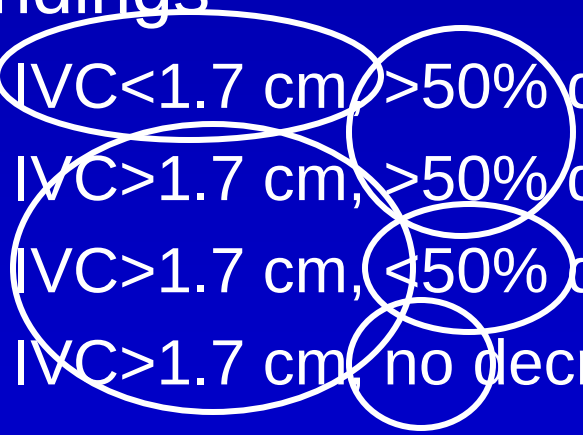
Right atrium minor axis dimension; men or women

Units: cm/M^2 (indexed for BSA)

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Right Atrial Pressure
IVC Echocardiography

- Technique: Image in subcostal window, in long axis, measure about 1-2 cm from RA-IVC junction, with respiration or with brief sniff
- Findings
  - IVC<1.7 cm, >50% decrease with sniff – RA = 0-5 mmHg
  - IVC>1.7 cm, >50% decrease with sniff – RA = 6-10 mmHg
  - IVC>1.7 cm, <50% decrease with sniff – RA = 10-15 mmHg
  - IVC>1.7 cm, no decrease with sniff – RA = 16-20 mmHg



ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Left Atrium - Size

Left Atrium - Size

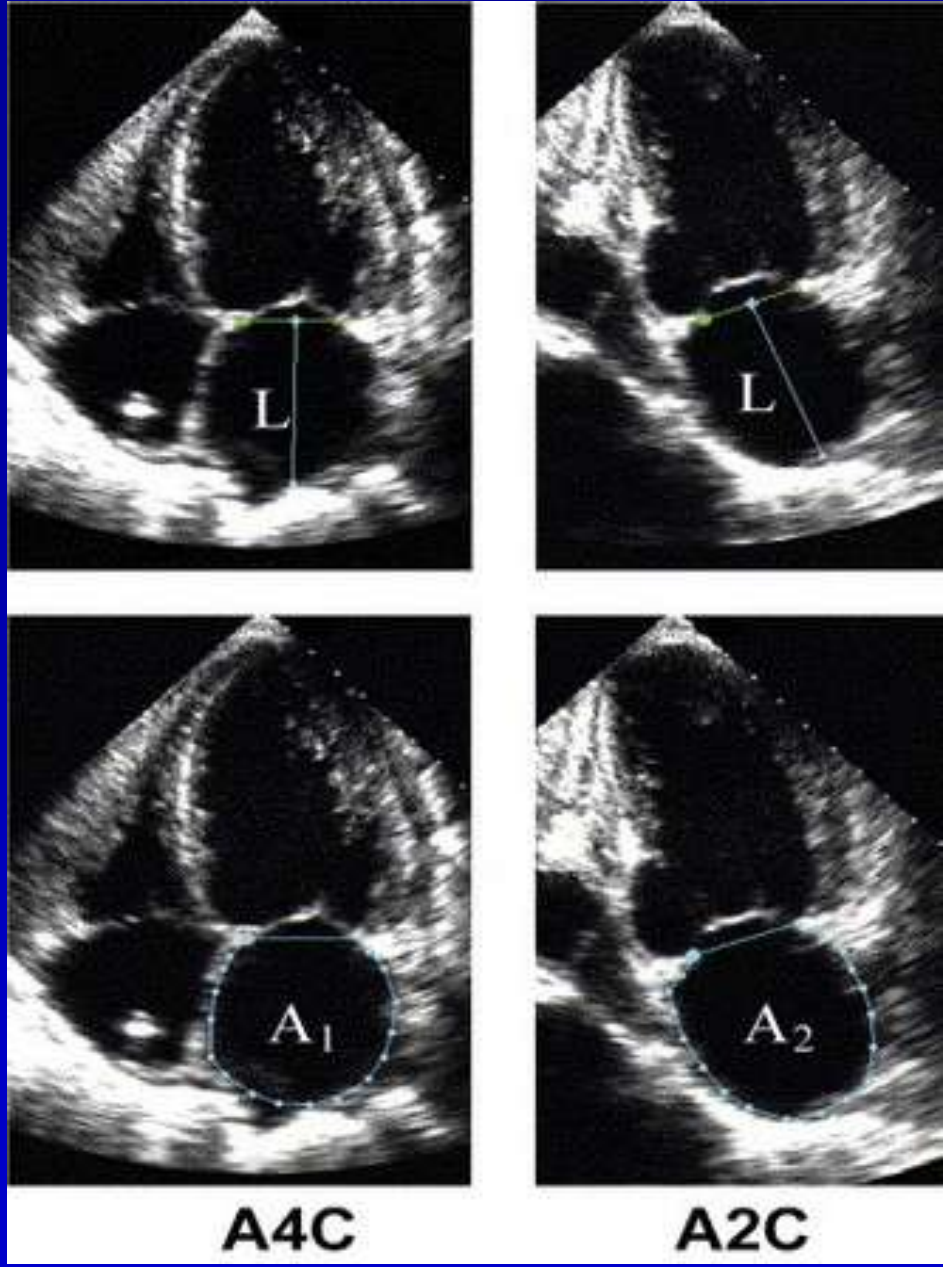
Left Atrial Volume =

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

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

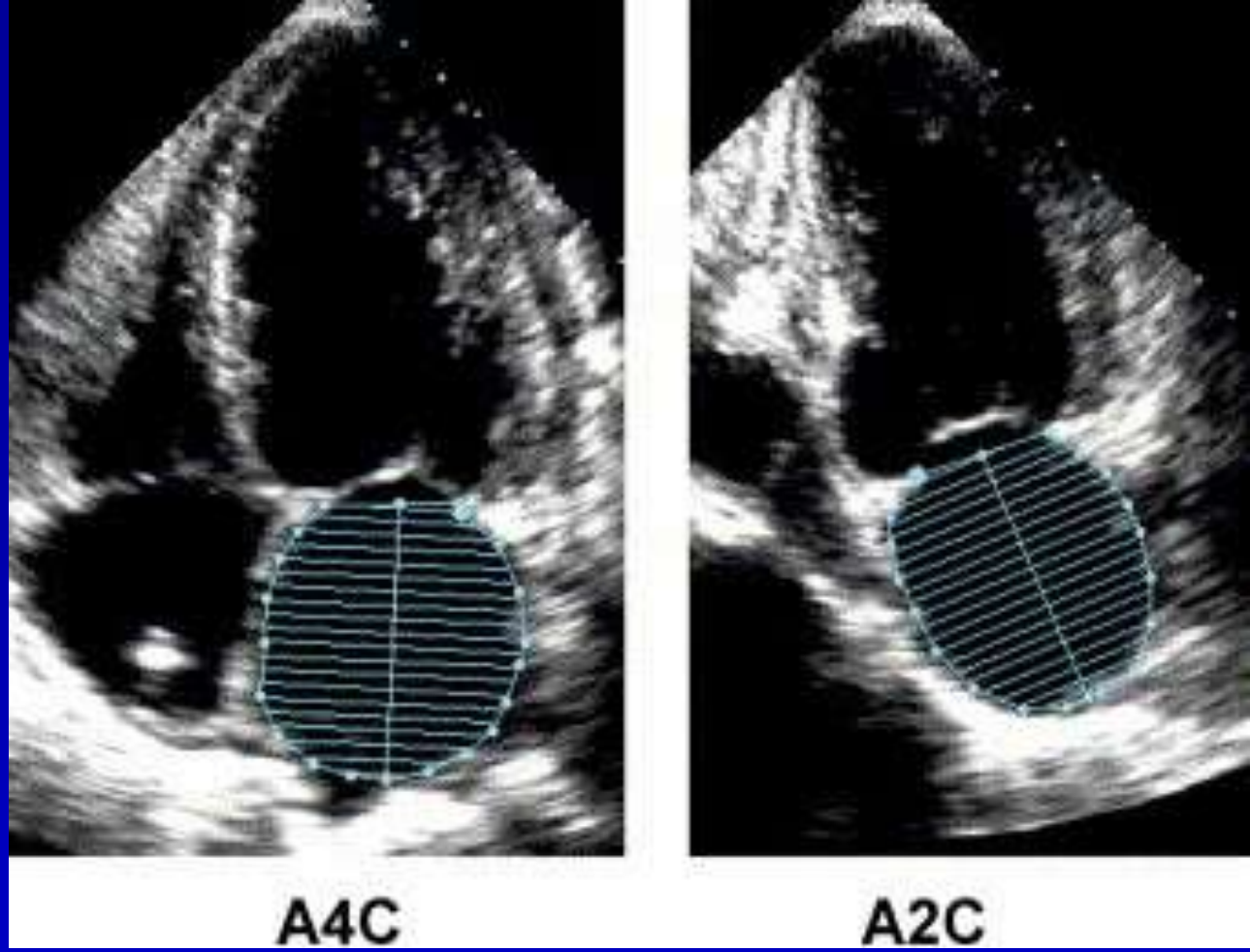
$0.85*A_1*A_2/L$

Measurement of LA volume from **area-length (*L*) method** using *A4C* and *A2C* views at ventricular end systole (maximum LA size). L is measured from back wall to line across hinge points of mitral valve. Shorter L from either A4C or A2C is used in equation.



ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Left Atrium - Size

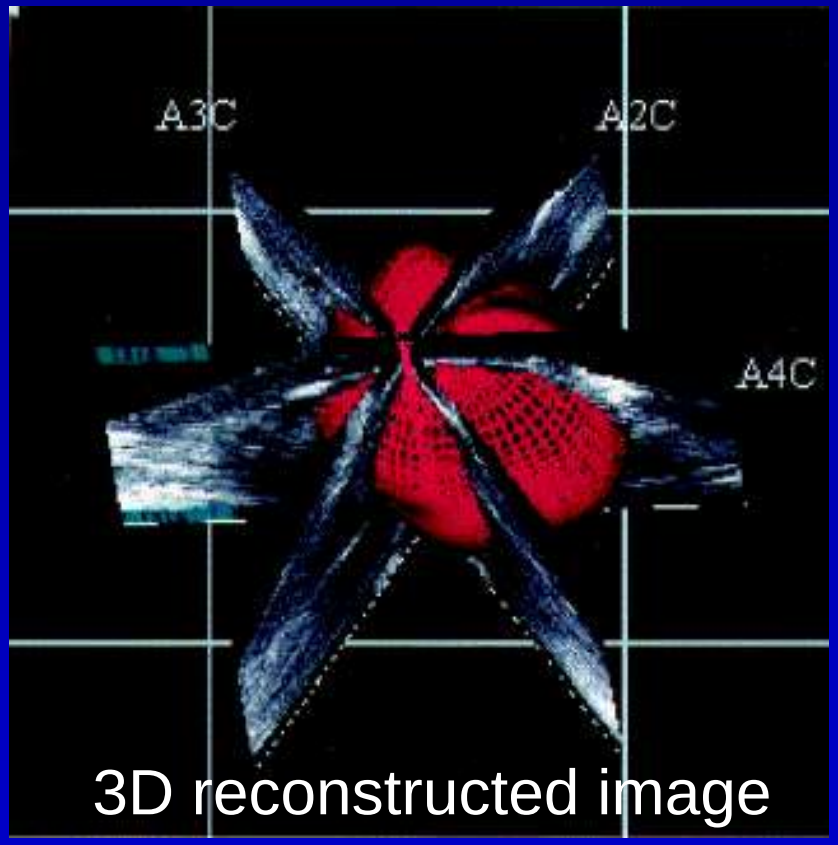


Measurement of LA volume from biplane method of disks (modified Simpson's rule) using A4C and A2C views at ventricular end systole (maximum LA size). NOT PREFERRED.

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Left Atrium - Size

Three-dimensional echocardiography should provide the most accurate evaluation of LA volume and has shown promise; however, to date no consensus exists on the specific method that should be used for data acquisition and there is no comparison with established normal values



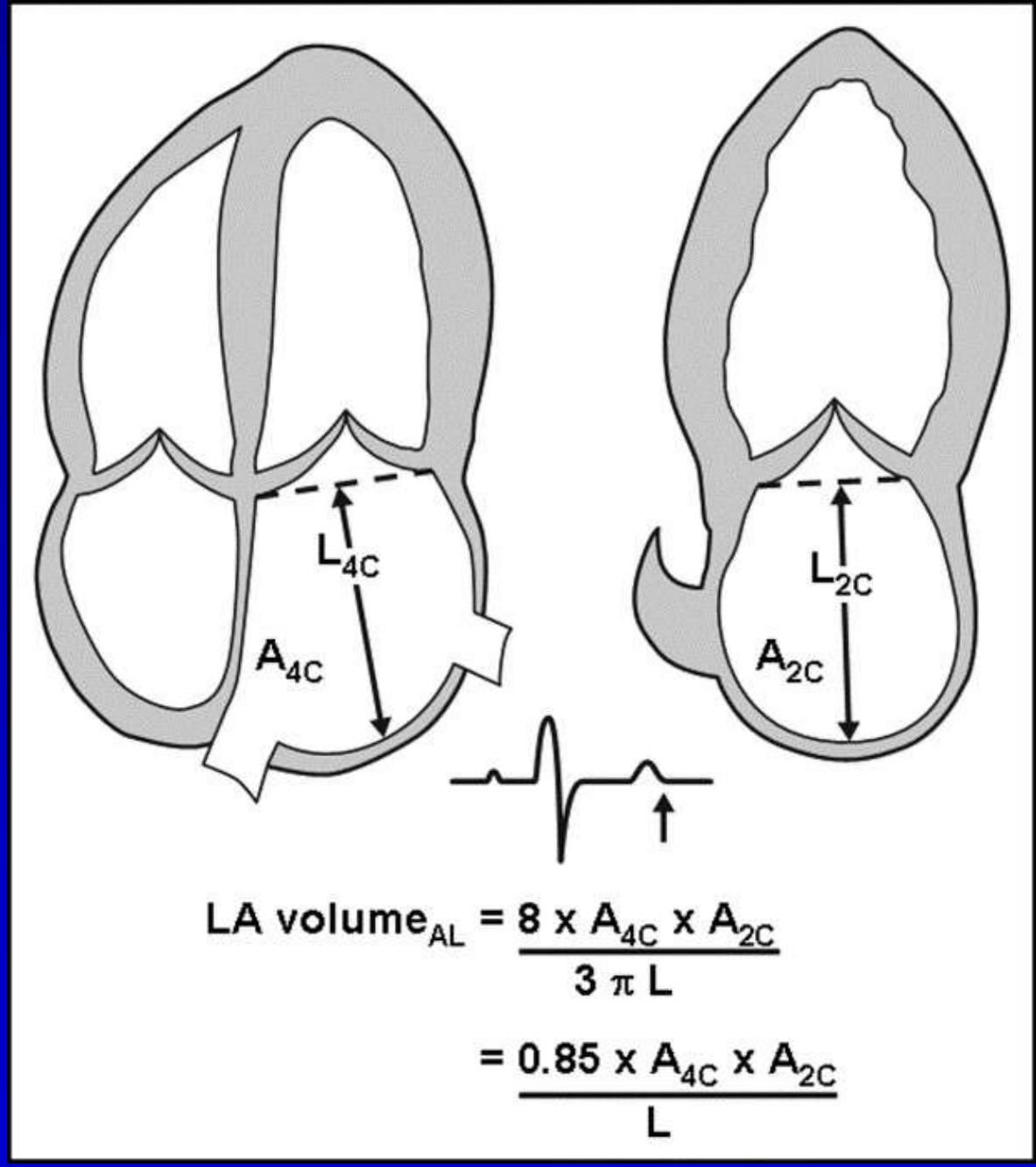
3D reconstructed image

Khankirawantana B et al. Am Heart J. 2004;147:369.

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Left Atrial Size

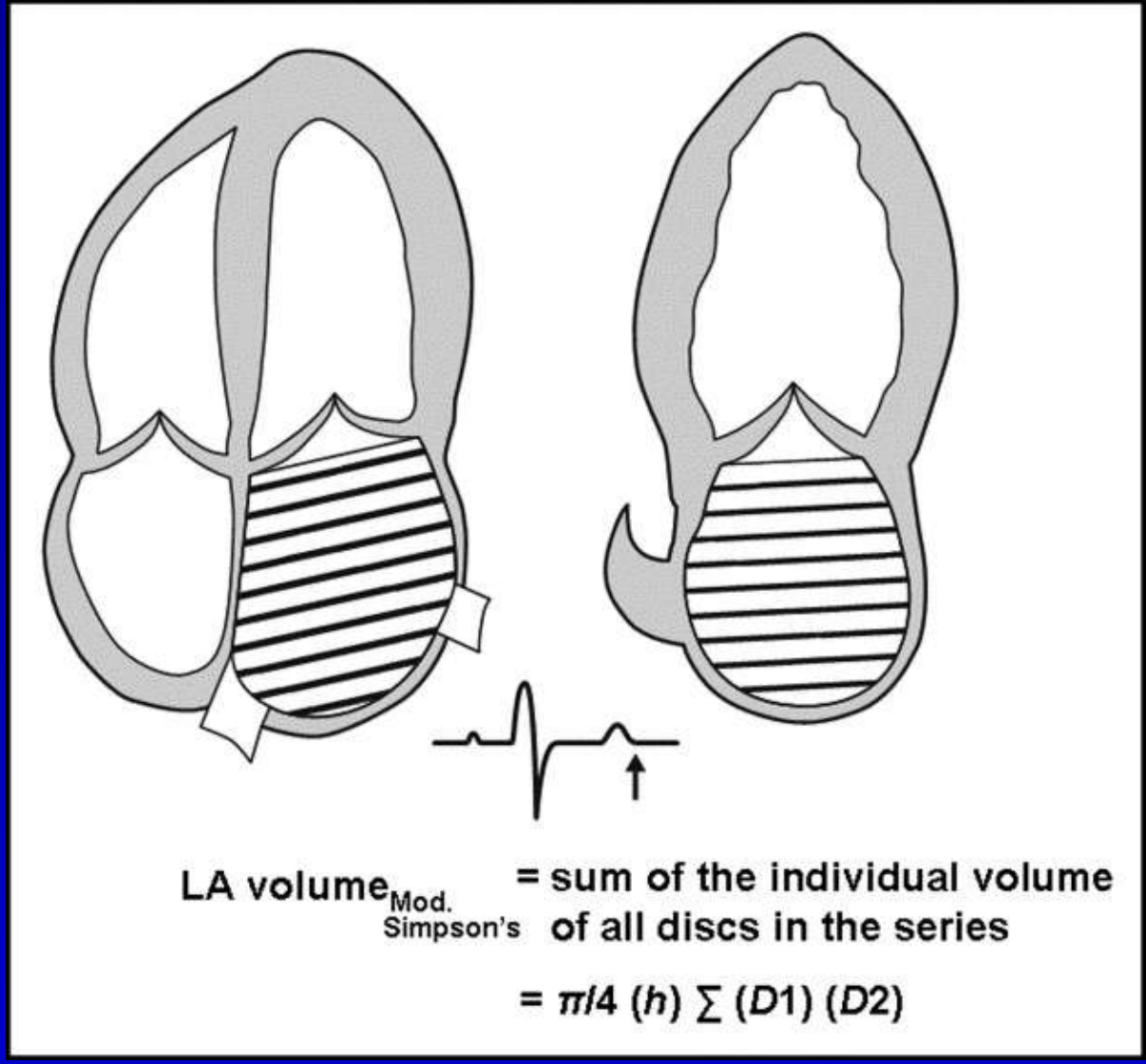
LA volume by biplane area–length (AL) method. A2C = maximum planimetered area in apical 2-chamber view; A4C = maximum planimetered area in apical 4-chamber view; L = average of L4C and L2C; L2C = length in 2-chamber view; L4C = length in 4-chamber view.



Ujino K et al. Am J Cardiol. 2006;98:1185.

Left Atrial Size

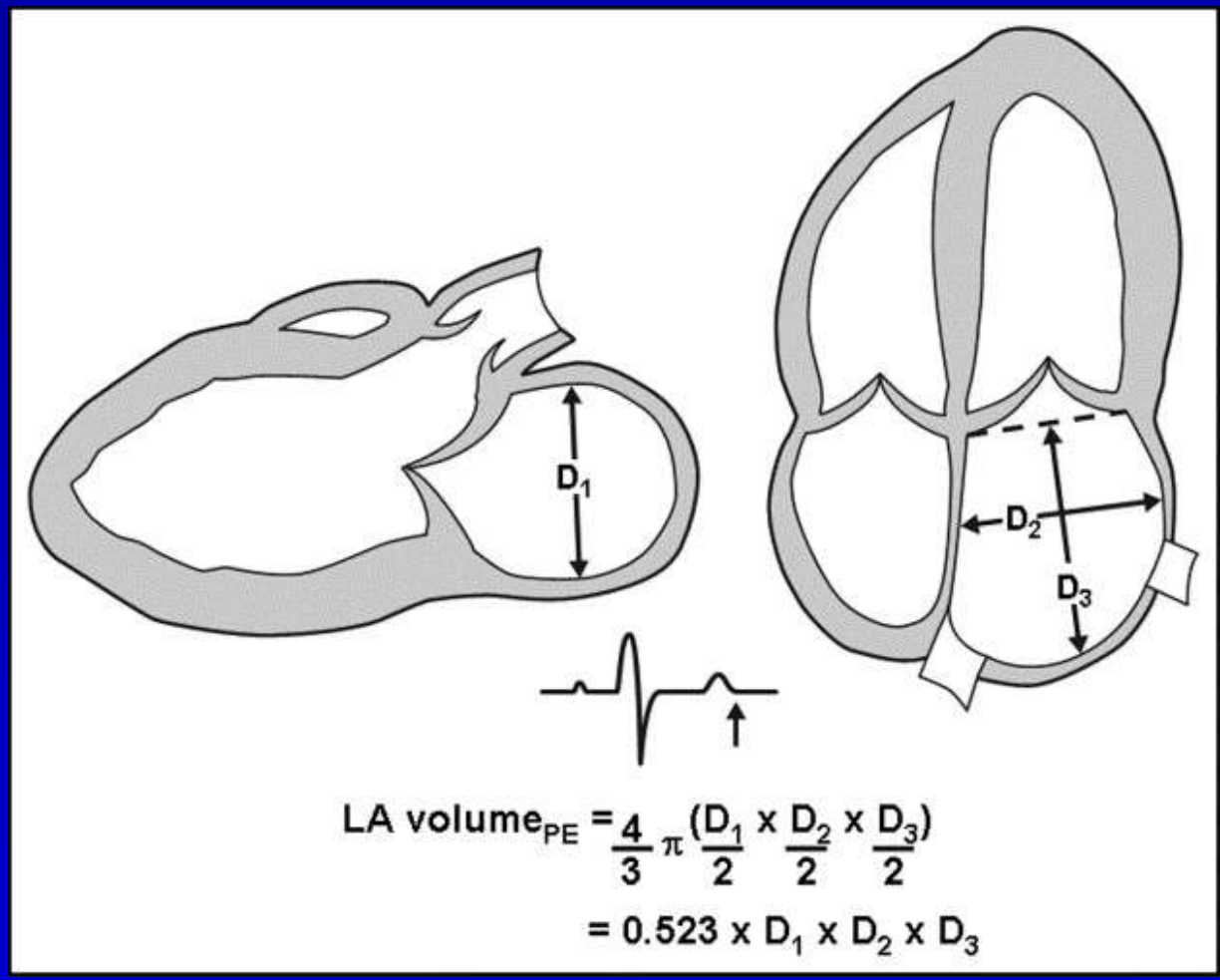
LA volume by Simpson's method of disc summation. D1 and D2 = orthogonal major and minor axes of the discs; h = height of the discs



Ujino K et al. Am J Cardiol. 2006;98:1185.

LA volume by prolate-ellipsoid (PE) method. D1 = anteroposterior dimension measured from the parasternal long-axis view; D2 = width (or minor axis) of 4-chamber view; D3 = perpendicular length (major axis) of 4-chamber view

Left Atrial Size

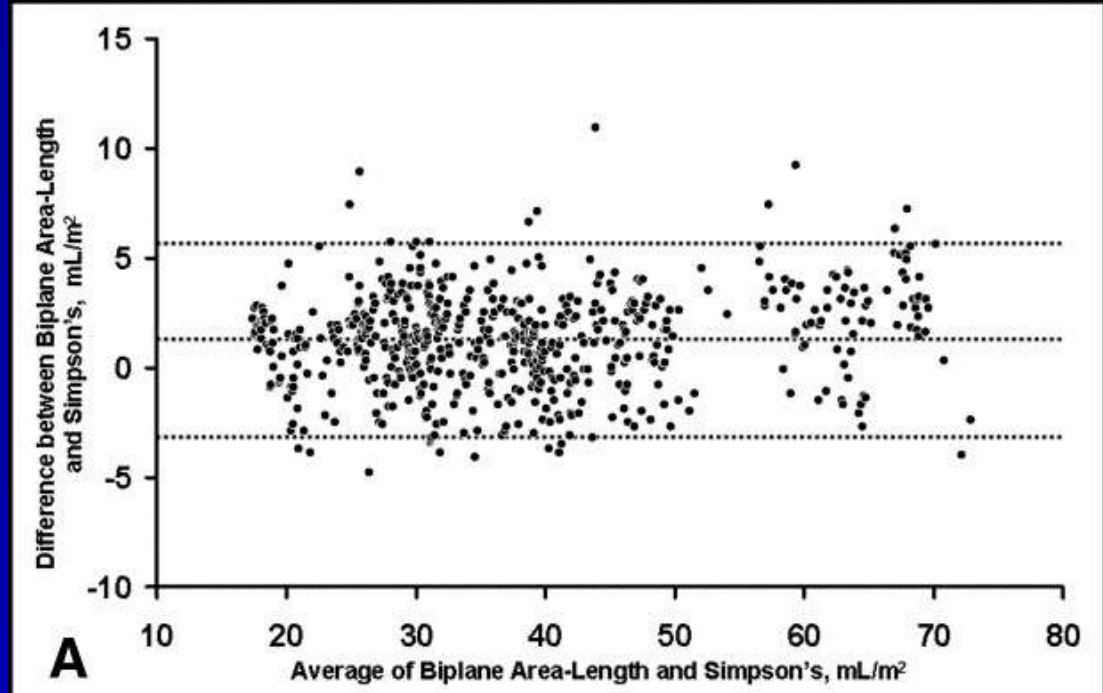


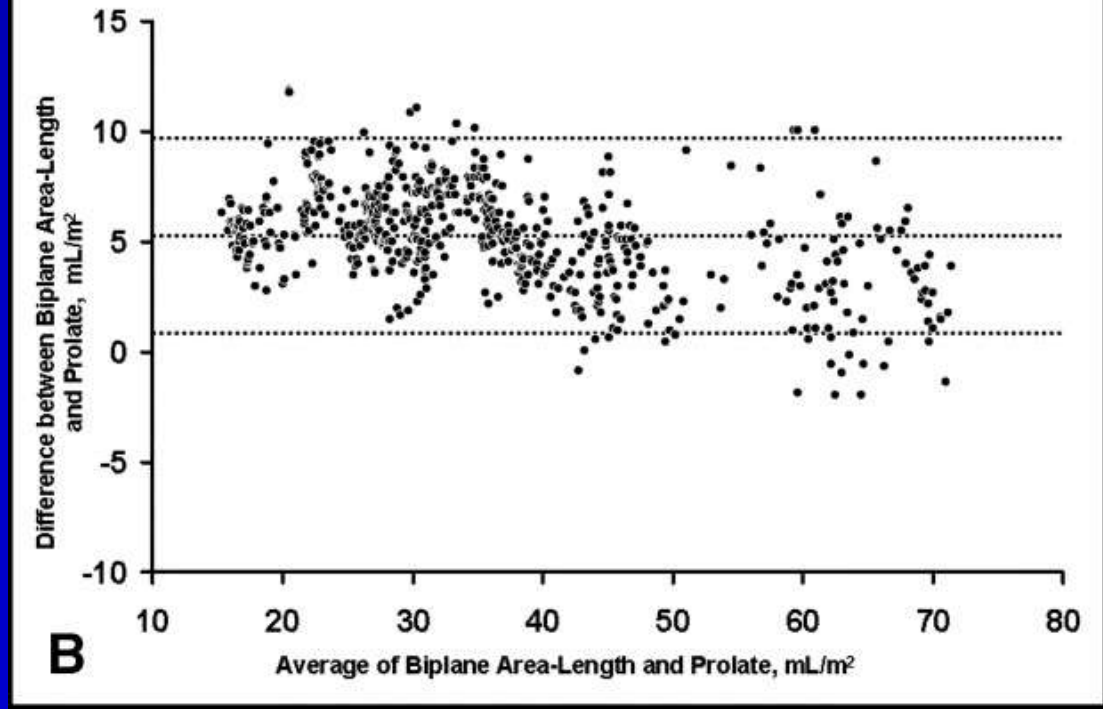
Ujino K et al. Am J Cardiol. 2006;98:1185.

Left Atrial Size

A: Biplane Area-Length minus Simpson's, mL/m^2

B: Biplane Area-Length minus Prolate, mL/m^2





Ujino K et al. Am J Cardiol. 2006;98:1185.

Normal Values for Atrial Size

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

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

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

ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

Values for Left Atrial Enlargement

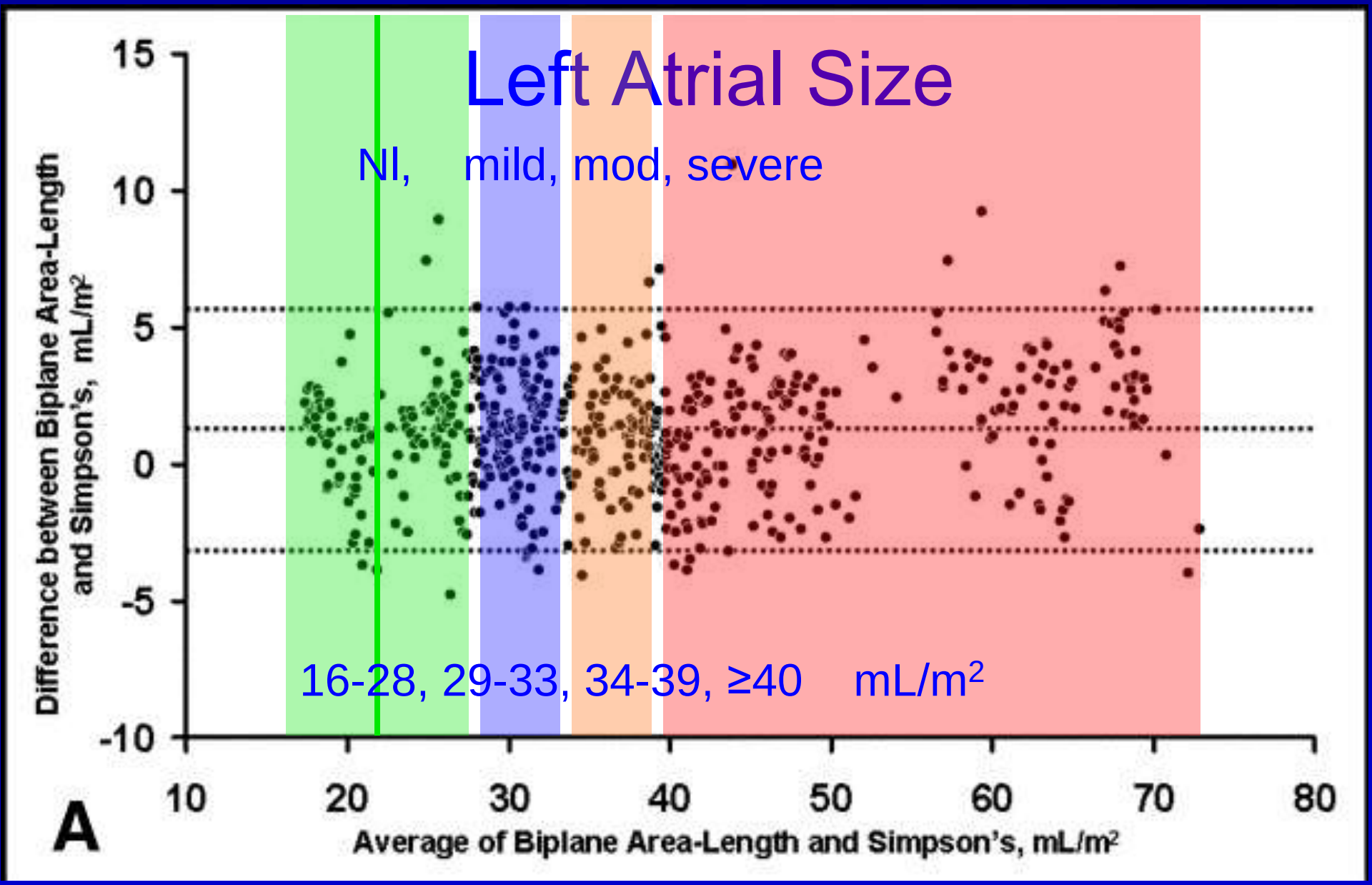
Normal	Mild	Moderate	Severe
22±6	29-33	34-39	≥40

Left atrium; men or women

Units: mL/M^2 (indexed for BSA)

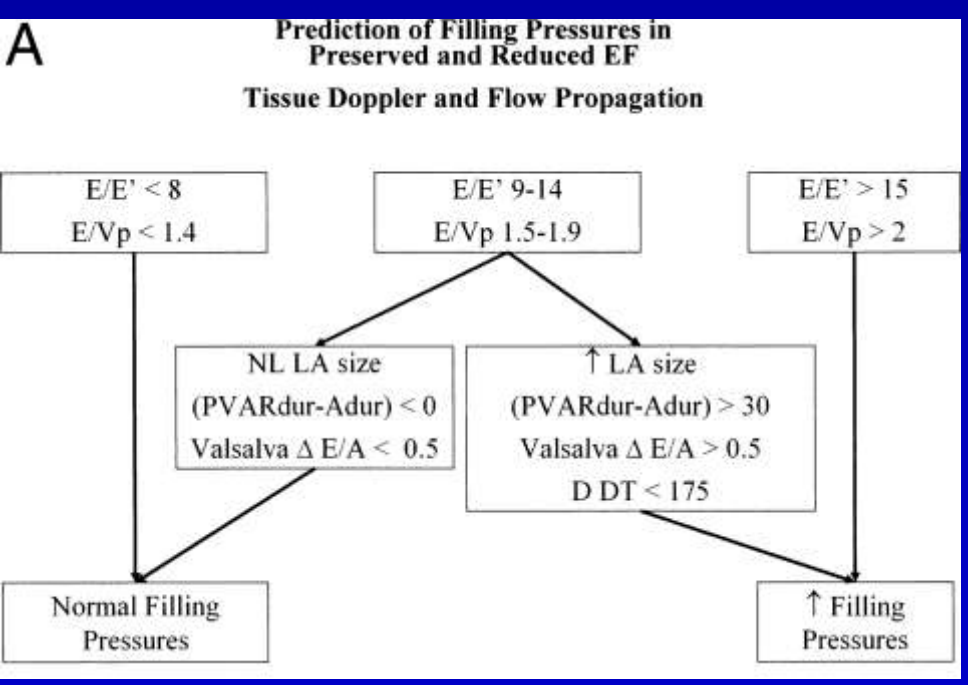
ASE Recommendations for Chamber Quantification. Lang RM et al. J Am Soc Echocardiogr. 2005;18:1440.

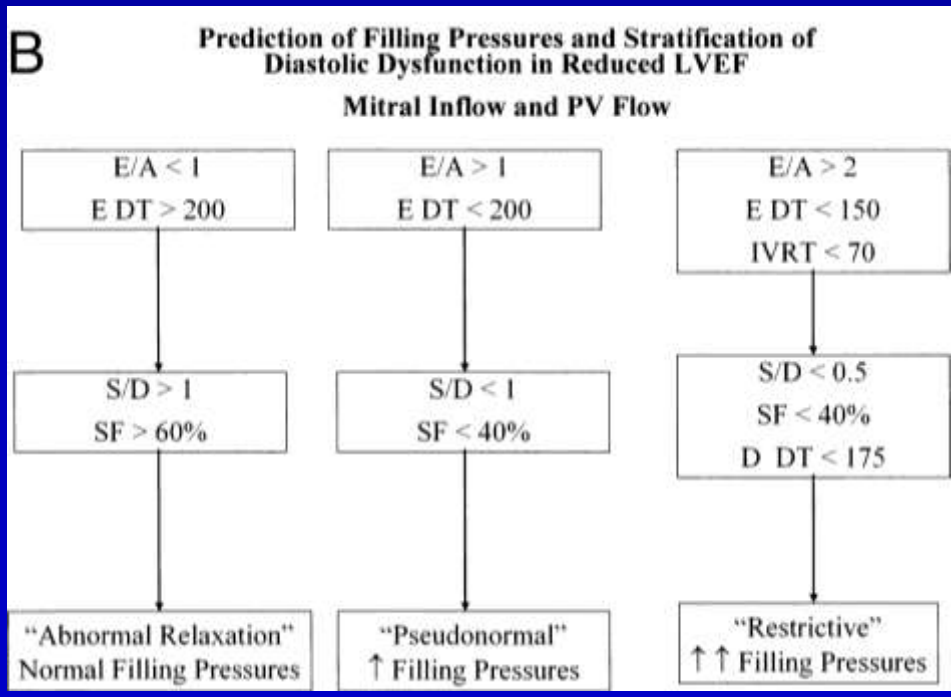
Left Atrial Size



Ujino K et al. Am J Cardiol. 2006;98:1185.

Atrial Ins and Outs in Heart Failure



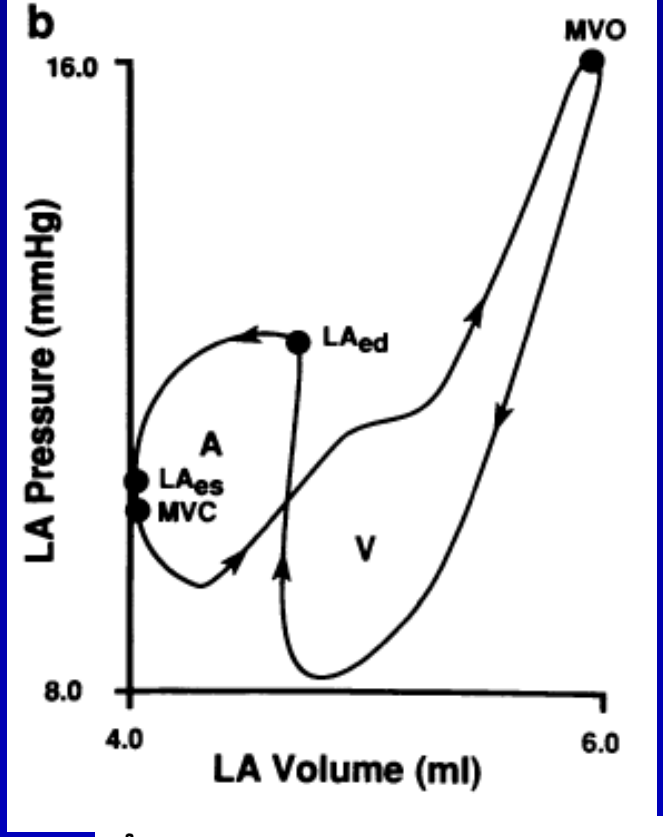


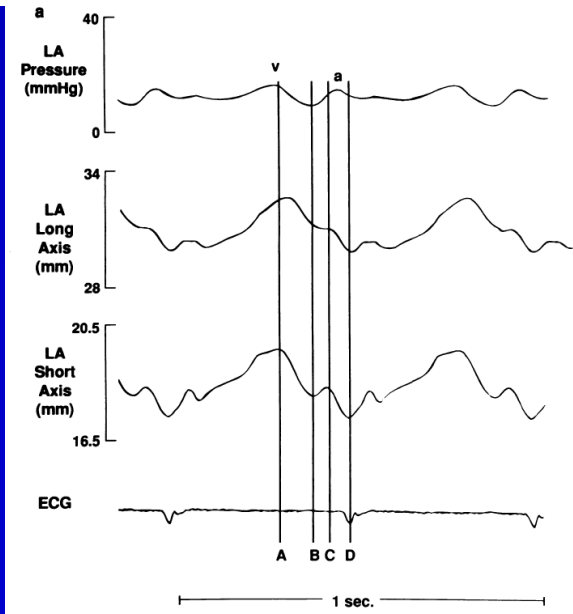
On line edition July 25, 2007.

Kirkpatrick JM et al. J Am Coll Cardiol. 2007;50:381.

Atrial Function

- Poorly defined
- Atrial systolic wall motion
  - Afterload, preload, contractility
  - M-mode aortic root
  - Atrial ejection fraction
  - Atrial filling fraction of LV
- Inflow tract atrial velocity
  - P wave required for atrial systolic function
  - Peak A wave
  - A wave VTI





Hoit BD et al. Circulation. 1994;89:1829.

Atrial Function

- Atrial Active transport
- Atrial conduit

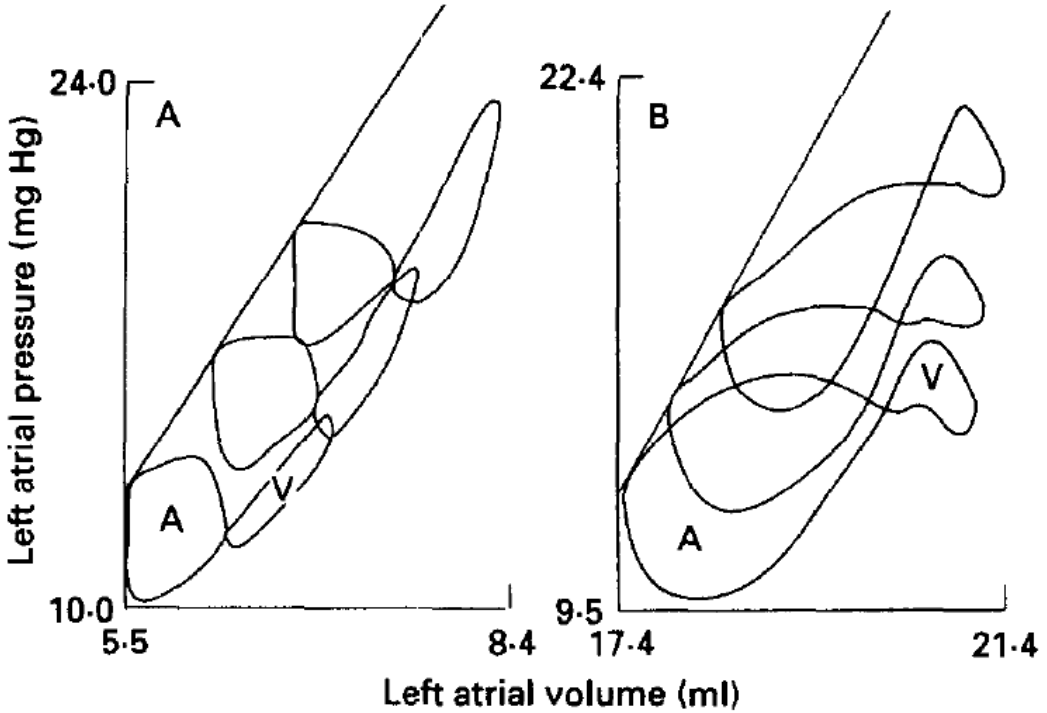
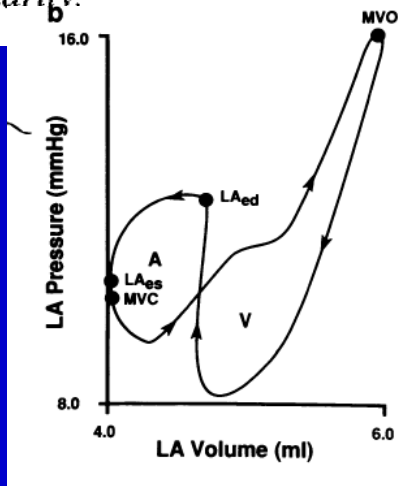


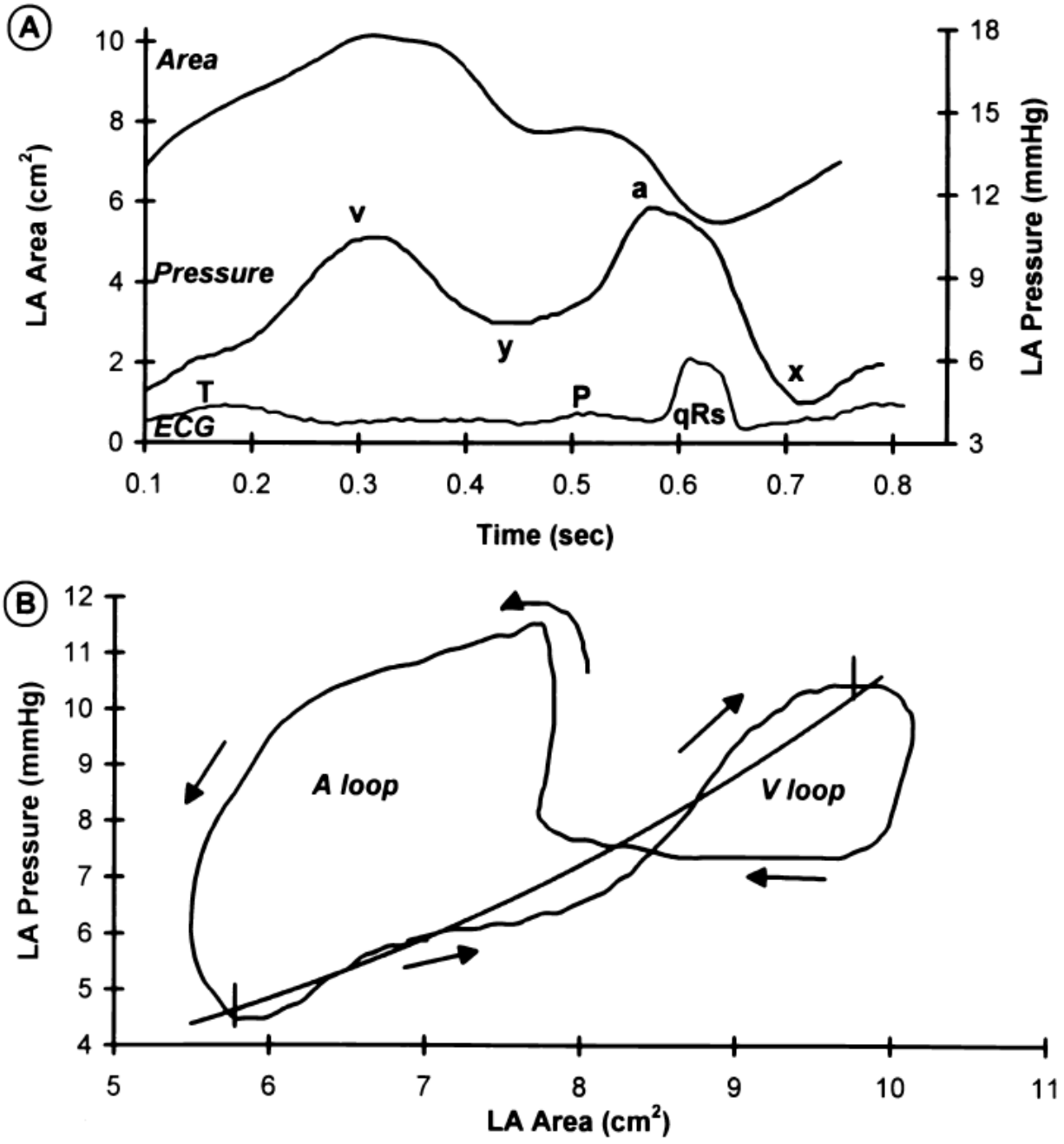
Figure 1 *Left atrial pressure-volume loops from three variably loaded beats in a control dog (A) and in a dog with pacing induced heart failure (B). The A loop represents active atrial contraction. The V loop represents passive filling and emptying of the left atrium. Loops are computer smoothed for clarity.*



Hoit BD et al. Cardiovasc Res. 1995;29:469.

Atrial Function

- In Humans
- LA area by echo

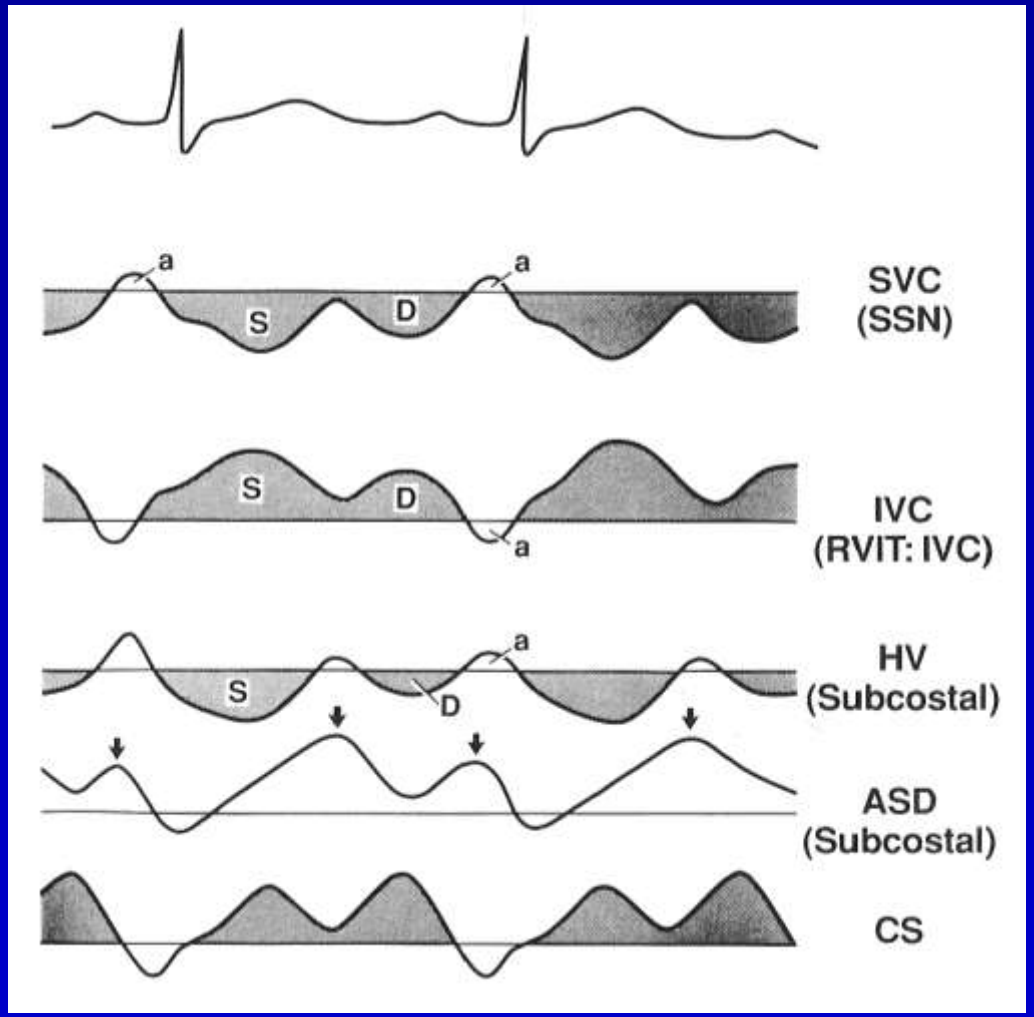


Stefanadis C et al. J Am Coll Cardiol. 1998;31:426.

Atrial Inflows and Outflows

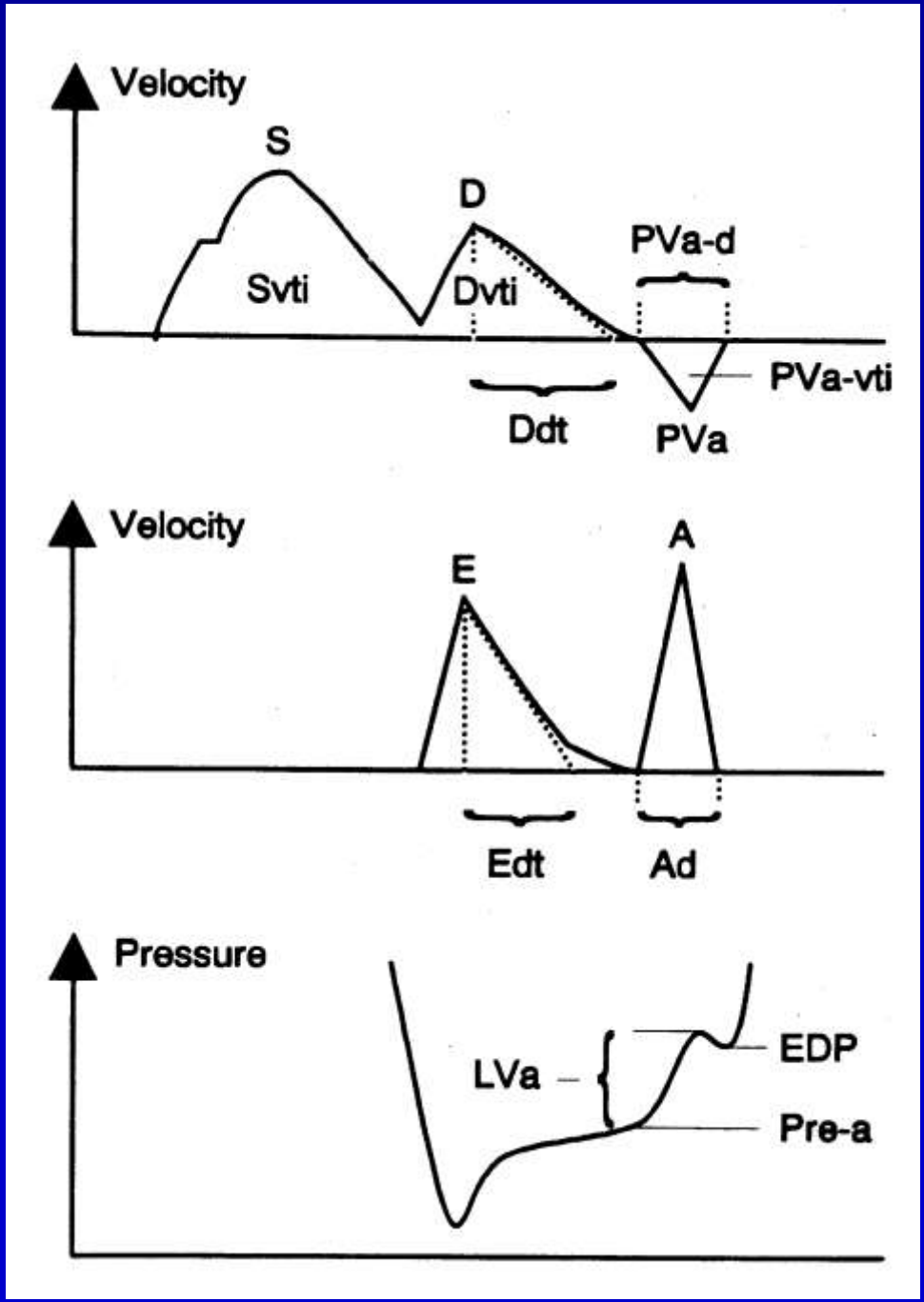
Comparing Atrial Inflow Patterns

- Hepatic vein
- IVC
- SVC
- Coronary sinus
- ASD
- Pulmonary vein



Reynolds T et al. J Am Soc Echocardiogr. 1991;4:503.
Reproduced in Weyman 1994.

Pulmonary Venous Flow



From Rossvoll O et al. (Hatle)
J Am Coll Cardiol
1993;21:1687

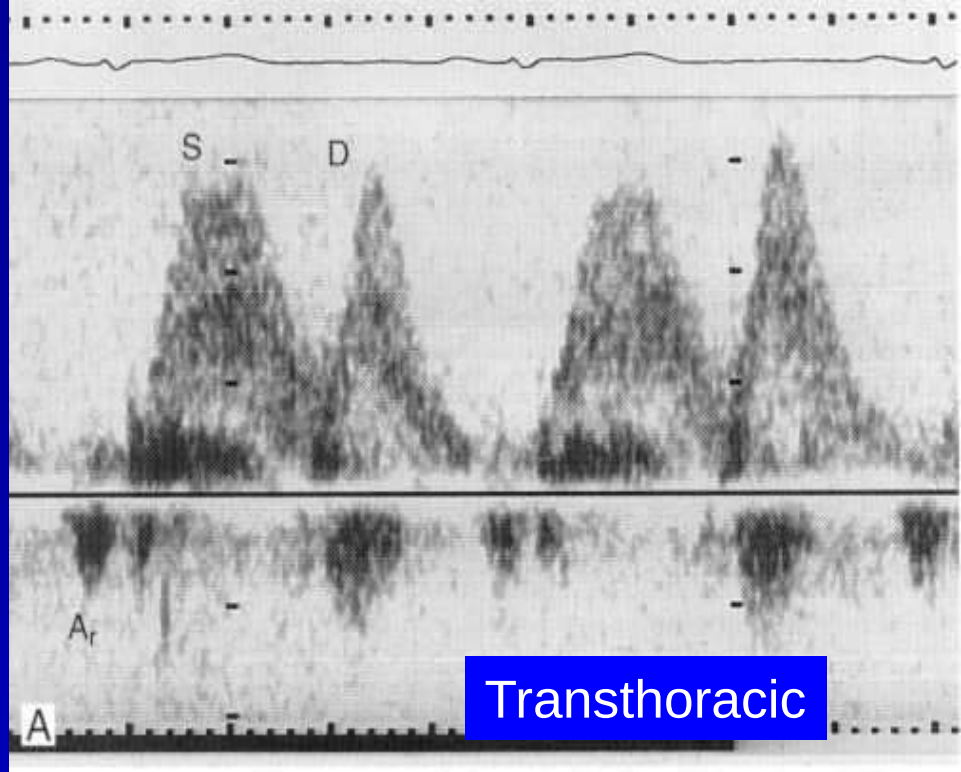
Pulmonary Venous Flow Pattern

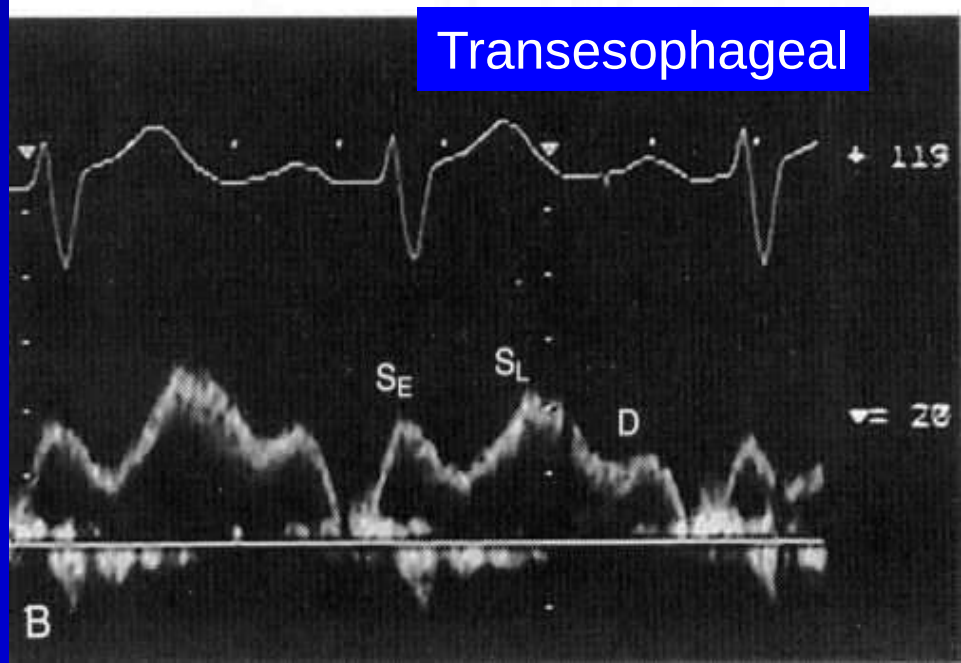
- LV preload and systolic and diastolic function
  - Increased LA pressure - lower S if LV systolic dysfunction, (more S if LV systolic function is preserved)
  - Impaired relaxation – larger S and lower D, corresponding to lower MV E
  - Pseudonormal – lower S and dominant D wave and larger Ar wave (lower LV compliance)
  - Restrictive – low S and large D and rapid D deceleration, Ar is variable
- Age increases systolic dominance and maybe Ar
- Mitral regurgitation* reduces S wave, reverses if severe MR
- Large ASD causes single continuous antegrade wave and diminished AR wave**

*Rossi A, et al. J Am Soc Echocardiogr 2001;14:562
**Saric M, et al. J Am Soc Echocardiogr 2001;14:386

Normal Pulmonary Vein PW Doppler Patterns

- S - systolic
- D - diastolic
- S_E - early systolic atrial relaxation
- S_L - late systolic descent of MV annulus
- A_r - atrial reversal
- S_i - systolic integral
- D_i - diastolic integral





Smith, MD, in Otto, 2002, p. 123

Comparing Atrial Outflow Patterns

- Mitral flow
- Tricuspid flow

Right Atrial Normal Variants

- Eustachian valve (RVIT view)
- Chiari network
- Prominent crista terminalis

Right Atrial Abnormalities - 1

- Tumor – primary or metastatic
  - Primary – myxoma (15% of myxomas are in the RA, typical origin from atrial septum near fossa ovalis), sarcoma
  - Metastatic – hypernephroma, hepatoma, testicular sarcoma
- Thrombus (native or on catheter)

Right Atrial Abnormalities - 2

- Congenital
  - (cor triatriatum dexter)
  - Prominent drainage from coronary sinus due to persistent left SVC
  - Anomalous pulmonary venous connection (partial or complete)
  - IVC interruption with azygous continuation
  - Tricuspid atresia

Left Atrial Abnormalities

- Tumor (primary or metastatic)
- Thrombus (appendage or other)
- Congenital
  - cor triatriatum (sinister)
  - Supravalvular mitral stenosis
  - Congenital mitral stenosis (Shone's syndrome)

Interatrial Septum

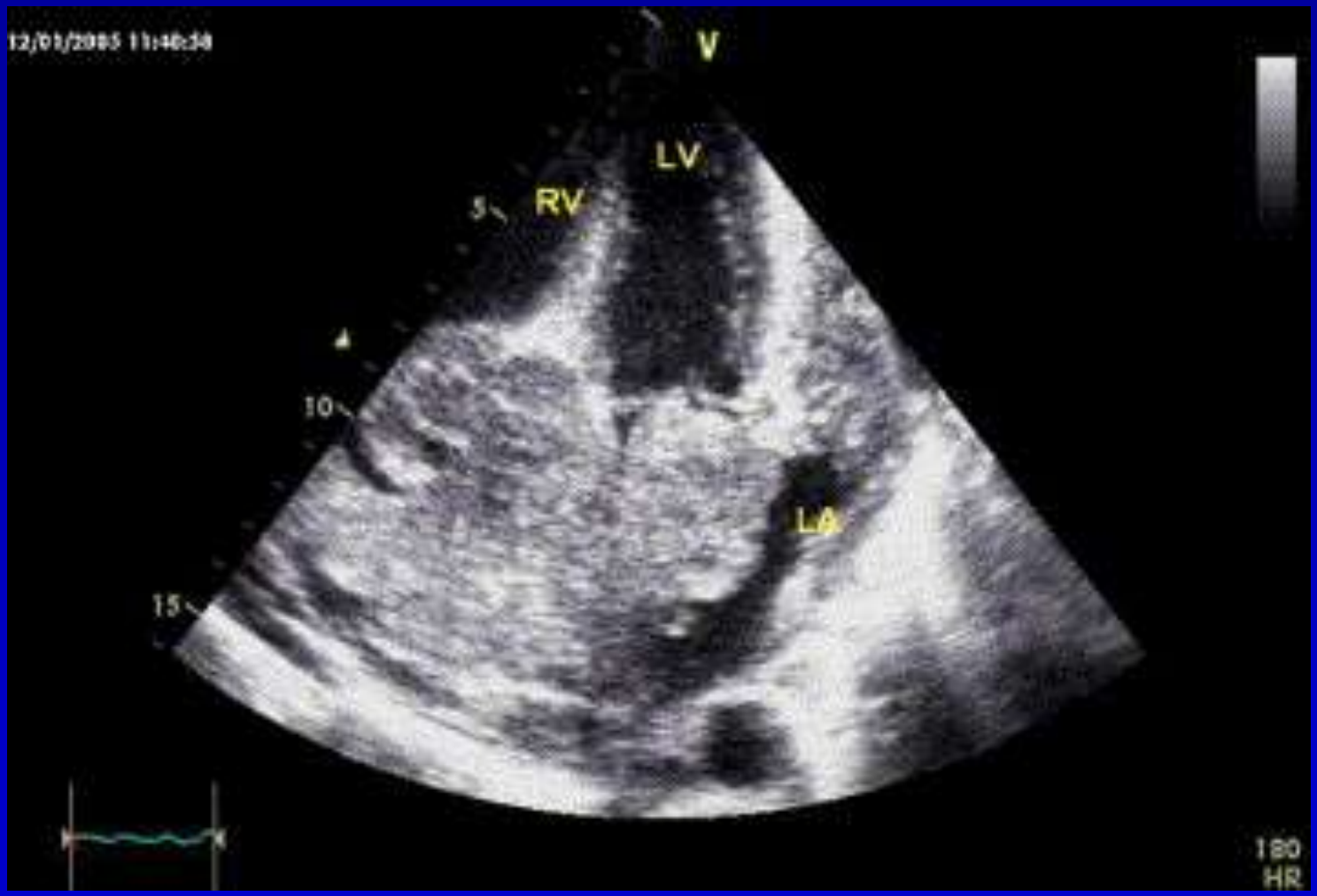
- Atrial septal defect – secundum, primum, sinus venosus (absent septum – single atrium)
- Patent foramen ovale
- Atrial septal aneurysm
- Lipomatous hypertrophy of the interatrial septum
- Myxomas usually arise from the interatrial septum
- ATRIAL SEPTAL CURVATURE as a pressure indicator

Right Atrium - Mass

Asymptomatic giant RA myxoma

Yuce M. et al. International J Cardiol. 2007;114:405

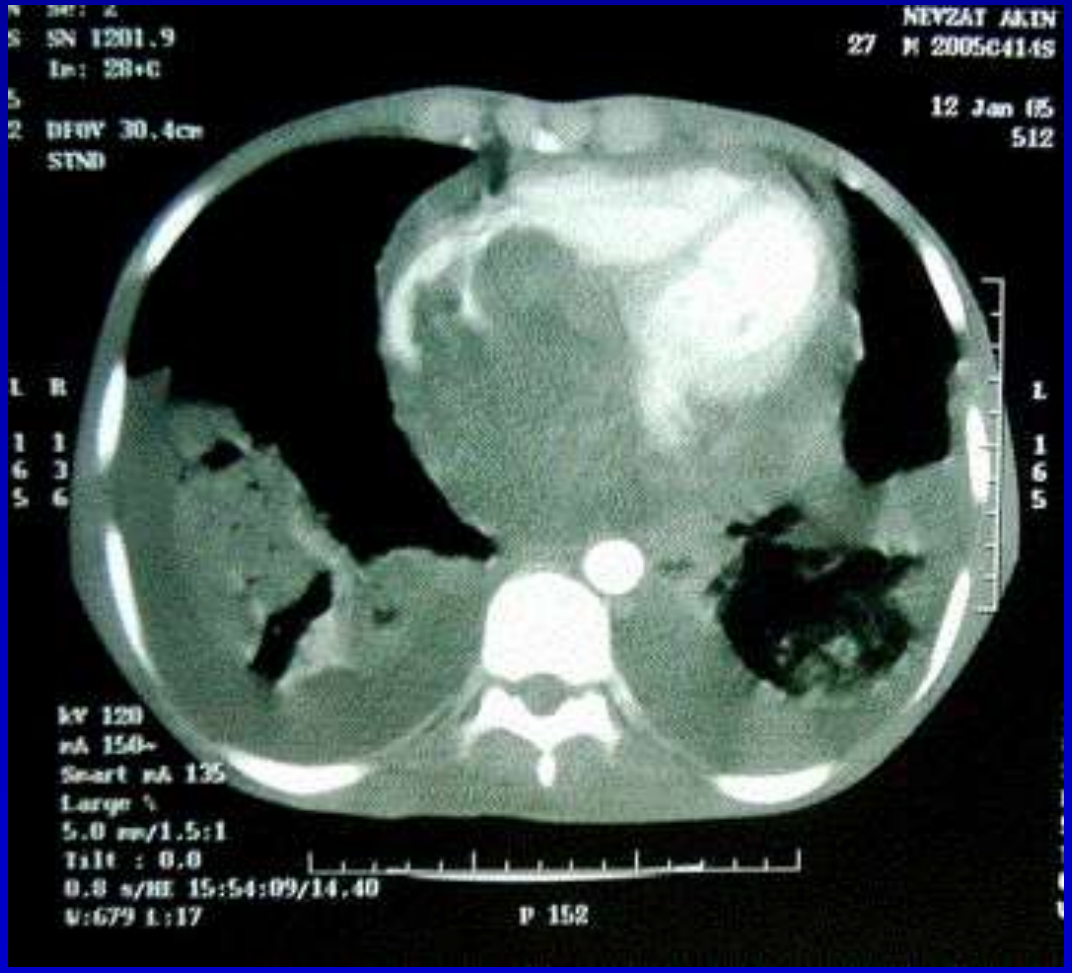
Biatrial Mass



Tavil Y et al. Cardiovascular Pathology. 2006;15:354.

Large rhabdomyosarcoma

Biatrial Mass



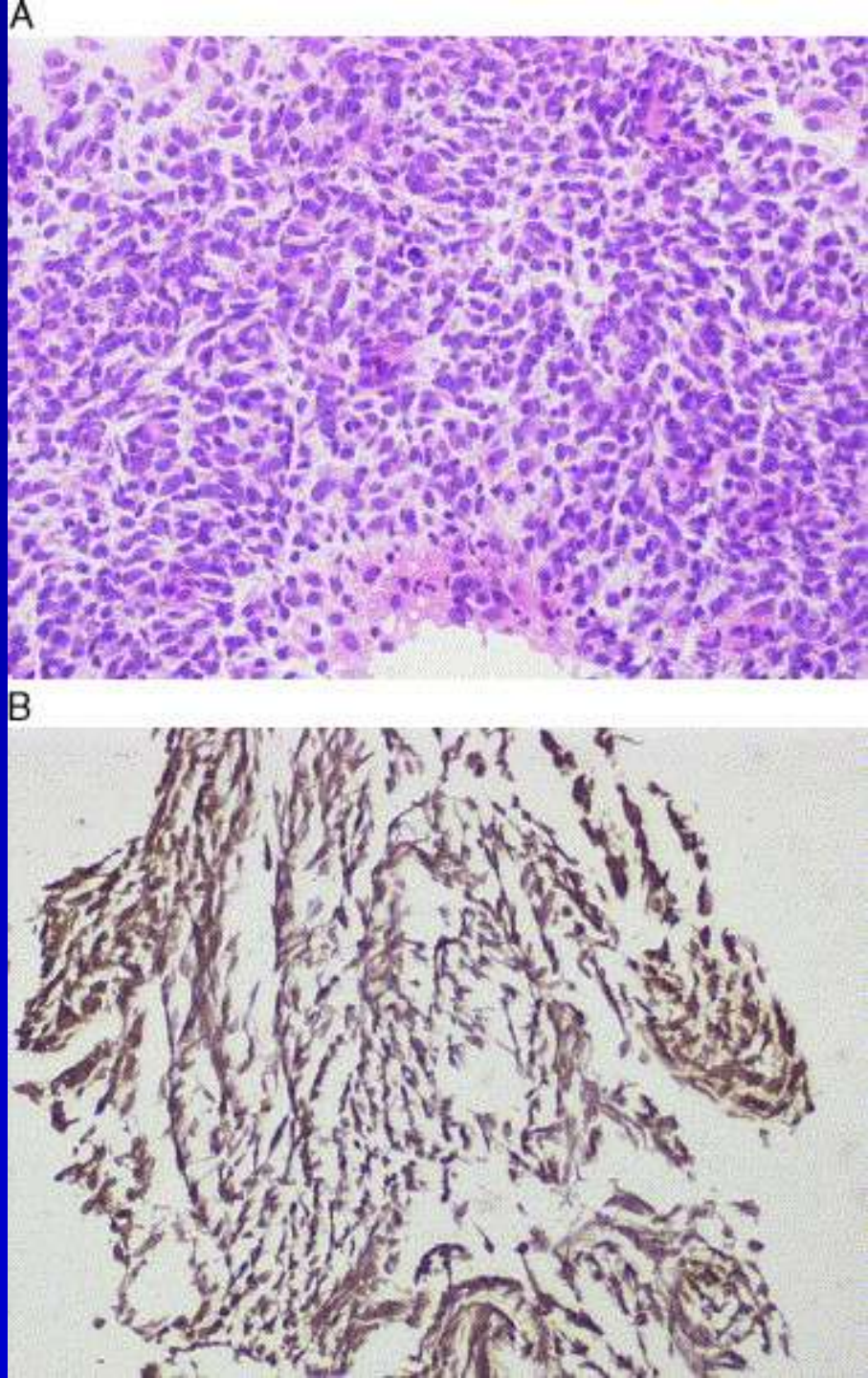
Tavil Y et al. Cardiovascular Pathology. 2006;15:354.

Large rhabdomyosarcoma

Biatrial Mass

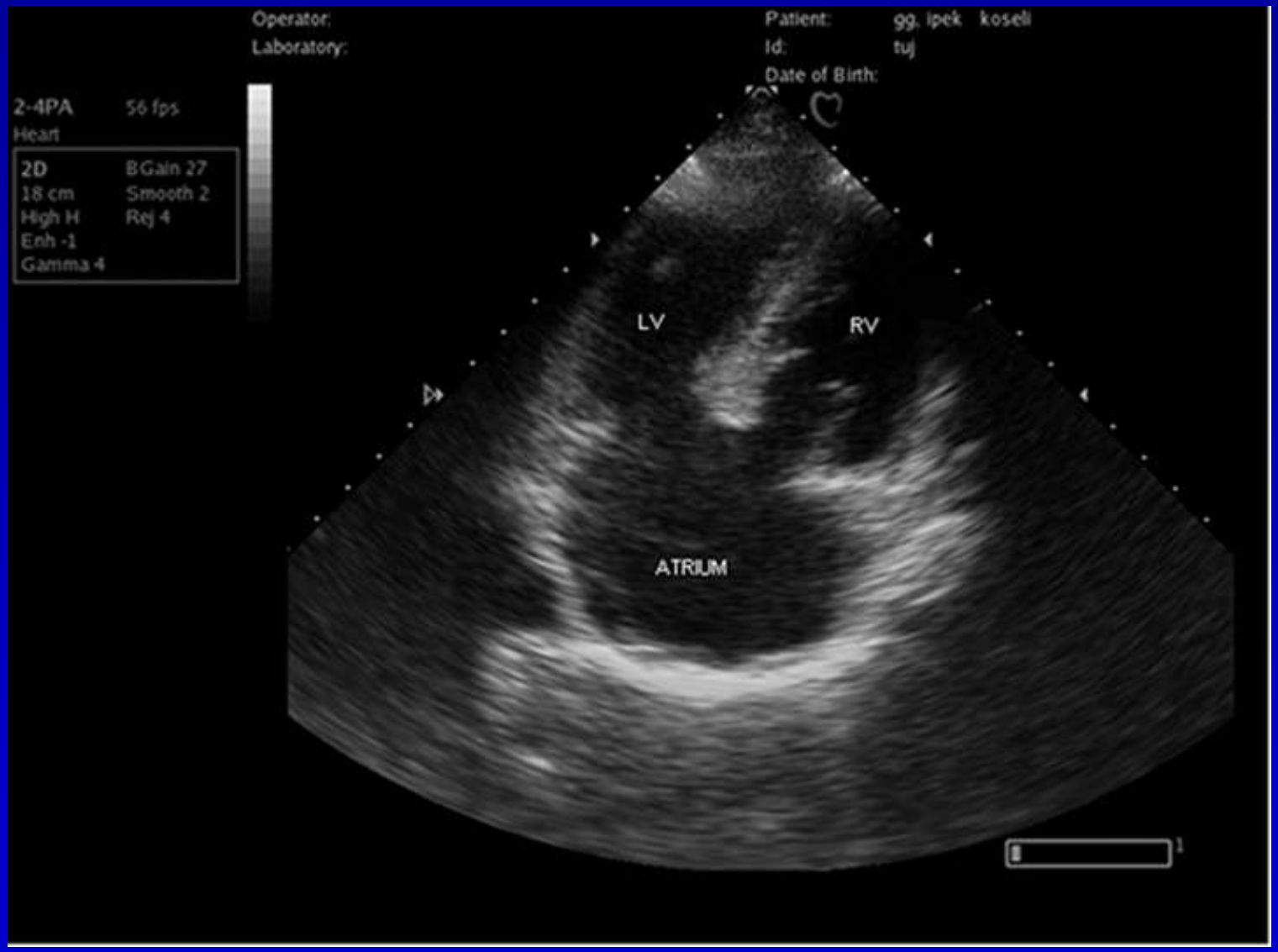
(A) Histopathologic examination shows a tumor composed of round cells with atypical mitoses and rhabdomyoblasts (H&E, ×100).

(B) (B) Immunohistochemical study demonstrating that the tumor cell showed strong positive staining for actin (×40).



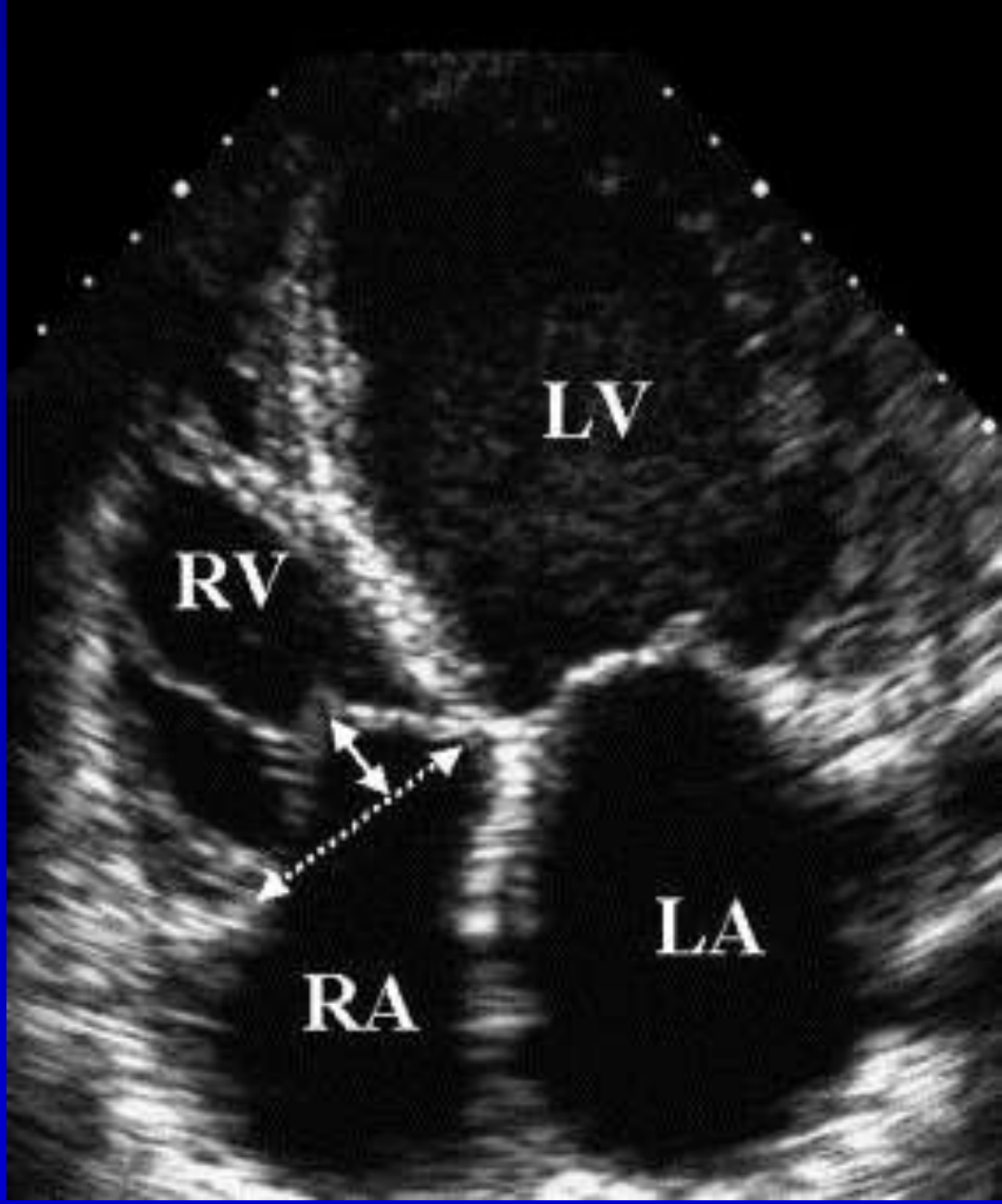
Tavil Y et al. Cardiovascular Pathology. 2006;15:354.

Single Atrium



Kaftan HA et al. Echocardiography 2006;23:701.

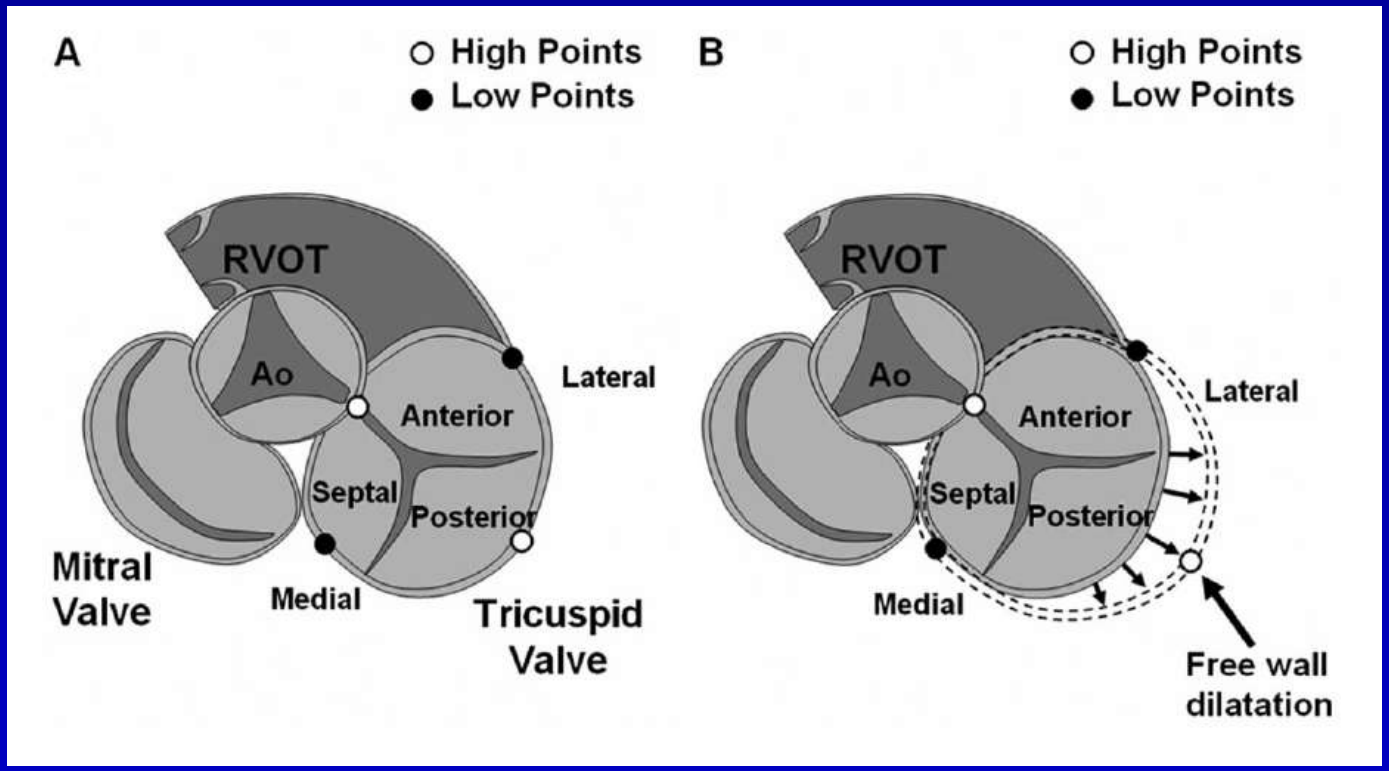
Measurement of TV Annulus and TV Displacement



An apical 4-chamber view demonstrating techniques for measuring TV deformations. The TV annular dimension (dashed line) and tethering height (solid line) were determined by the distance between the tips of the arrowhead, respectively. *LA*, Left atrium.

Fukuda S et al. Am Heart J. 2006;152:1208.

Functional Tricuspid Regurgitation

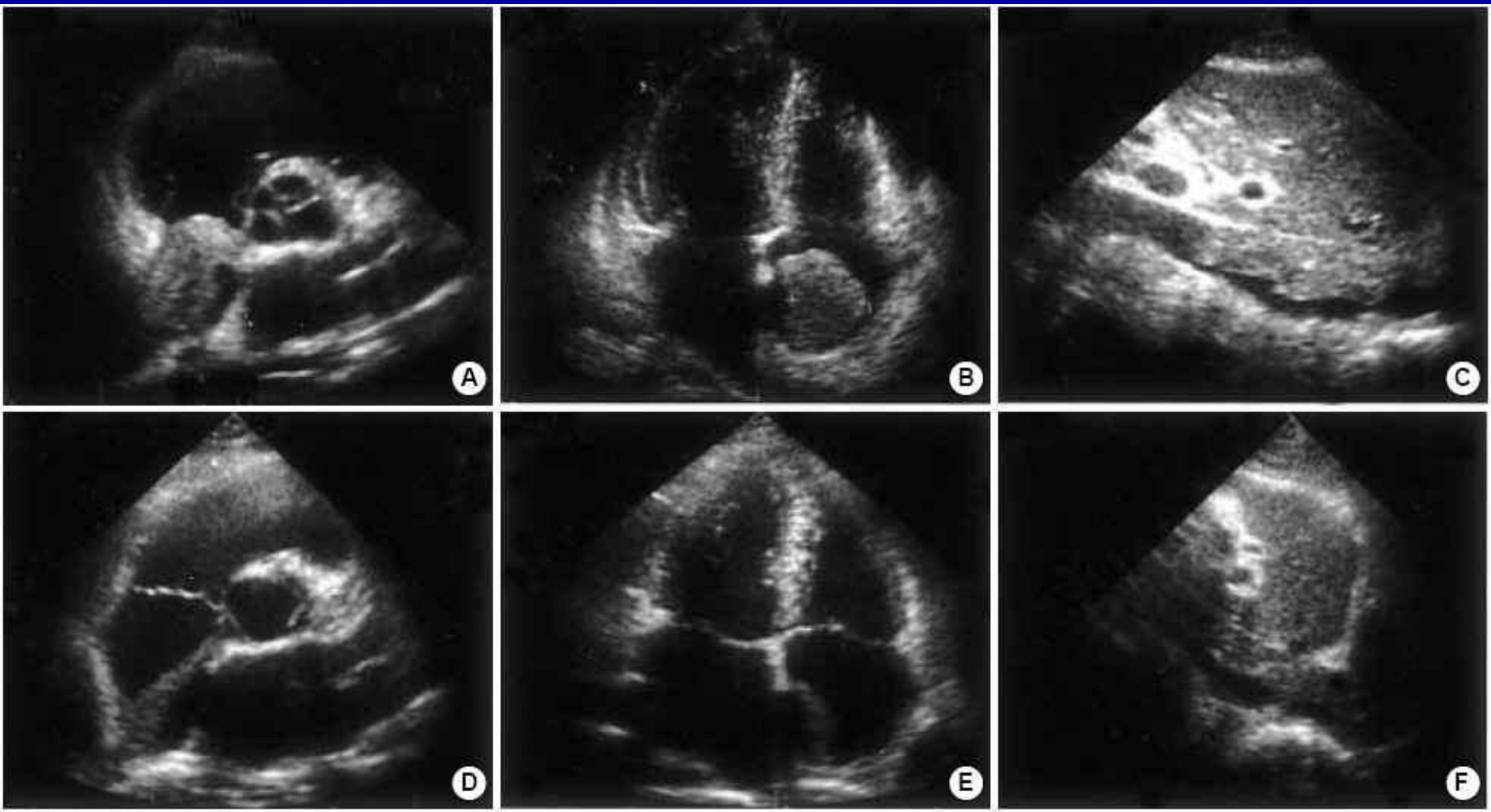


A, TV viewed from the atrium. The valve relative to anatomic structures is displayed, demonstrating the location of high and low points.

B, Dilation along the free wall aspect of the TV with functional TR (dashed lines).

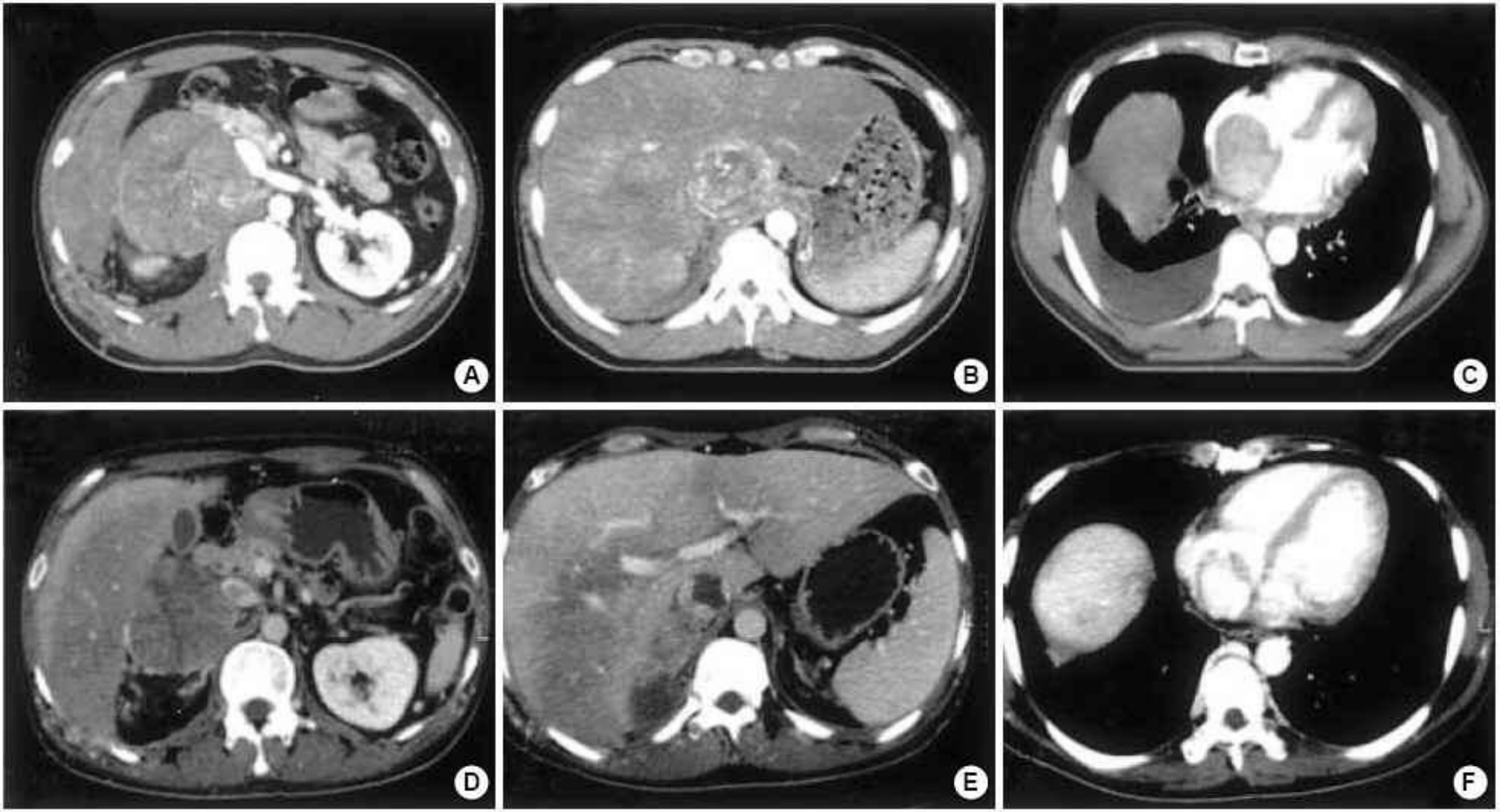
Thanh-Thao TN et al. Circulation. 2006;114:143.

Carcinoma from Adrenal to RA



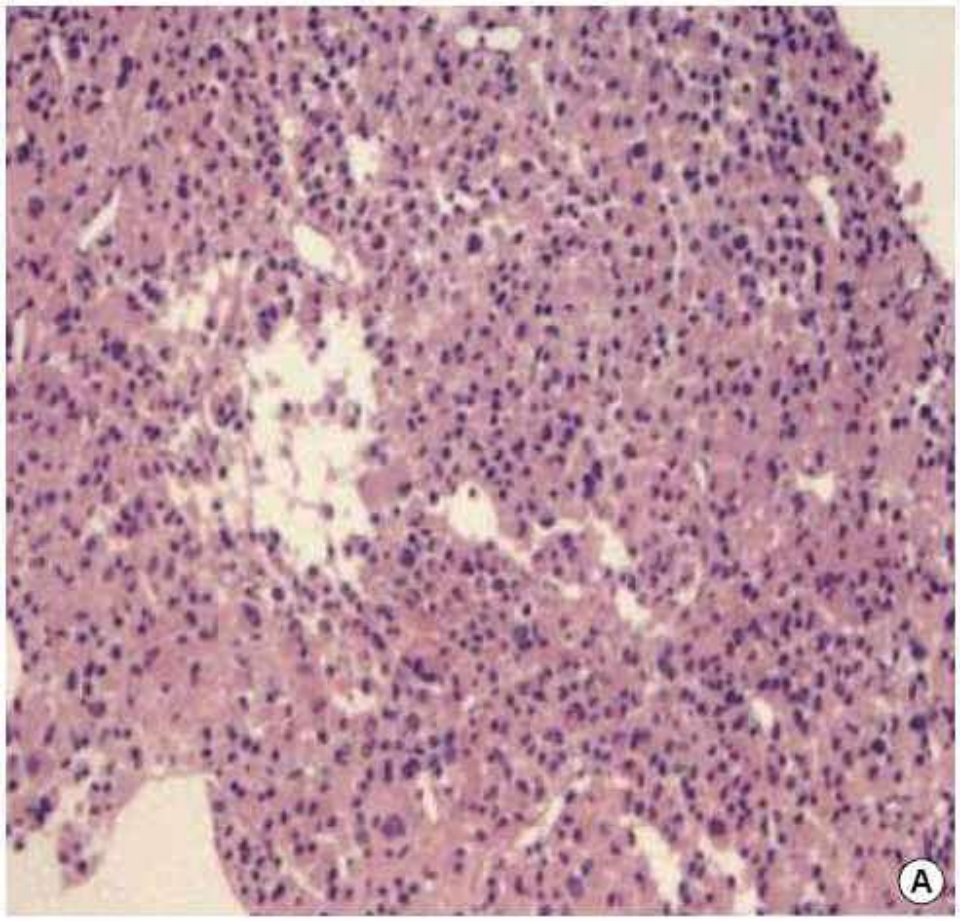
Kim KH et al. J Korean Med Sci. 2006;21:572.

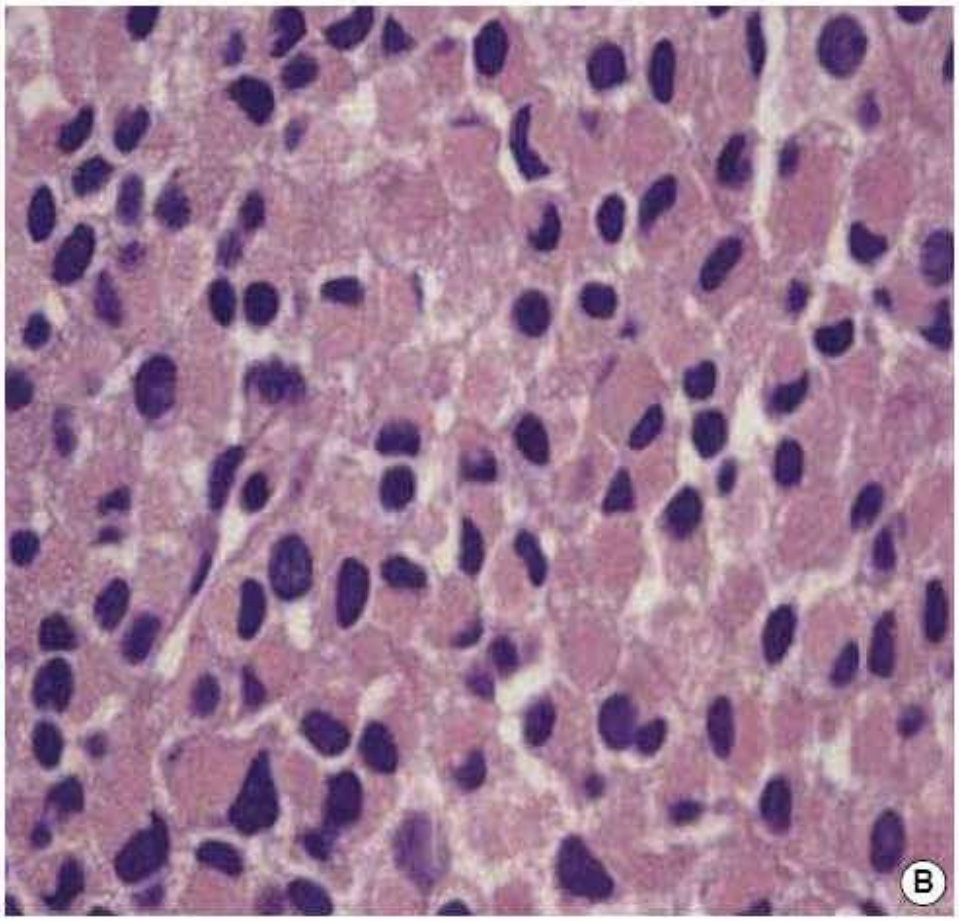
Carcinoma from Adrenal to RA



Kim KH et al. J Korean Med Sci. 2006;21:572.

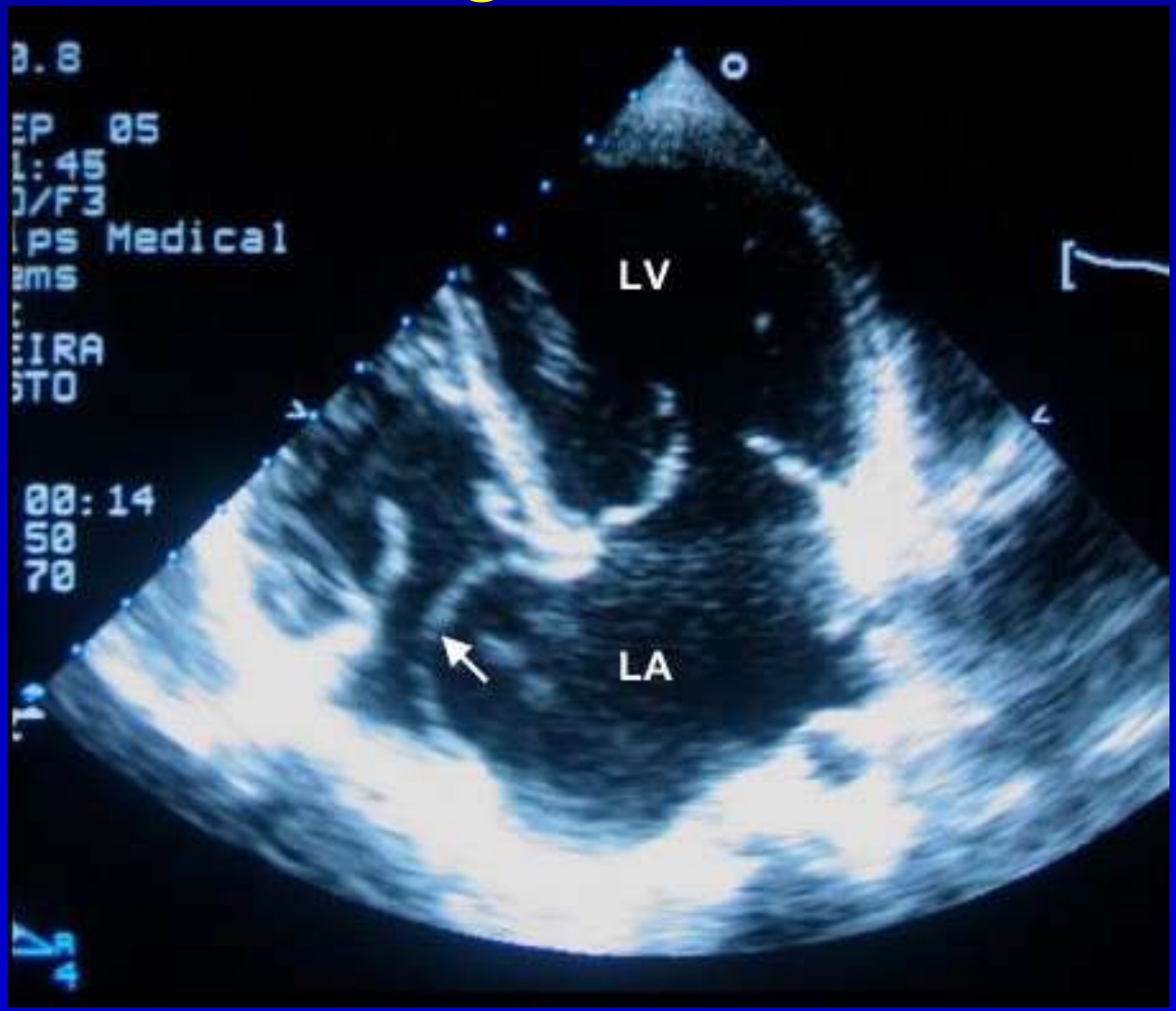
Carcinoma from Adrenal to RA





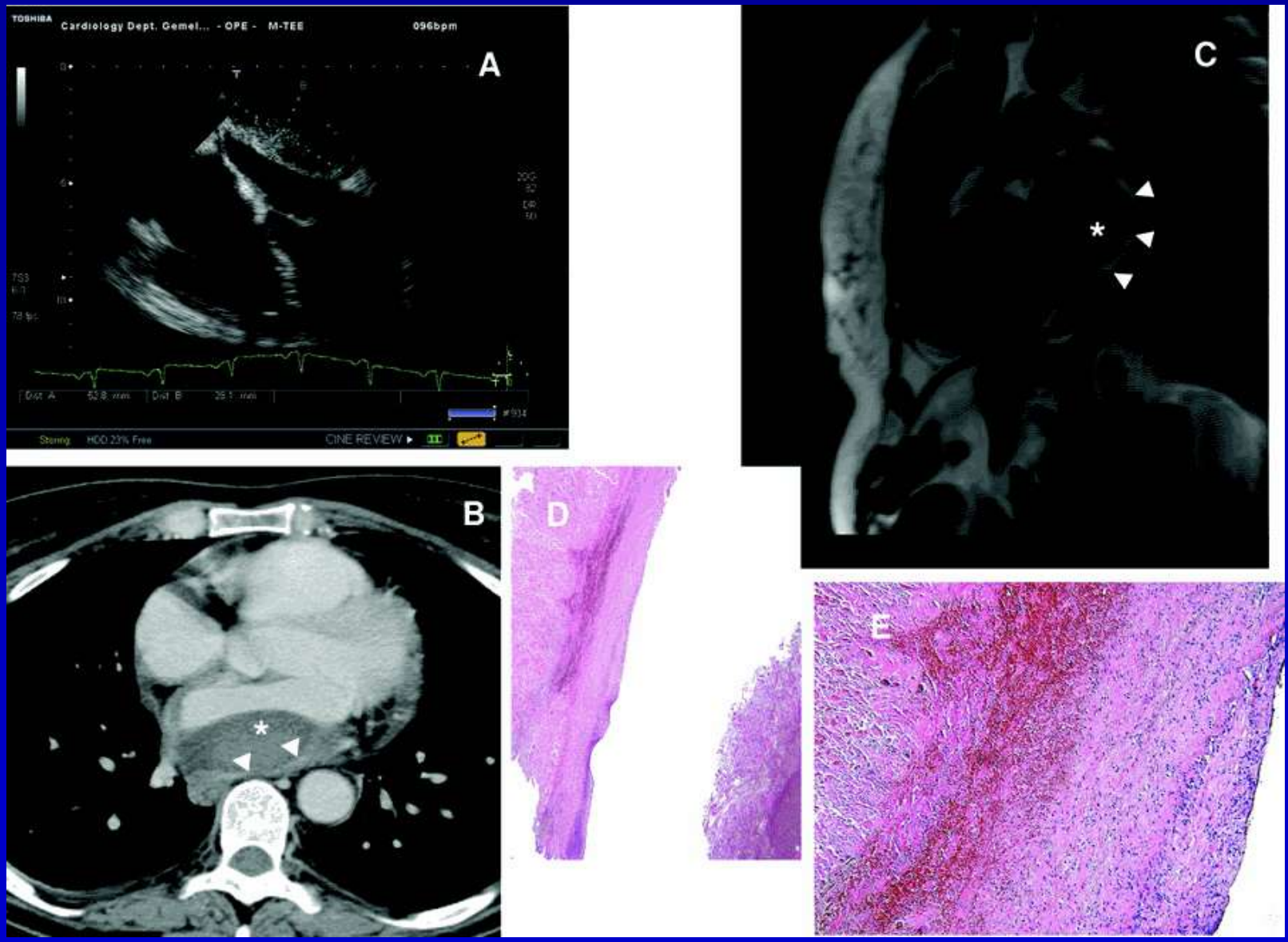
Kim KH et al. J Korean Med Sci. 2006;21:572.

MR and Normal PA Pressure and Large LA



Marijon E et al. Cardiovascular Ultrasound. 2006;4:31.

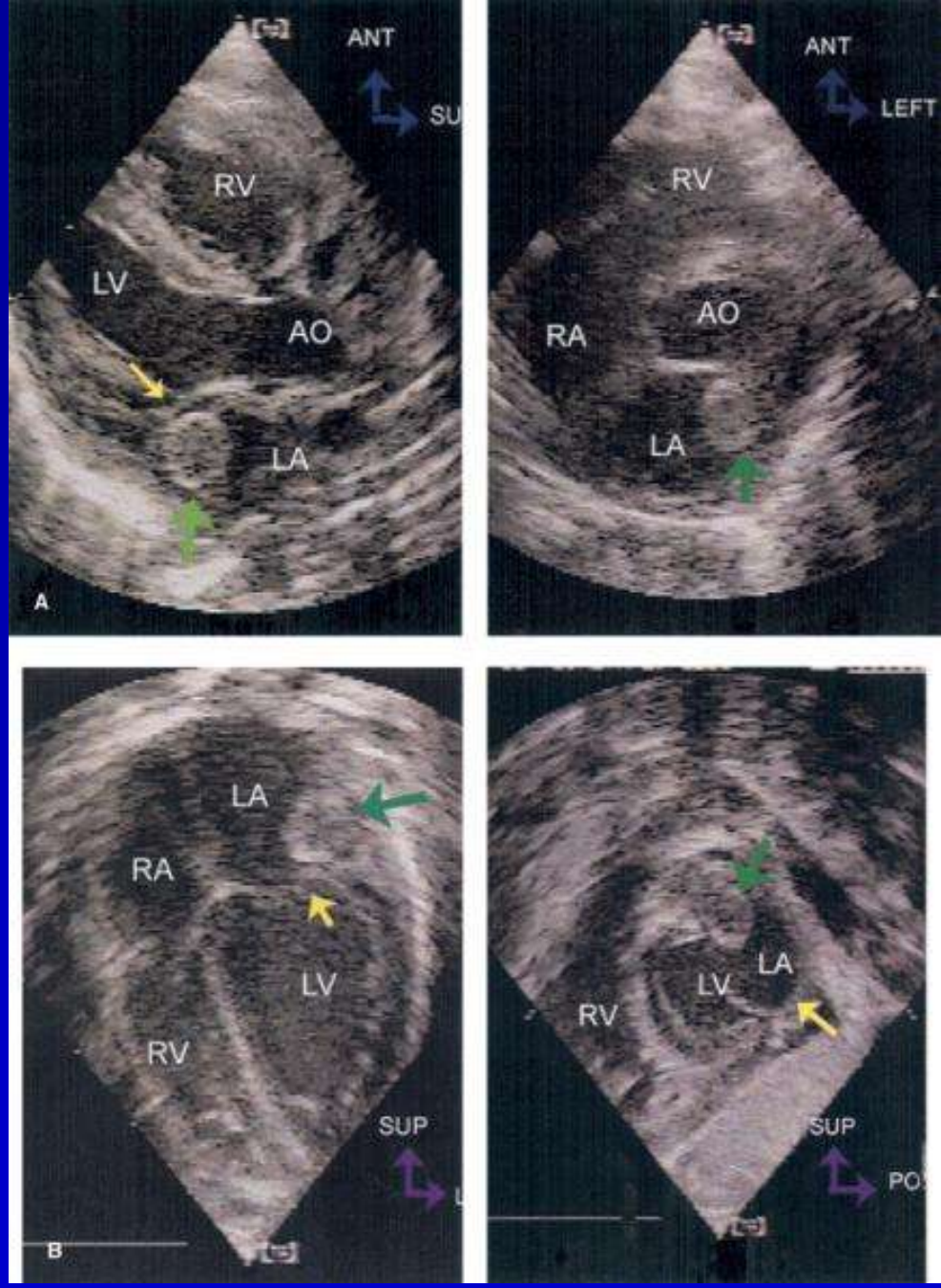
LA Dissection



Lombardo A et al. Circulation. 2006;114:e249.

LA Appendage spontaneous inversion

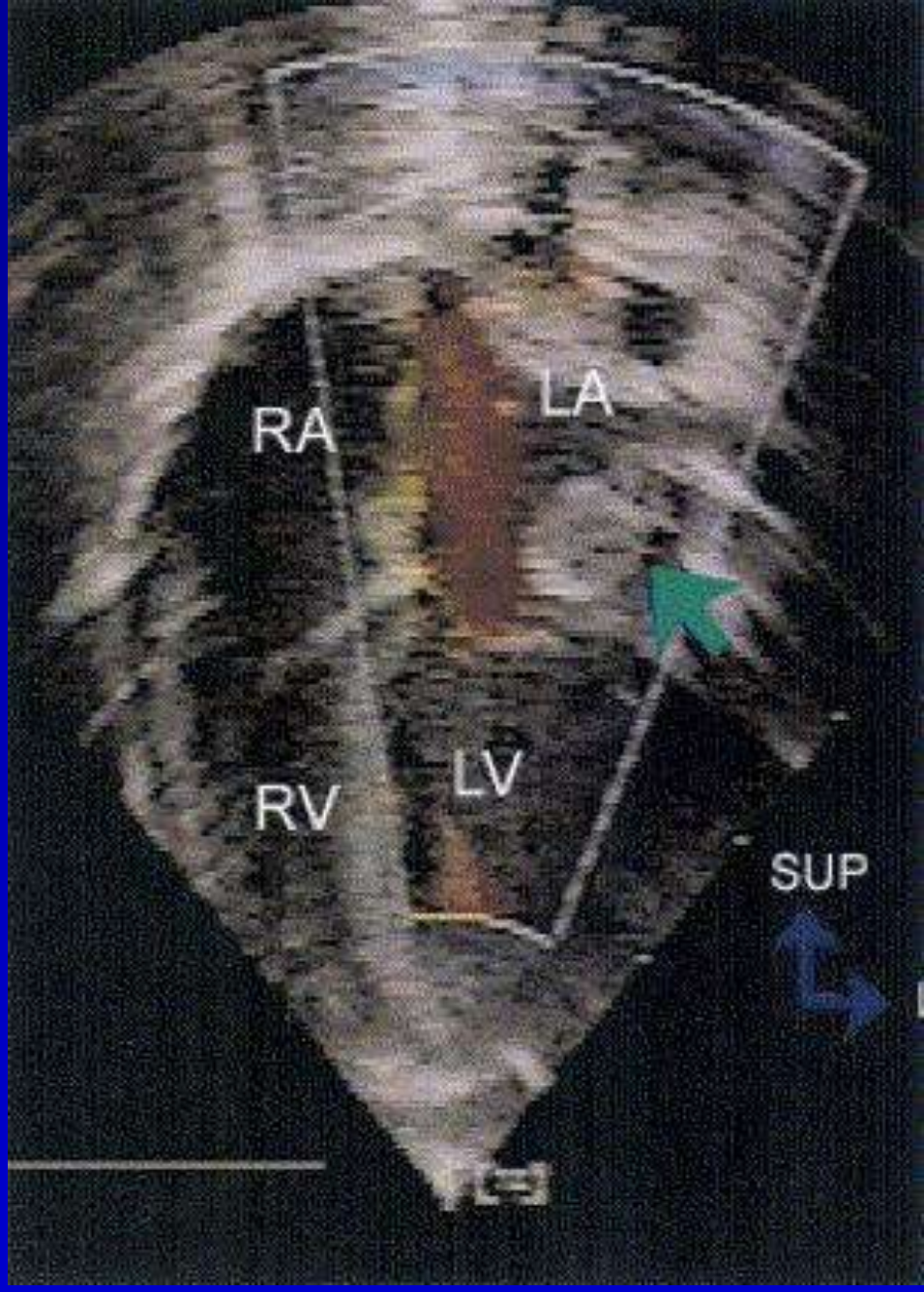
Images taken from 4 views demonstrating the inverted left atrial appendage (*LAA*) (*green arrow*), in the left atrium (*LA*) *yellow arrow* is pointing to mitral valve (*MV*). Parasternal long-axis (**A**), parasternal short-axis (**B**), apical 4-chamber (**C**), and subcostal sagital (**D**) views



Meredith DS et al. J Am Soc Echocardiogr. 2004;17:901.

LA Appendage spontaneous inversion

Apical 4-chamber view in the same patient with laminar color Doppler demonstrated in left atrium (*LA*) indicating no obstruction. This was later confirmed with pulsed Doppler. *LV*, Left ventricle; *RA*, right atrium; *RV*, right ventricle



Meredith DS et al. J Am Soc Echocardiogr. 2004;17:901.

LA Appendage spontaneous inversion

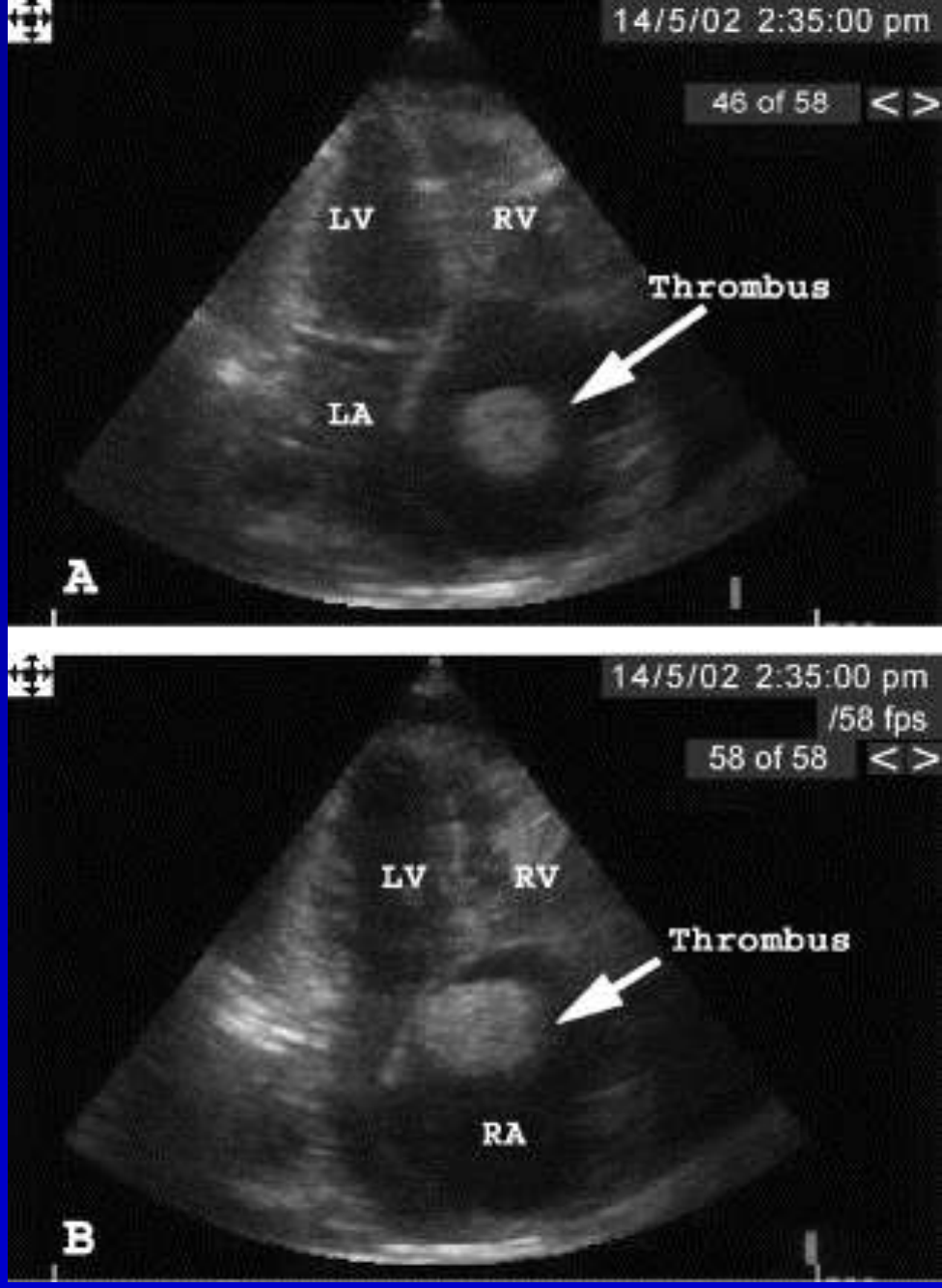
Parasternal short-axis view, in the same patient 9 days after cardioversion. Left atrial (*LAA*) appendage (*green arrow*) has returned to its normal, everted position. *AO*, Aorta; *RA*, right atrium; *LA*, left atrium

Meredith DS et al. J Am Soc Echocardiogr. 2004;17:901.

RA Ball Valve Thrombus

(A and B) Transthoracic two-dimension echocardiography in the four chamber view showing a large mobile thrombus moving like ping-pong ball within the right atrium.

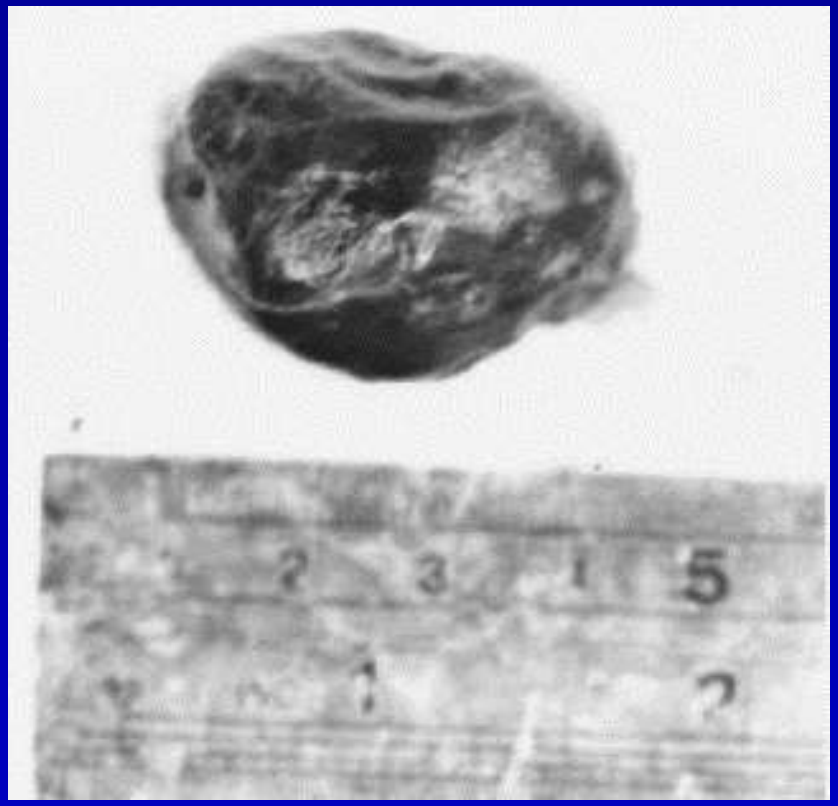
Tricuspid stenosis is present.



Acikel M et al. International J Cardiol. 2004;94:329.

RA Ball Valve Thrombus

A large mobile thrombus removed from the right atrium at emergency surgery.



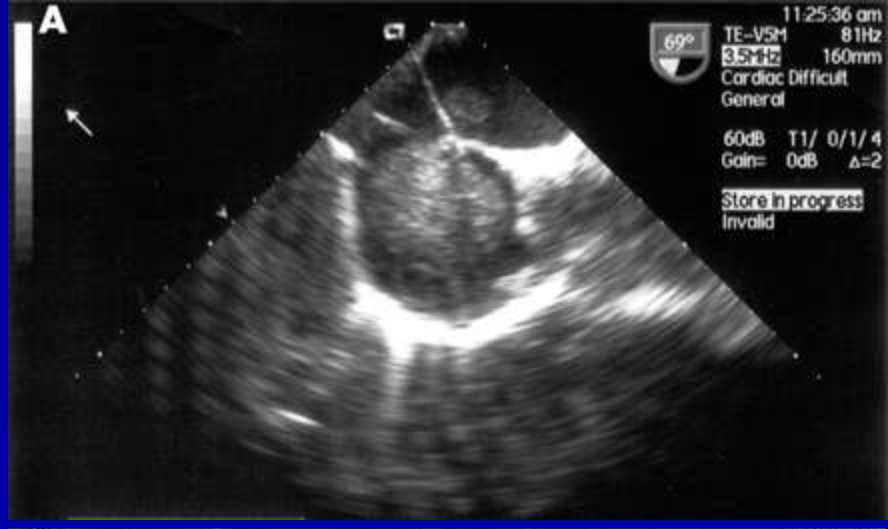
Acikel M et al. International J Cardiol. 2004;94:329.

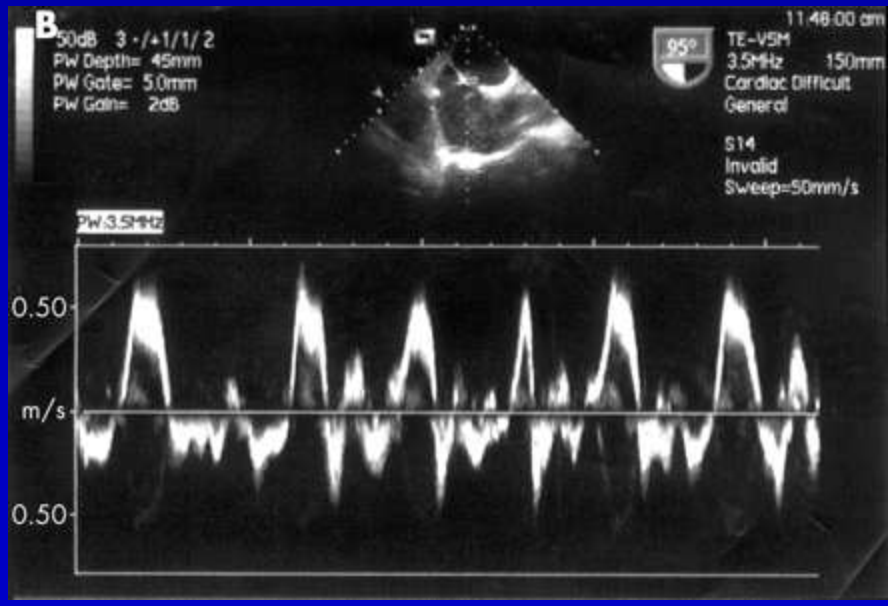
Giant Atrial Septal Aneurysm Simulating RA Tumor

75 yo man pre CABG with AFib, and intraoperative TEE.

Initial picture appears as tumor or thrombus in RA.

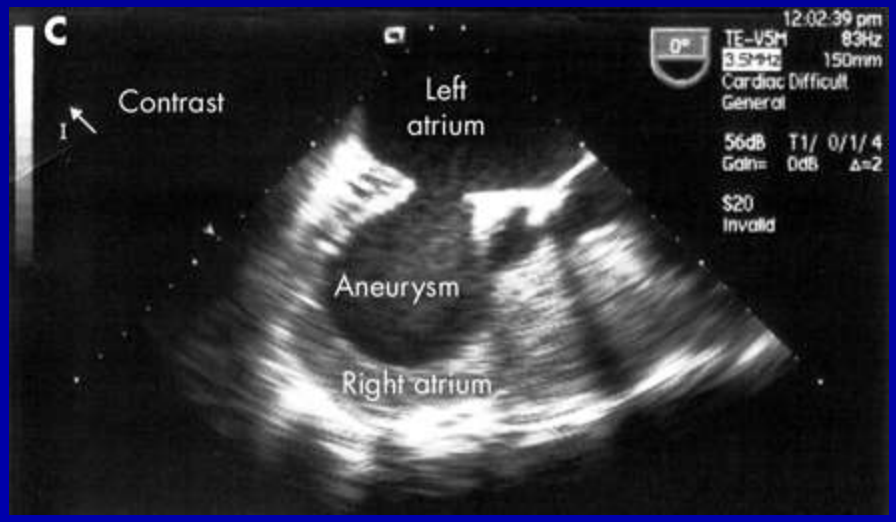
Doppler shows flow across the interatrial septum.

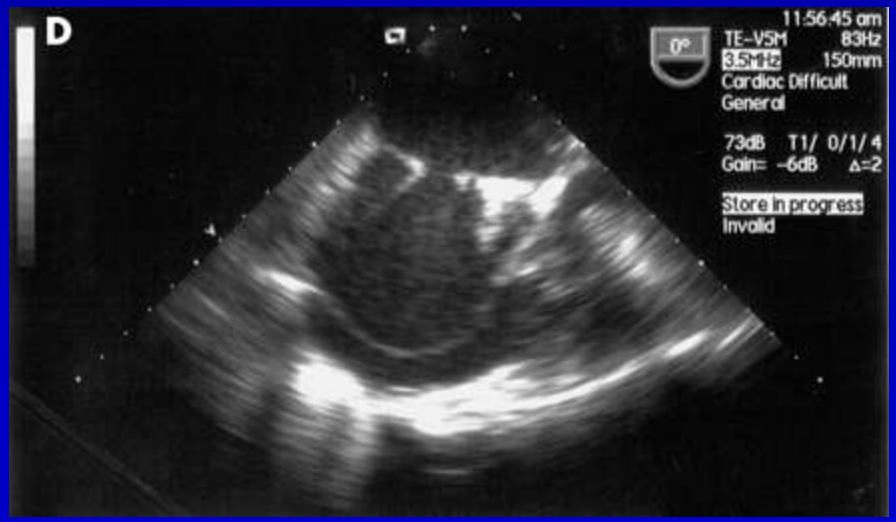




Pappas KD et al. Heart. 2004;90:493.

Giant Atrial Septal Aneurysm Simulating RA Tumor





75 yo man pre CABG with AFib, and intraoperative TEE.

Agitated saline opacifies the RA and leaves the atrial septal aneurysm unopacified.

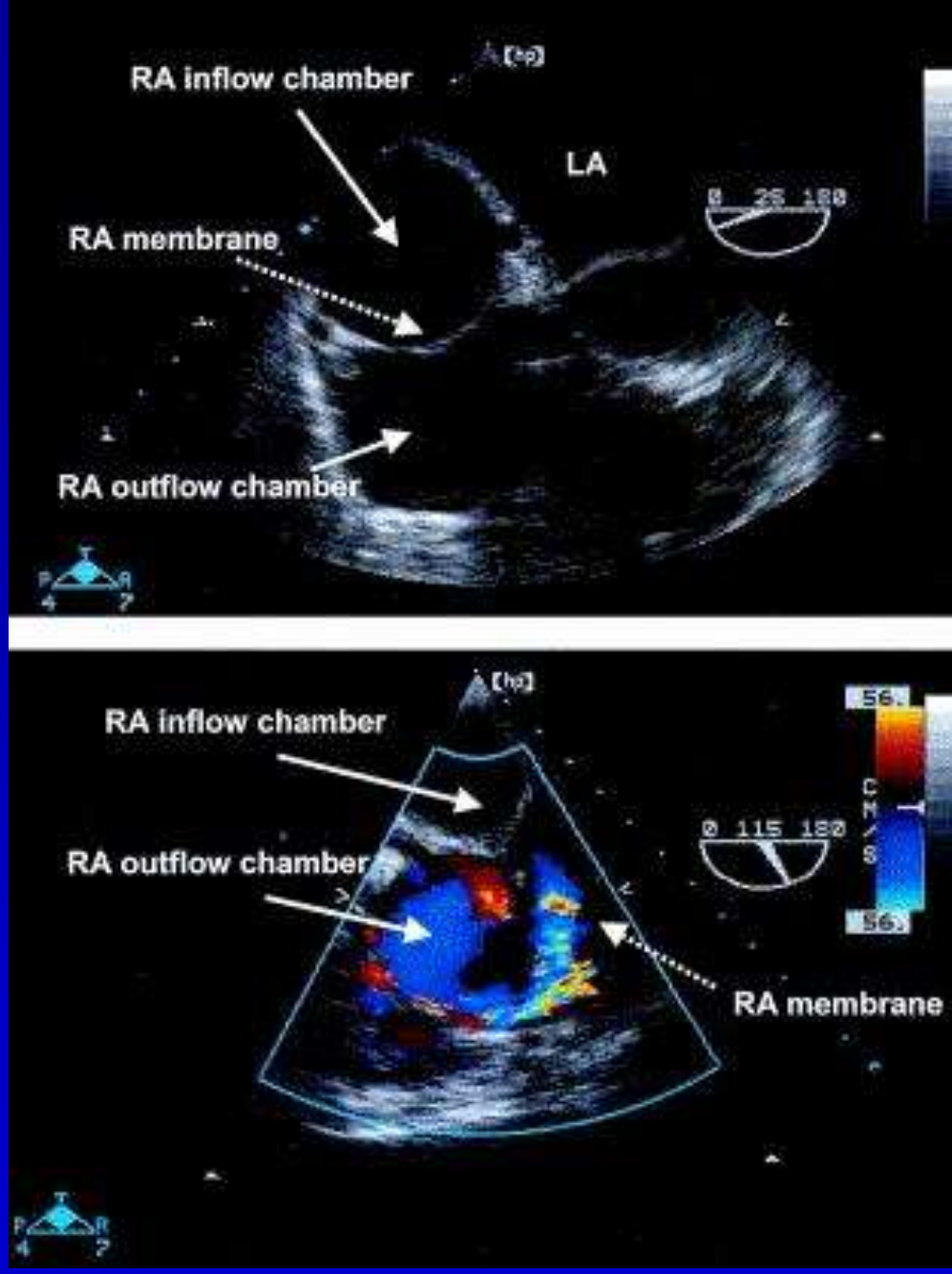
Spontaneous echocontrast in aneurysm disappeared with lower blood pressure.

Pappas KD et al. Heart. 2004;90:493.

Cor Triatriatum Dexter

30 yo man with severe hypotension after surgery for extensive burn injury.

Multiplane transesophageal echocardiography images (*top*). Large membrane divides right atrium (*RA*) into 2 subchambers (*bottom*). Hole (0.9 × 1 cm) permitted forward flow. *LA*, Left atrium

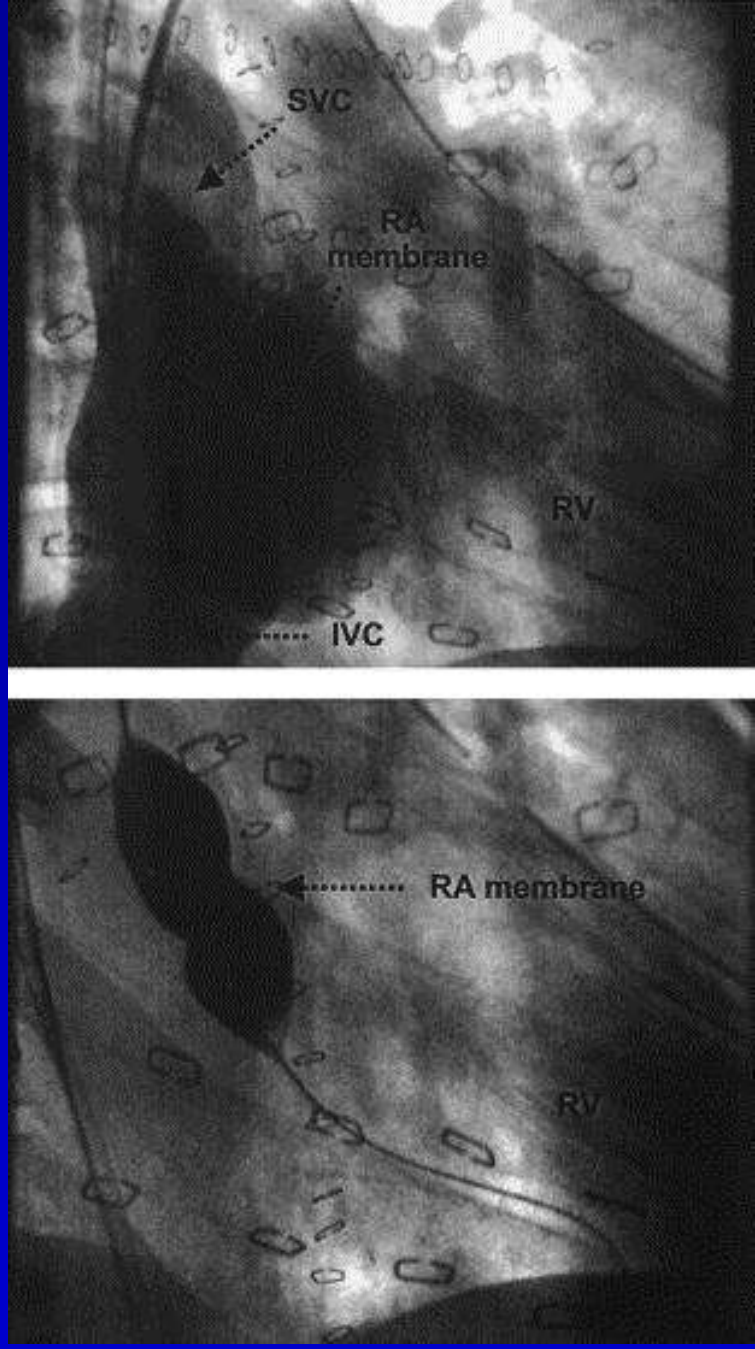


Bisinov EA et al. J Am Soc Echocardiogr. 2003;16:897.

Cor Triatriatum Dexter

30 yo man with severe hypotension after surgery for extensive burn injury.

Right atrial (*RA*) angiography (*top*). Large membrane divides right atrium into 2 subchambers (*bottom*); balloon dilation of RA membrane. *IVC*, inferior vena cava; *RV*, right ventricle; *SVC*, superior vena cava



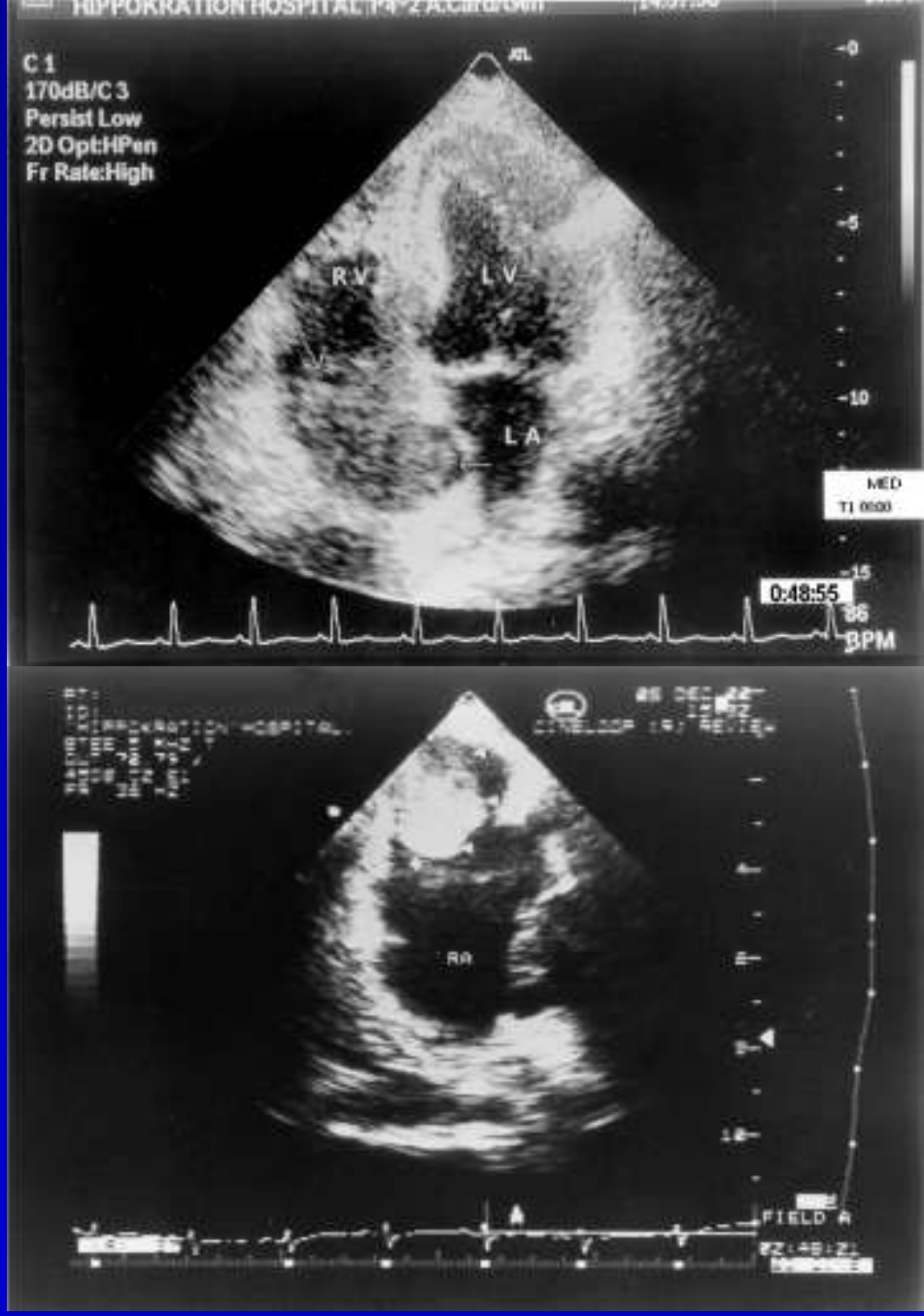
Bisinov EA et al. J Am Soc Echocardiogr. 2003;16:897.

Metastatic Hepatocellular Carcinoma Extending into RA

66 yo man with cirrhosis

2D-E A4C reveals the mass (arrows) in the RA.

TEE of RA shows mass protruding into the RA



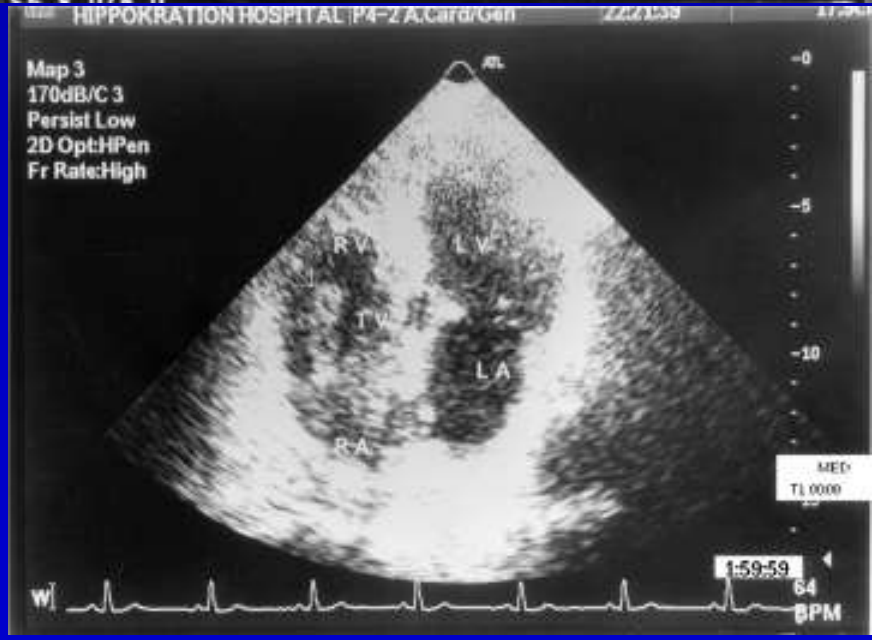
Vlasseros I et al. Echocardiogr. 2003;20:387.

Metastatic Hepatocellular Carcinoma Extending into RA

66 yo man with cirrhosis

Abdominal CT illustrates an infiltrating structure in the left lobe of the liver. .

Apical 4C reveals the tumor mass (arrows) extending through the tricuspid valve into the right ventricle



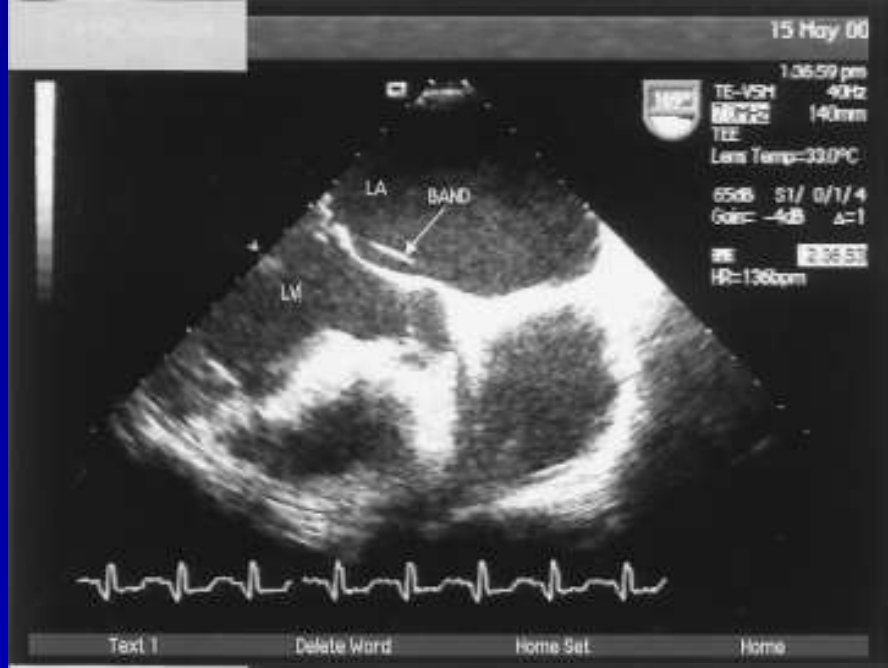
Vlasseros I et al. Echocardiogr. 2003;20:387.

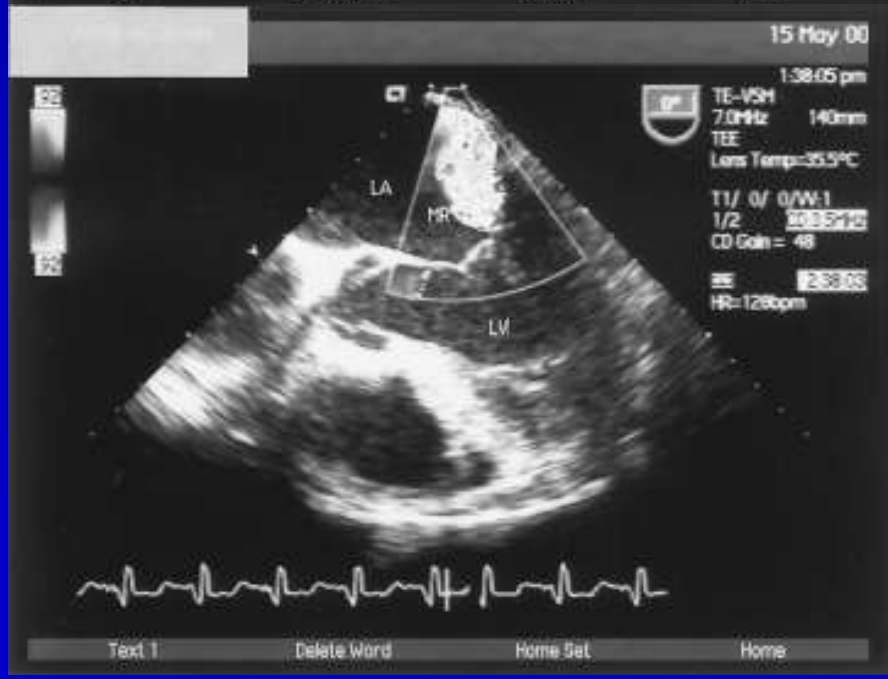
LA Anomalous Band Causing MR

43 yo woman with dyspnea.

TEE view showing the anomalous band in the LA, connecting the atrial side of the anterior MV leaflet and atrial septum .

TEE view showing the anomalous band in the left atrium, causing prolapse and moderate-to-severe mitral regurgitation.





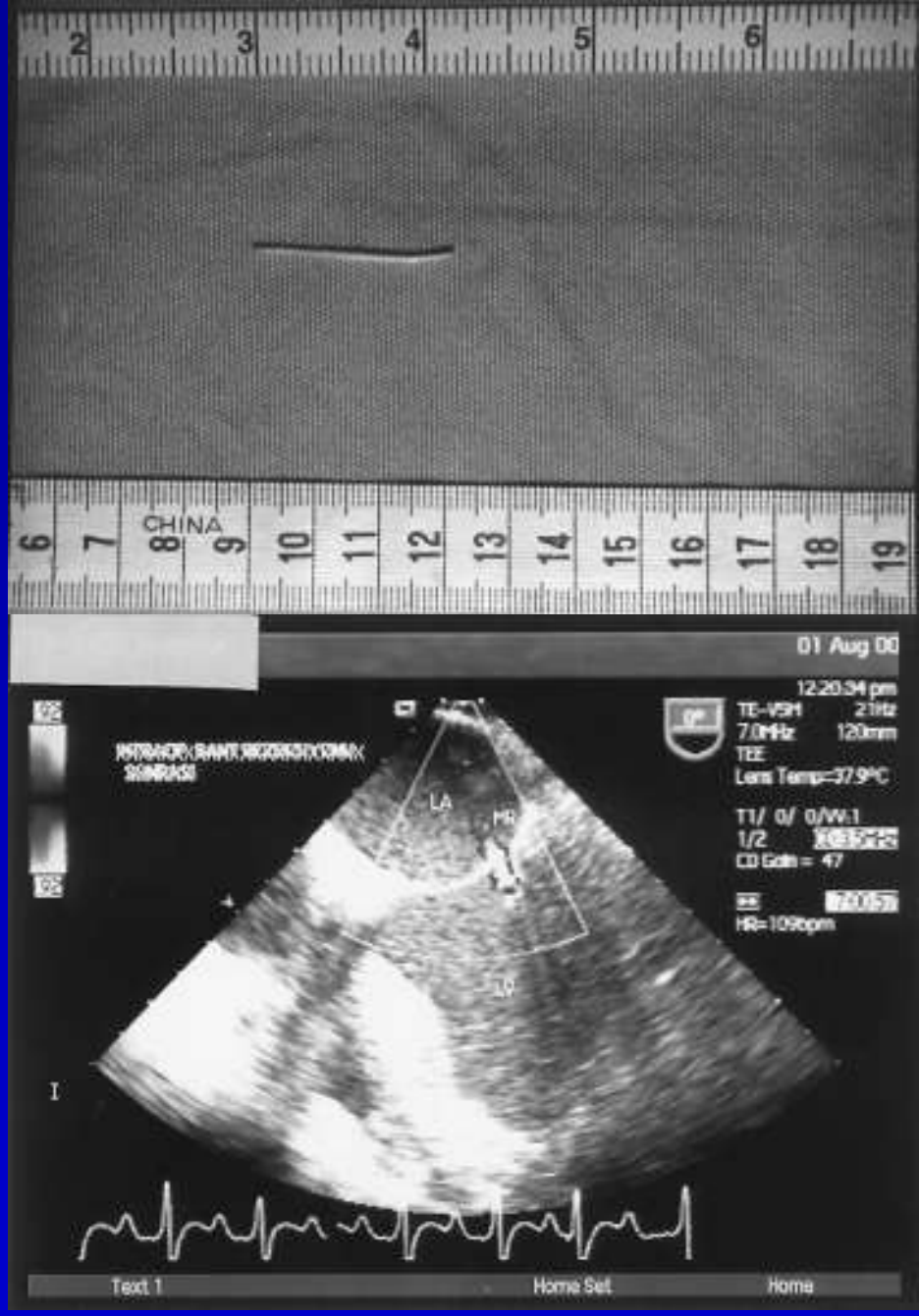
Baran T et al. Echocardiogr. 2003;20:83.

LA Anomalous Band Causing MR

43 yo woman with dyspnea.

Pathological specimen of the removed band.

TEE view showing improvement in the regurgitation after resection of the band.

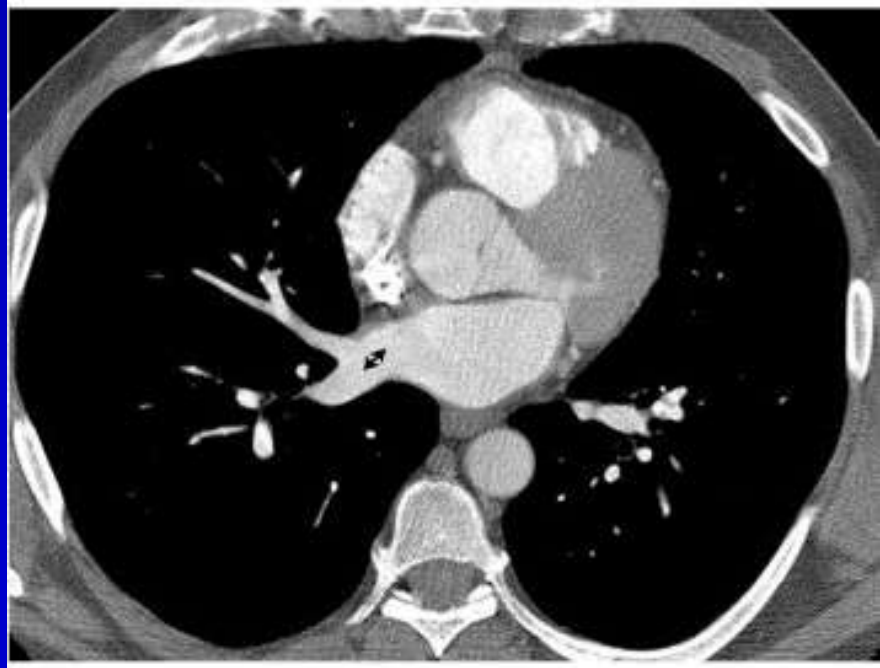


Baran T et al. Echocardiogr. 2003;20:83.

Pulmonary Vein Anatomy

- Pulmonary venous Diameter
- Distance to first bifurcation

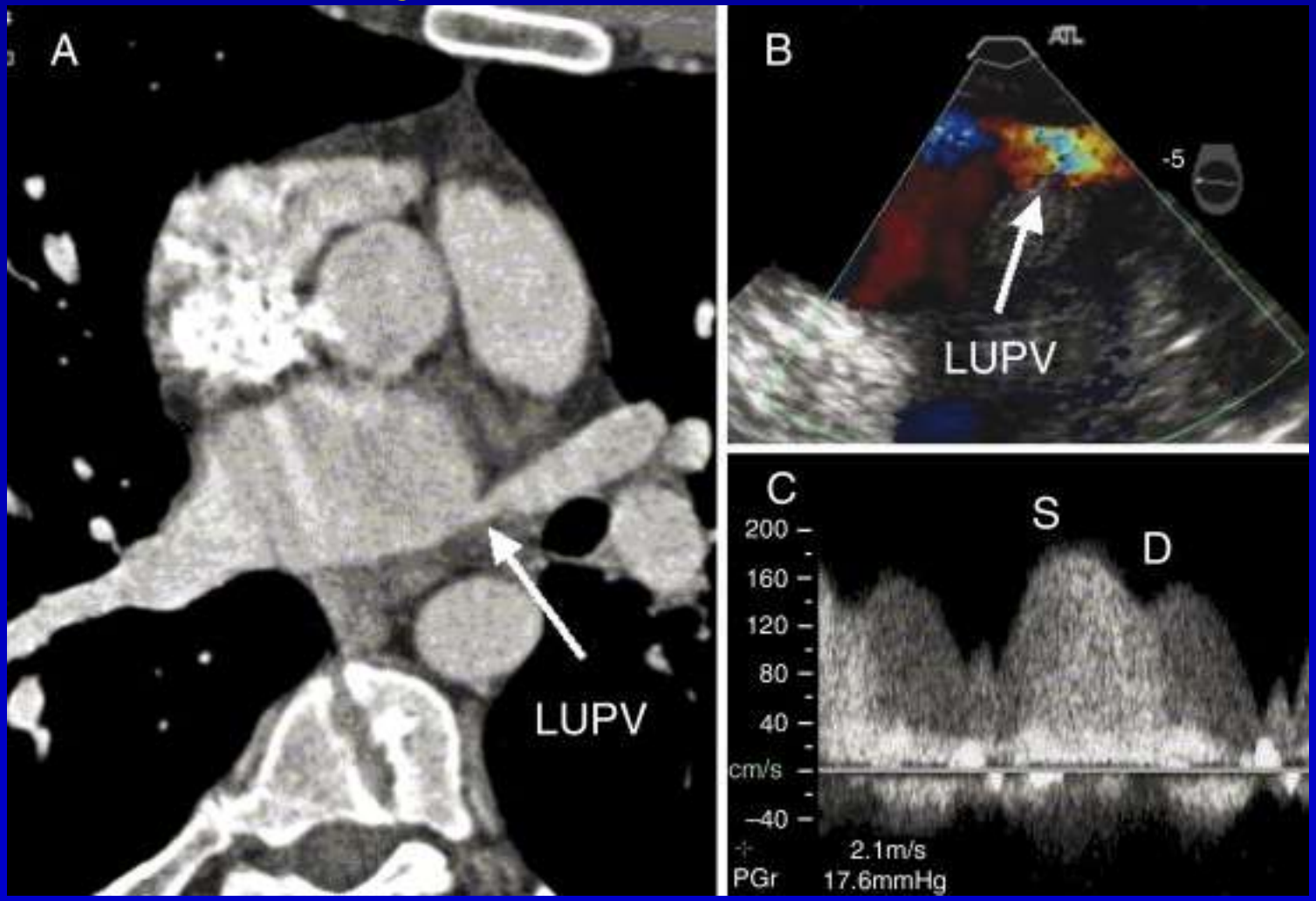
a.



b.

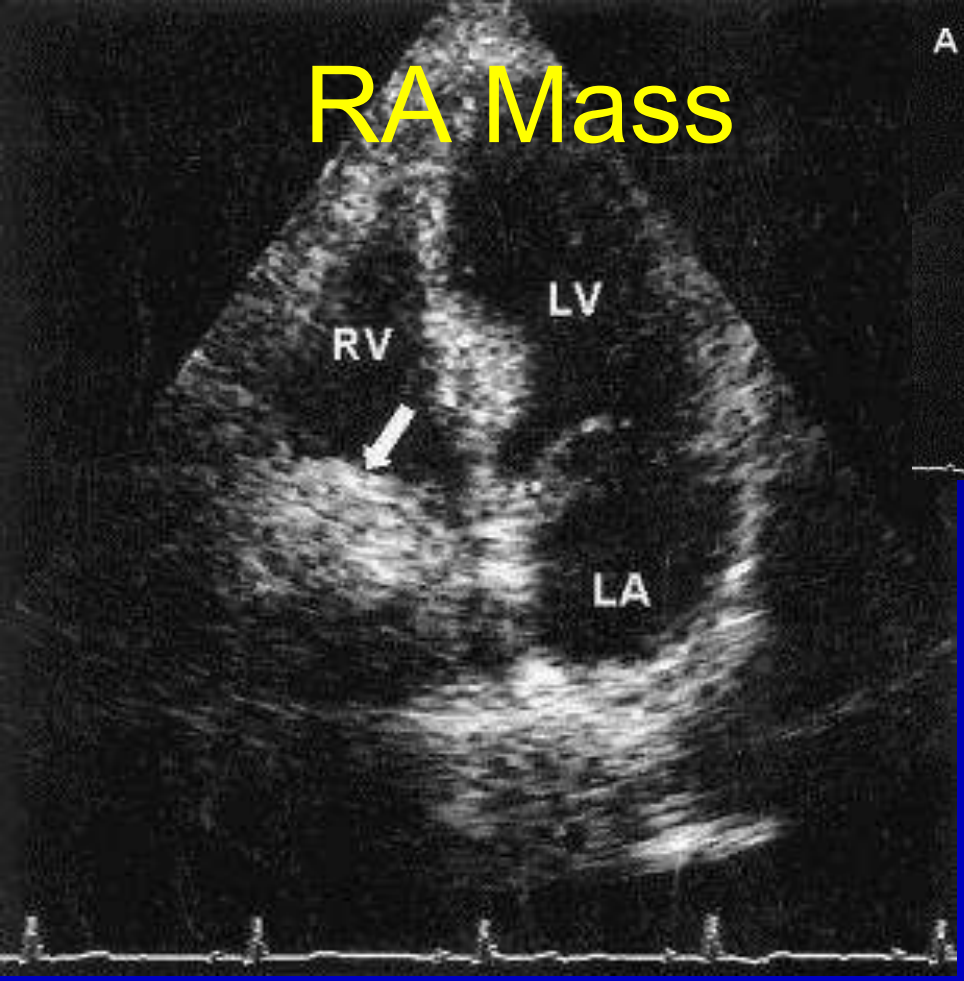
Cronin P et al. Academic Radiology. 2007;14:437.

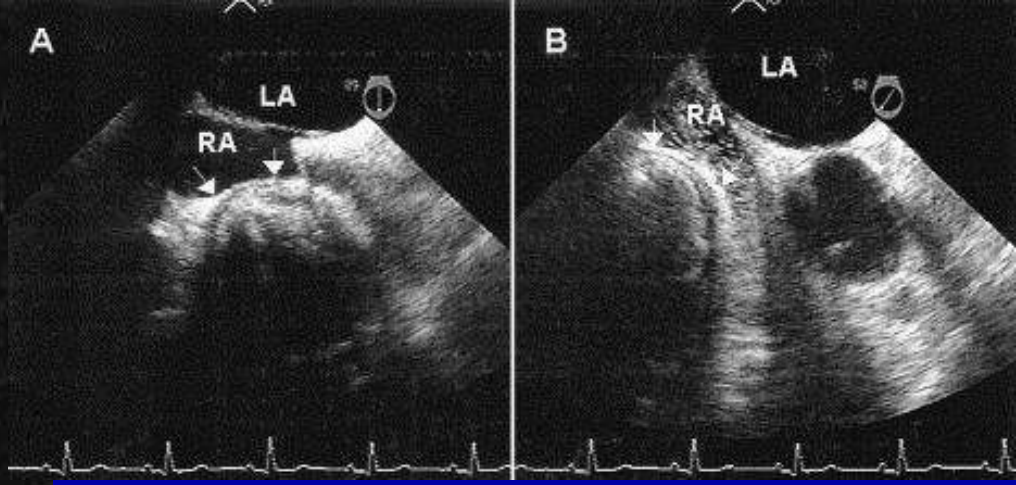
Pulmonary Vein Stenosis



Sigurdsson G et al. Am Heart J. 2007;153:800.

RA Mass





Transesophageal echocardiography showing 5.7- × 5.2-cm extracardiac mass in pericardial space, with compression of right atrium (*RA*). Note thick contour surrounding mass and heterogeneous content (*arrows*), with echodense areas causing acoustic shadowing (**A**). After injection of agitated-saline solution, note microbubbles in RA without contrast into mass (*arrows*), confirming absence of blood flow (**B**).

Transthoracic echocardiogram in apical 4-chamber view demonstrating large rounded mass projecting in right atrial (RA) position (*arrow*). It was unclear whether it was inside or adjacent to RA

Tsutsui JM et al. J Am Soc Echocardiogr. 2003;16:800.