Tricuspid Valve
When to intervene?

Echo Hawaii 2016

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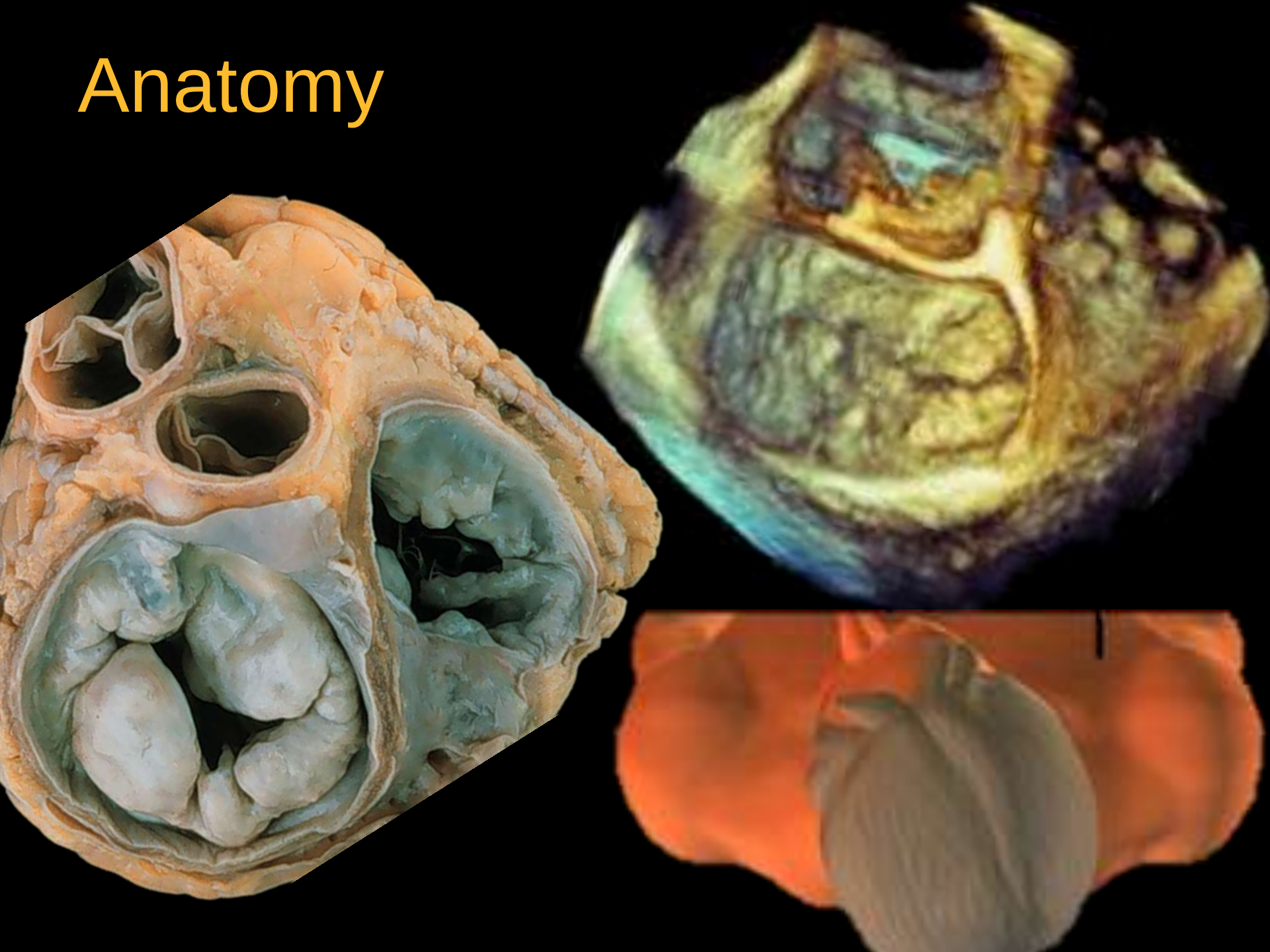
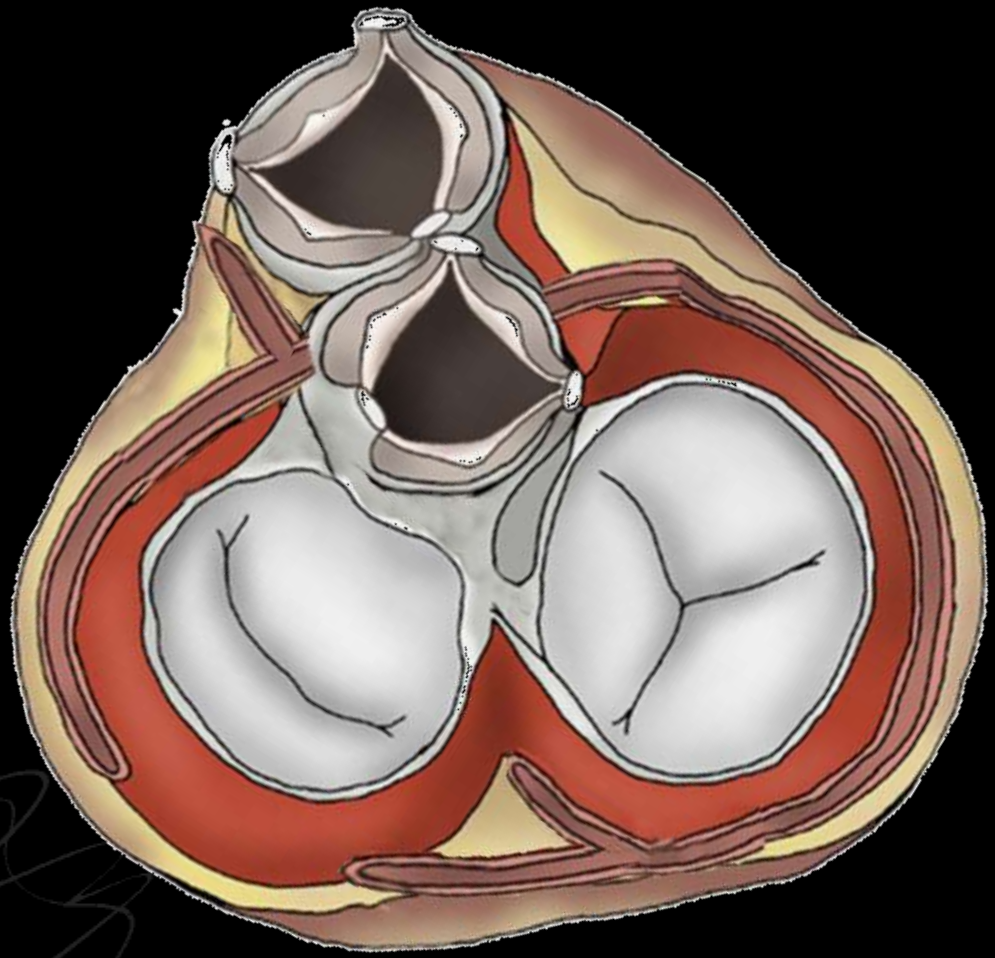
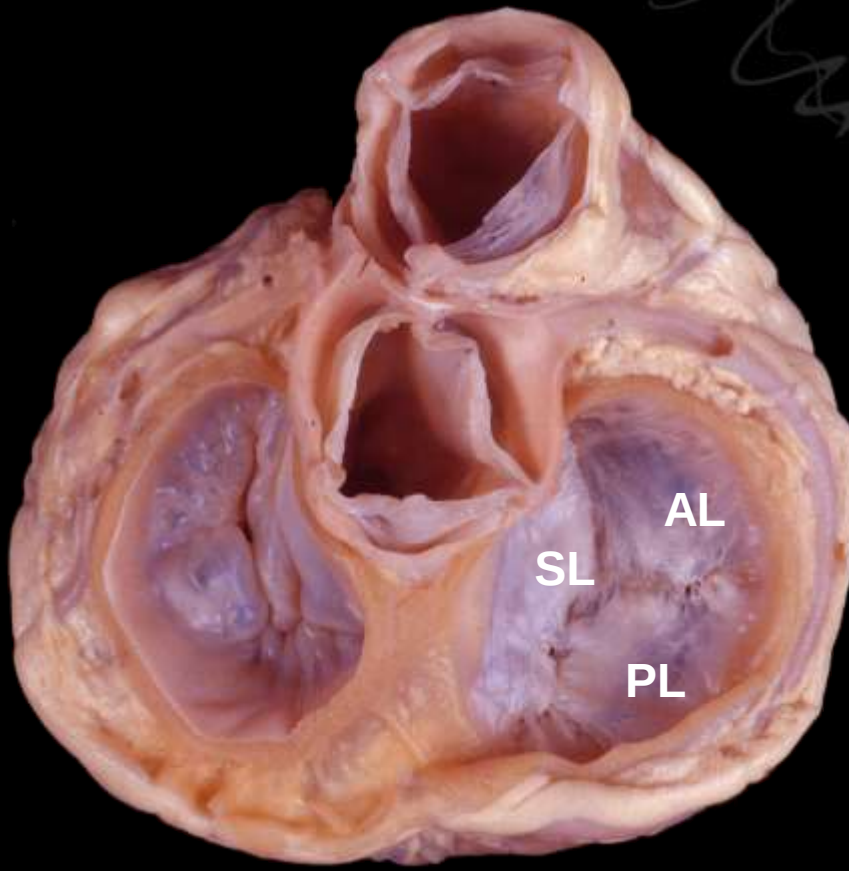
Anatomy



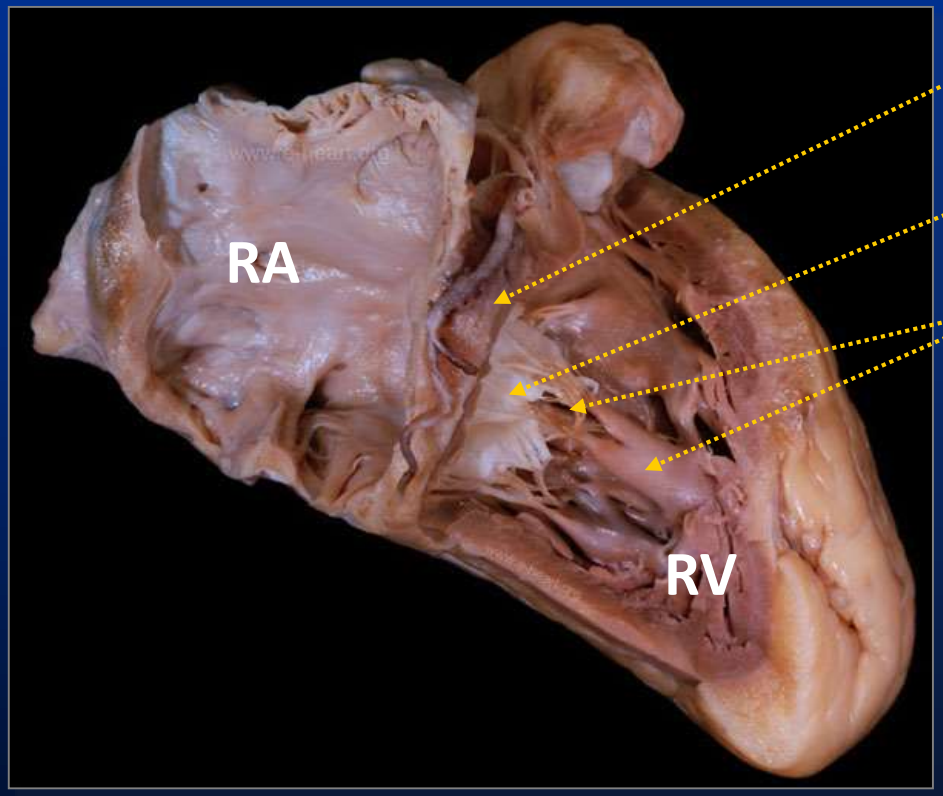
Surgical View





Courtesy of Dr William Edwards
Mayo Clinic

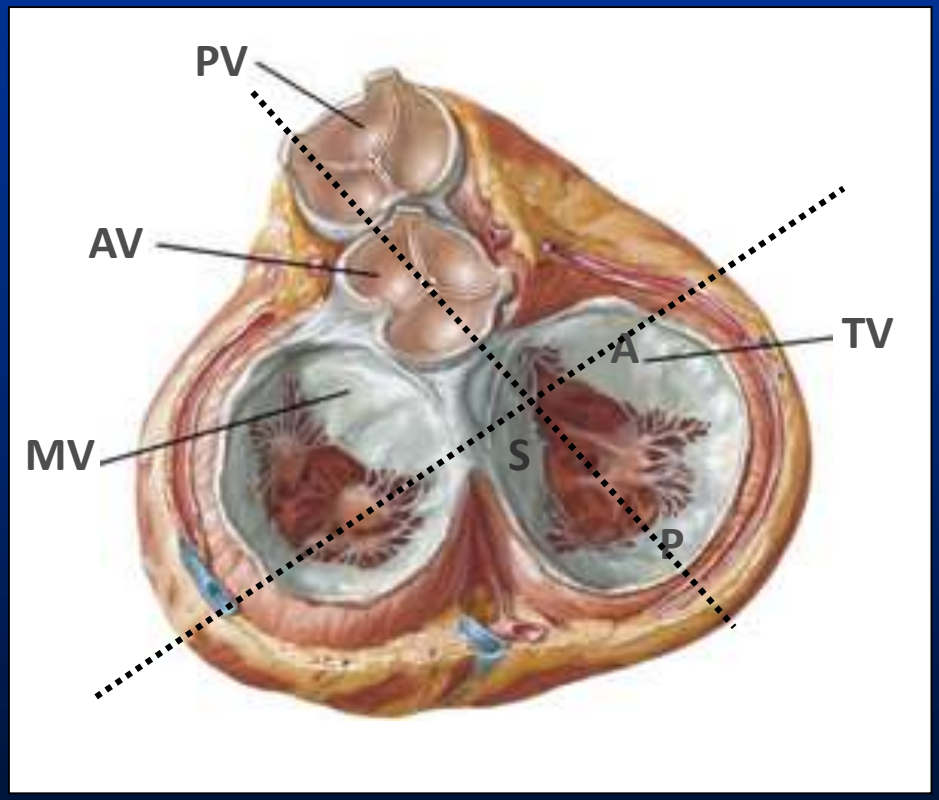
Imaging the Tricuspid Valve Anatomy



Tricuspid Valve Complex

- Annulus
- Leaflets
- papillary muscles and chordae tendineae.
- Right Ventricle (RV) & right atrial (RA) myocardium

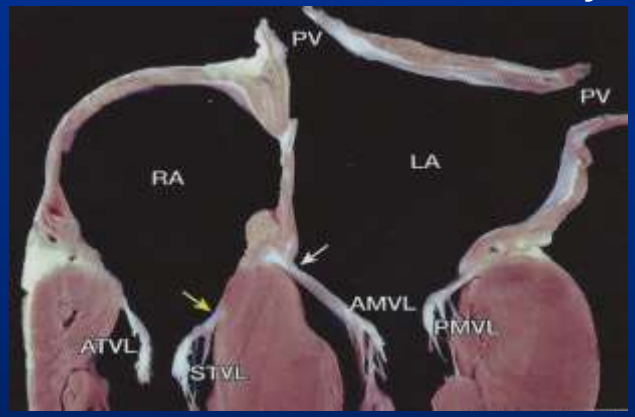
Imaging the Tricuspid Valve
Anatomy : Leaflets



- Three leaflets (anterior > posterior > septal)
- Posterior leaflet
  - often subdivided into 2 or 3 additional segments
- Adjacent anatomy
  - Antero-septal commissure : Aortic root
  - Anterior leaflet: RVOT
  - Septal leaflet : septum
  - Posterior leaflet : RV free wall
- Echo imaging
  - Standard 2D views demonstrate 2 leaflets only

Imaging the Tricuspid Valve
Anatomy : Annulus

Cardiac crux view anatomy

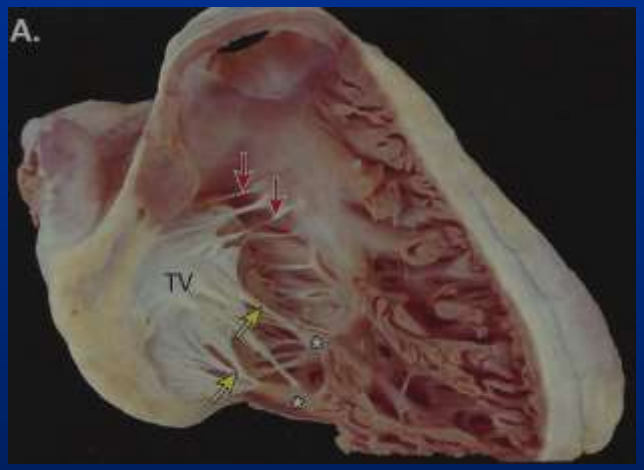


4 chamber view TTE/TOE

- Annulus is anatomically poorly defined fibrous structure
- Annular plane is located lower than the mitral annulus
  - More apical insertion of septal leaflet
- Echo imaging : defines annulus as the point of leaflet articulation (‘leaflet hinge’)
  - Annulus diameter in adults = 28+5 mm. (4ch view)
  - TV annulus diast. diameter ‘significantly’ dilated if > 21 mm/m^2 (4ch view)

Imaging the Tricuspid Valve
Anatomy : Sub valvular apparatus

RV chordal path view anatomy



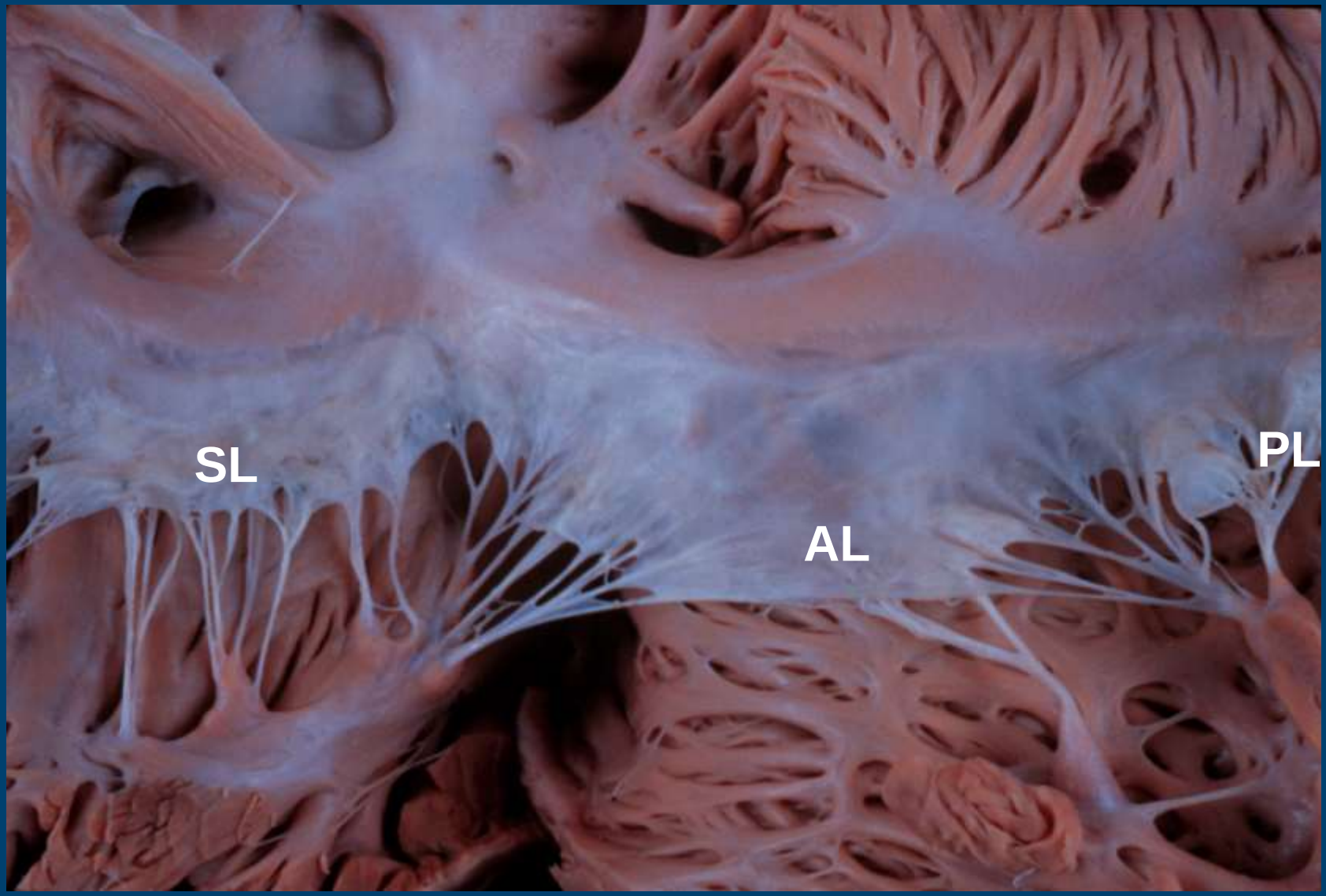
Ruptured chordae and large RV

- 3 major groups of papillary muscles
  - Anterior group
  - Posterior group
  - Septal group (often rudimentary)
- Pap muscles typically supply chordae to 2 adjacent TV leaflets
- Echo imaging : TTE struggles to assess subvalvular apparatus in normal RVs
  - More feasible when RV is large
  - More feasible with TOE (TG views)

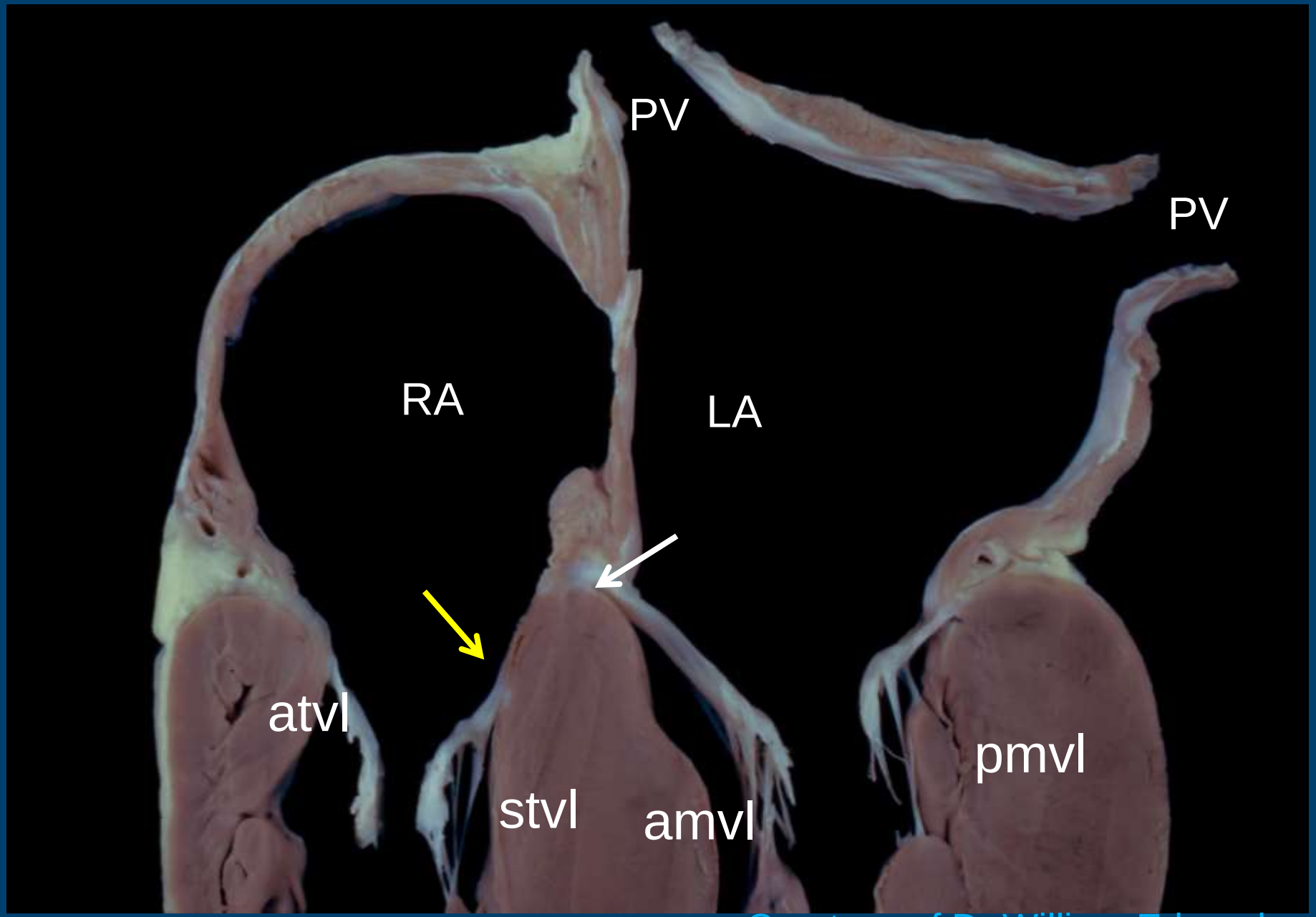
Imaging the Tricuspid Valve
Goals of Echo assessment

- Assess anatomy of TV complex
  - Leaflets, annulus, subvalvular apparatus
- Determine aetiology and mechanism of valve dysfunction
- Quantitate severity of valve dysfunction
- Impact on right heart : chamber enlargement and function

Courtesy of Dr William Edwards
Mayo Clinic



Courtesy of Dr William Edwards
Mayo Clinic



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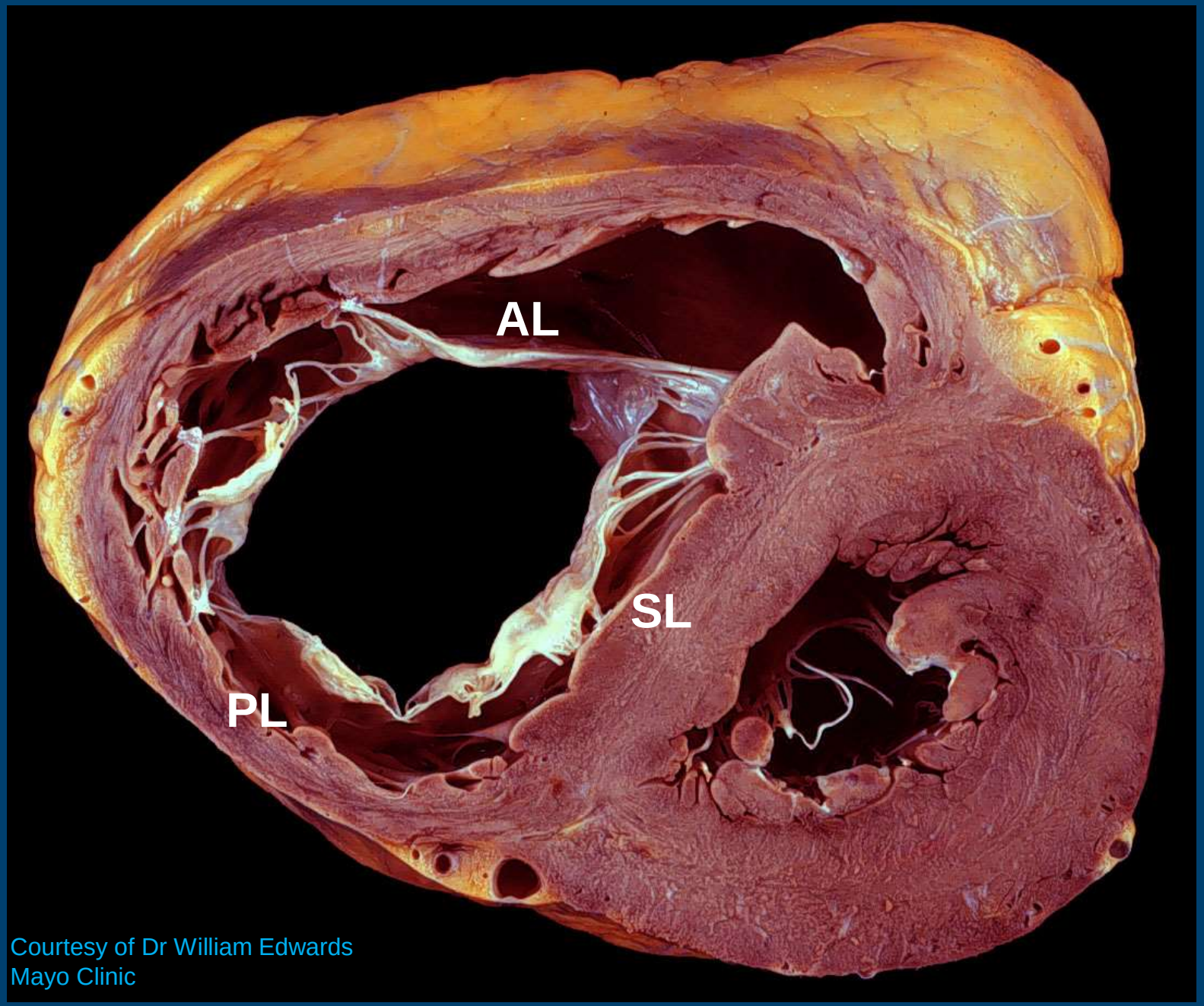

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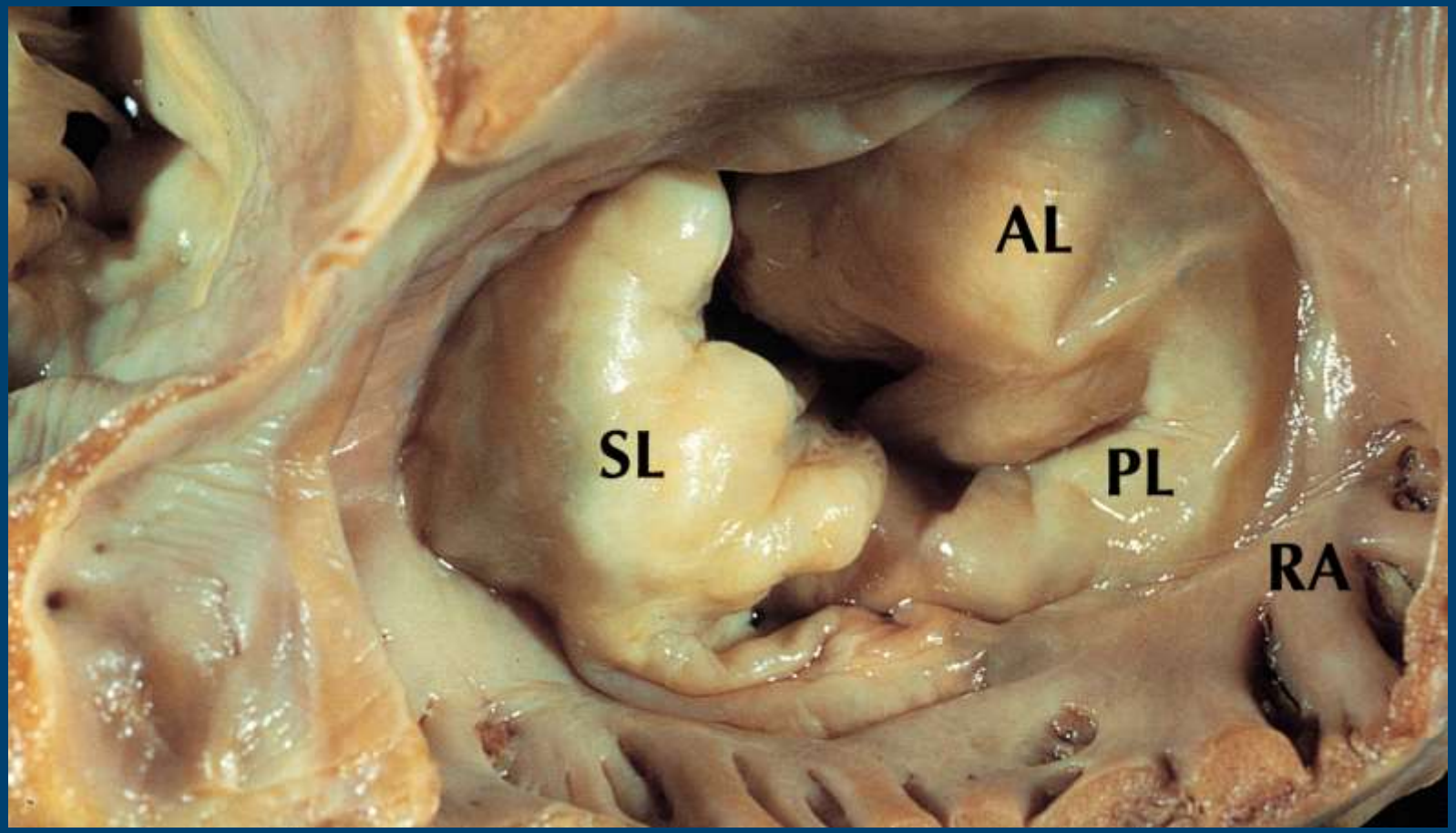
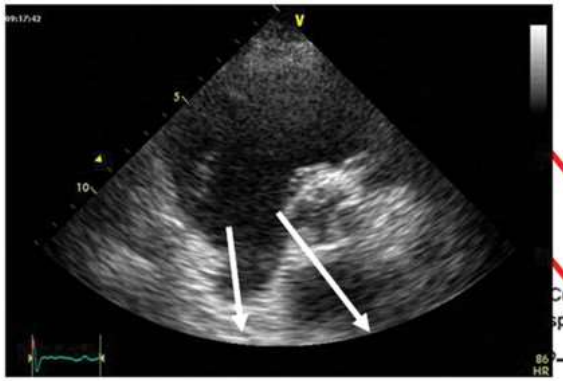


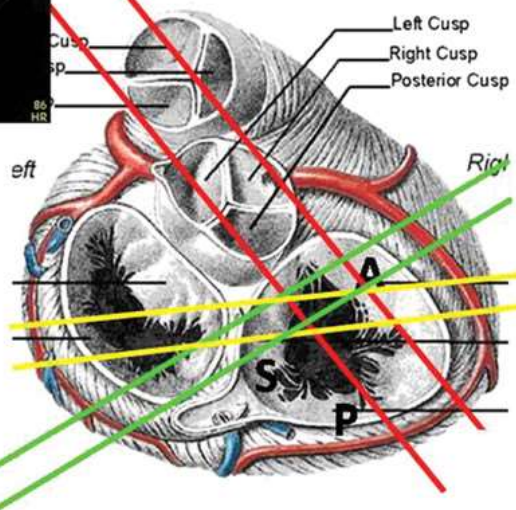
From Virmani R, Burke AP, Farb A: Pathology of valvular heart disease. In Rahimtoola SH [ed]: Valvular Heart Disease. In Braunwald E [series ed]: Atlas of Heart Diseases. Vol 11. Philadelphia, Current Medicine, page 1.17, 1997

Imaging

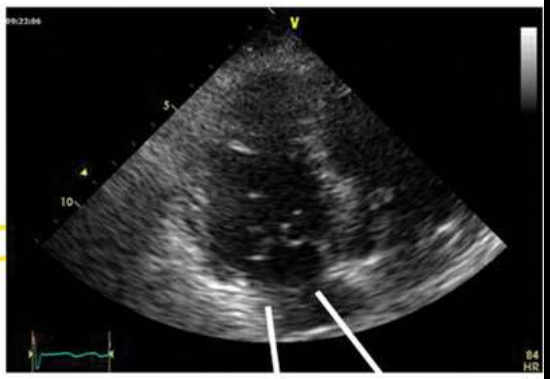
Parasternal SAX VIEW



Septal	0%	48%
Anterior	0%	52%
Posterior	92%	0%

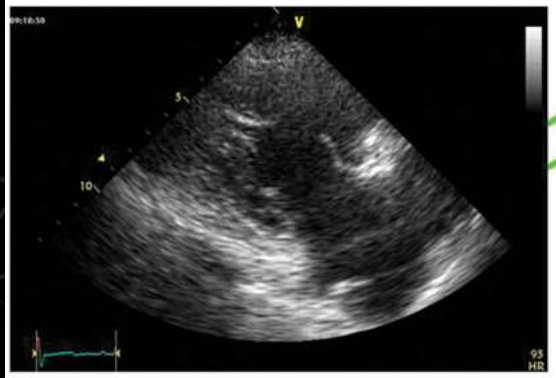


APICAL 4CH VIEW



Septal	0%	100%
Anterior	100%	0%
Posterior	0%	0%

PARASTERNAL RV-Inflow

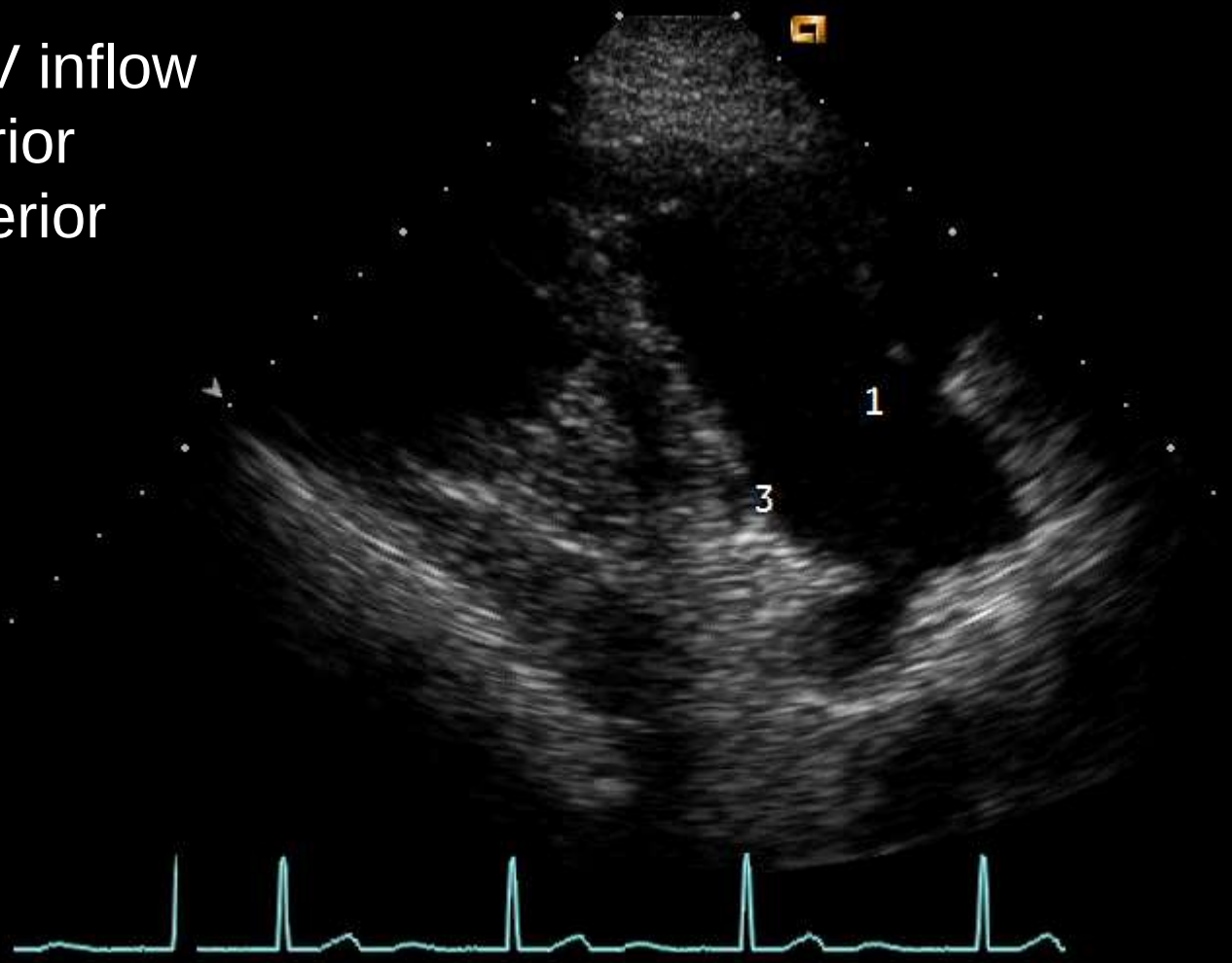


Septal	100%	0%
Anterior	0%	100%
Posterior	0%	0%

Badano L P et al. Eur J Echocardiogr 2009;10:477-484

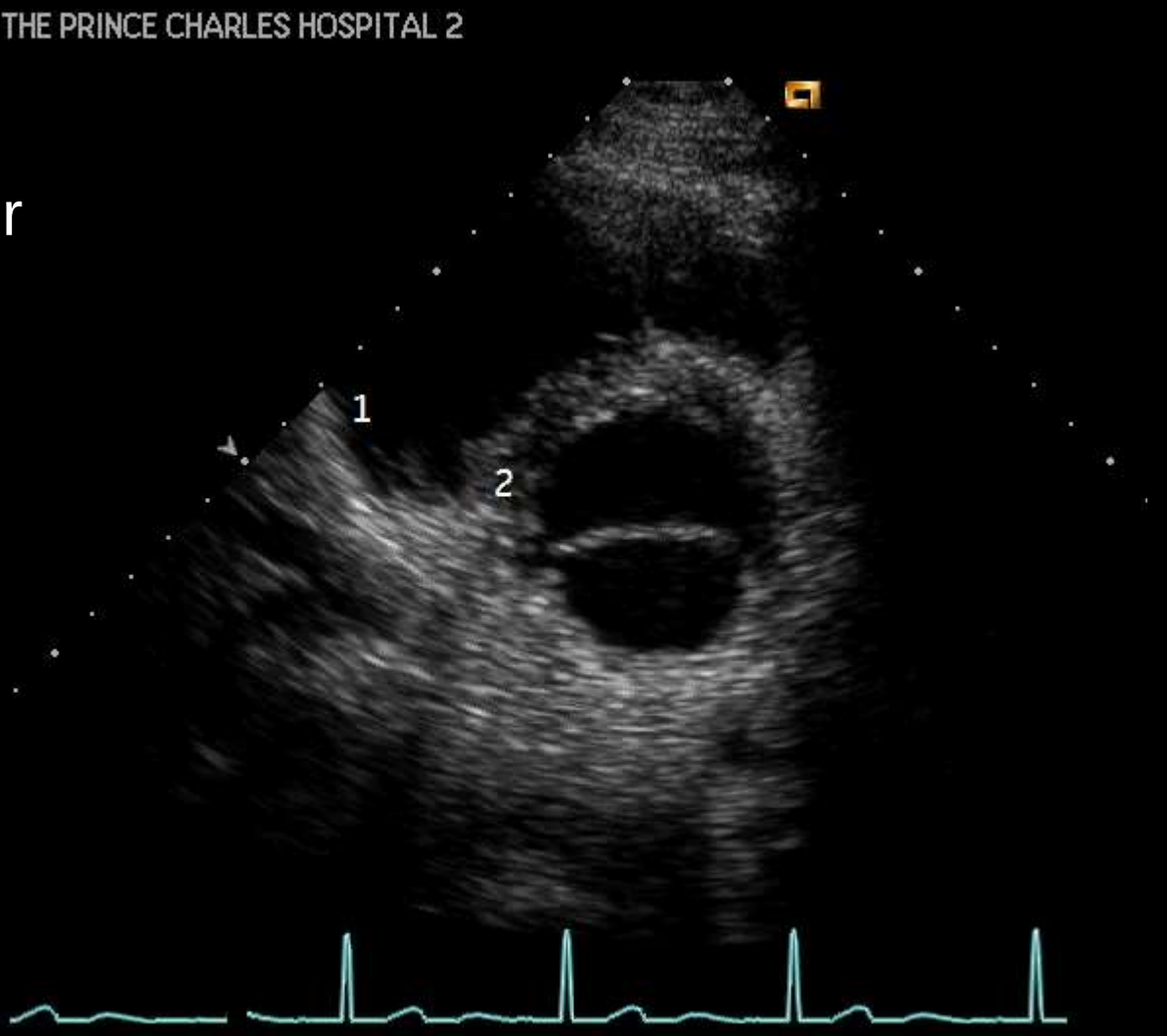
Views to visualise TV

PLAX RV inflow
1 = anterior
3 = posterior



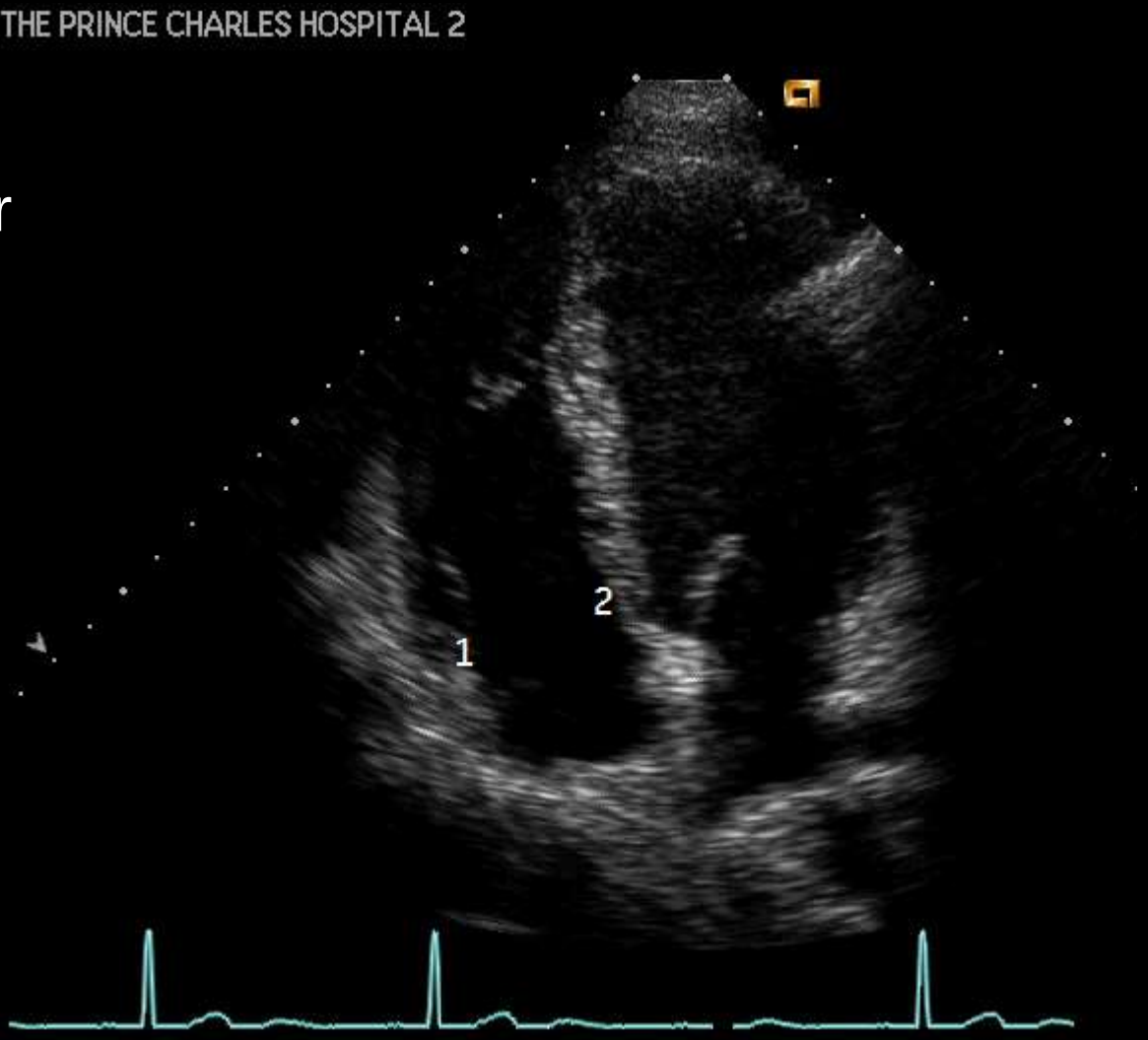
Views to visualise TV

PSAX
1 = anterior
2 = septal



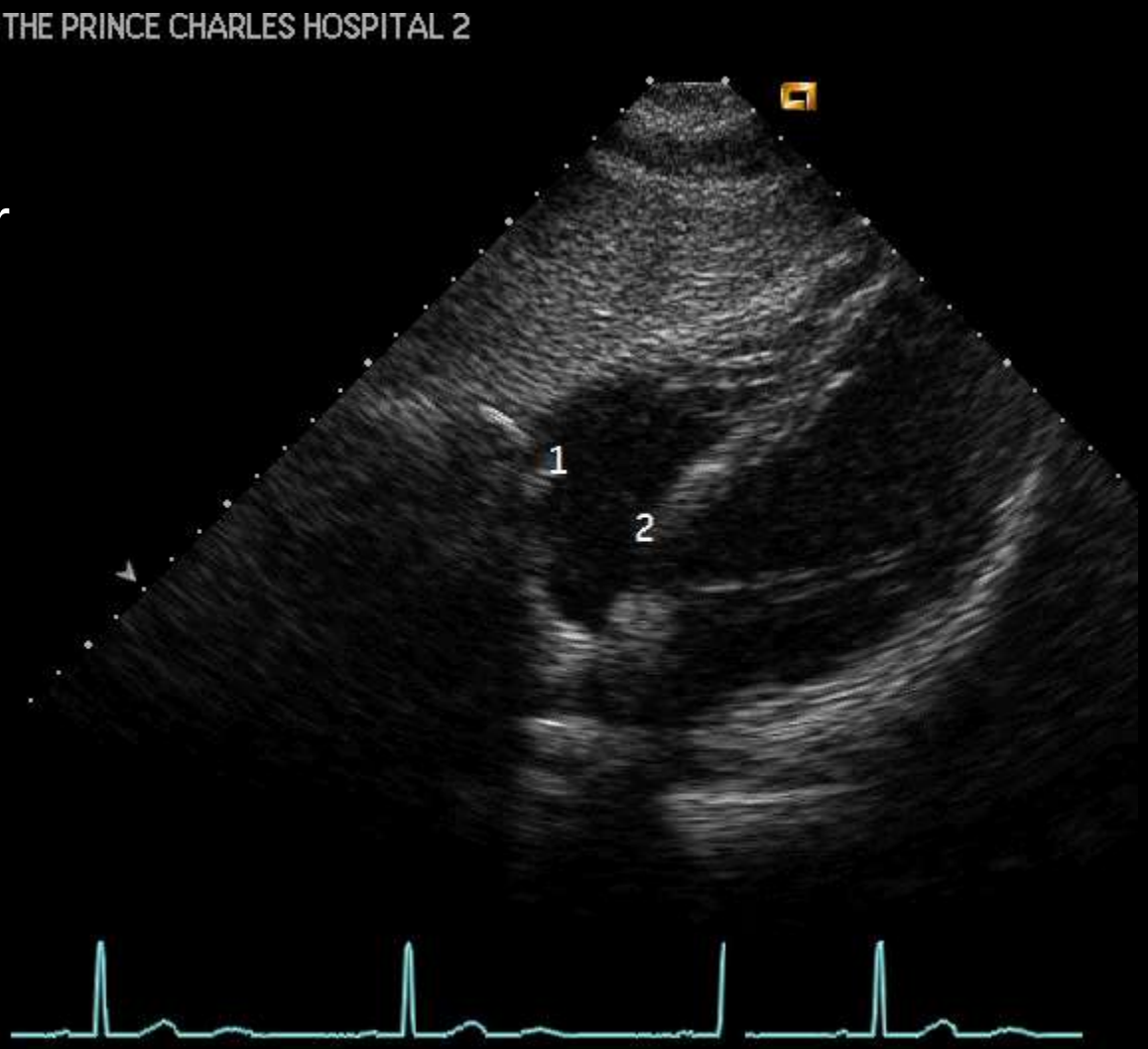
Views to visualise TV

Apical 4-ch
1 = anterior
2 = septal



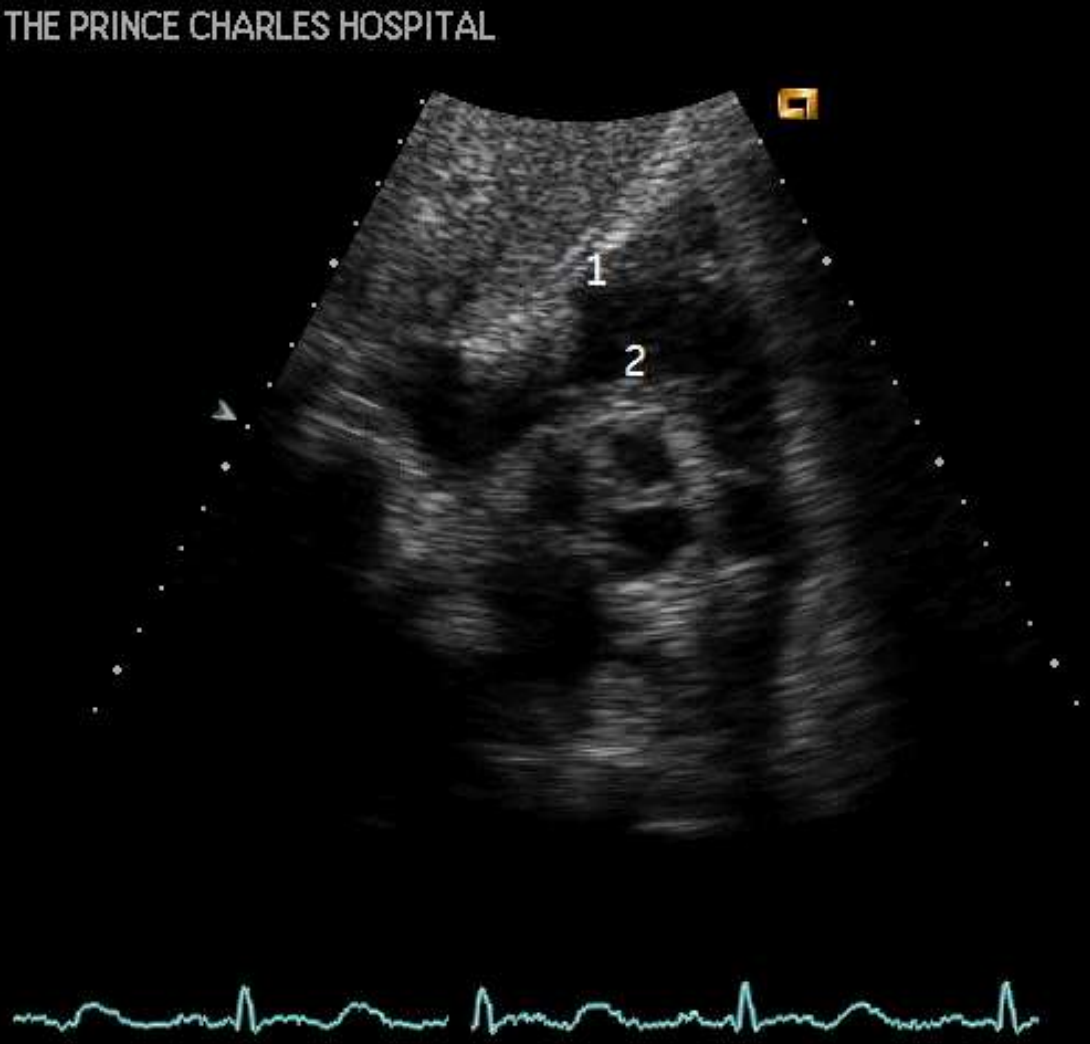
Views to visualise TV

Sub 4-ch
1 = anterior
2 = septal



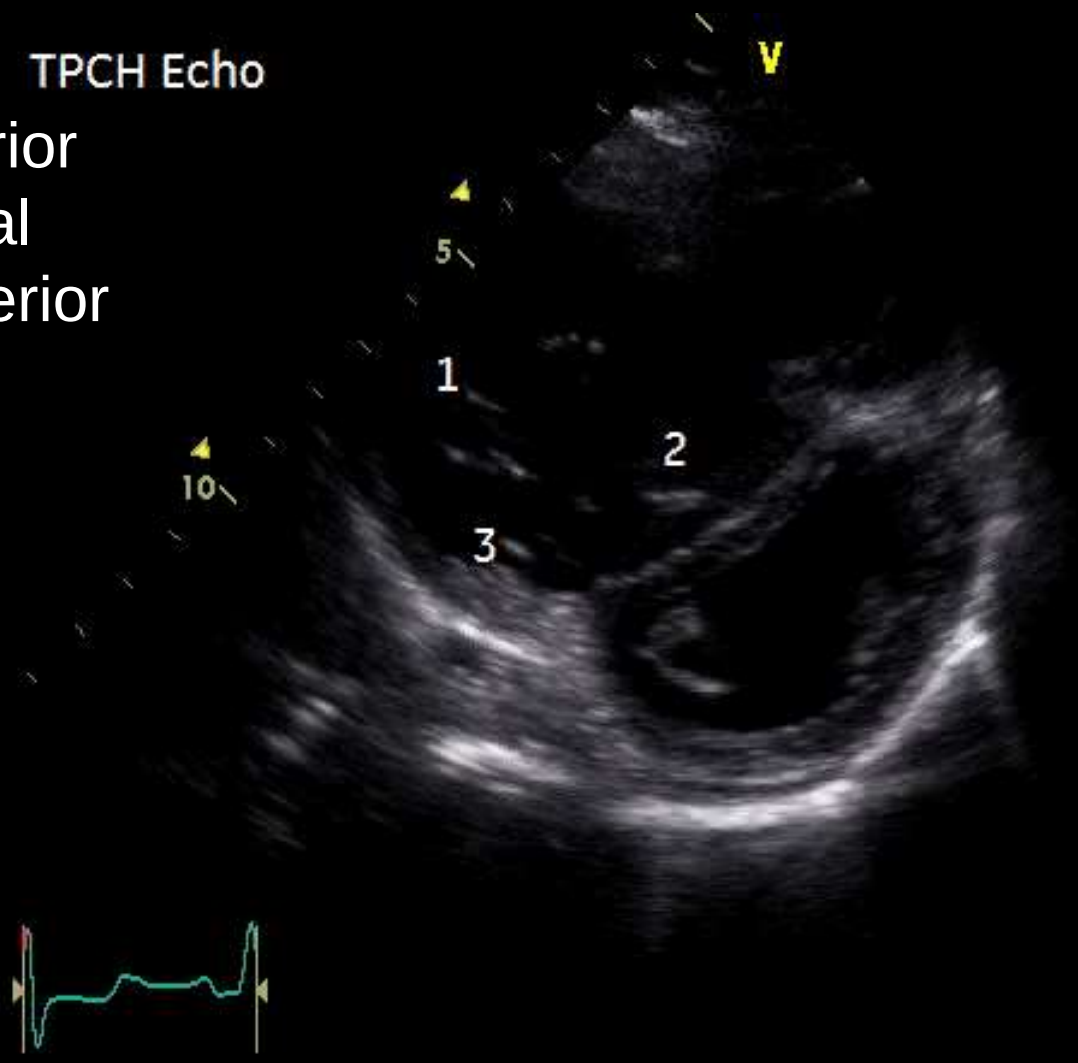
Views to visualise TV

Sub SAX
1 = anterior
2 = septal



All 3 leaflets

1 = anterior
2 = septal
3 = posterior



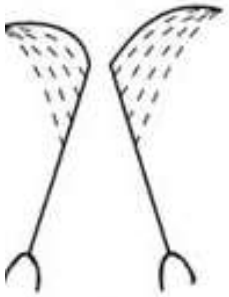
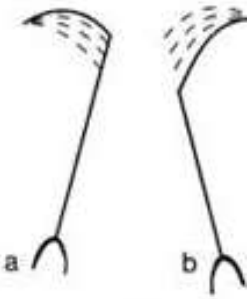
Pathology

Imaging the Tricuspid Valve
Aetiologies of TV dysfunction

- Organic (1^0 valvular)
  - Congenital e.g. Ebsteins
  - Myxomatous disease (TVP)
  - Rheumatic
  - Carcinoid
  - I.E.
  - Trauma
  - Iatrogenic e.g. pacemakers, EMB
  - Tumours
- Functional (annular dilatation / normal leaflets)
  - RV volume overload lesions e.g. ASD, PR
  - PHT
    - 2^0 to Left heart disease
    - PAHT
  - RV infarct
  - ARVD
  - AF

Imaging the Tricuspid Valve Mechanism of Dysfunction

Carpentier's Classification

Type of Dysfunction	 Type I Normal leaflet motion	 Type II Leaflet prolapse	 Type III Restricted leaflet motion (a) Diastolic (b) Systolic
Anatomical Lesion	Annular dilatation Leaflet perforation	Chordal elongation Chordal rupture PM rupture	(a) Chordal fusion Chordal shortening Leaflet thickening Commissural fusion (b) Ventricular dilatation Ventricular aneurysm Leaflet entrapment

Carcinoid TV

Courtesy of Dr William Edwards
Mayo Clinic

Carcinoid Tricuspid Valve Disease

Carcinoid Tricuspid Valve Disease

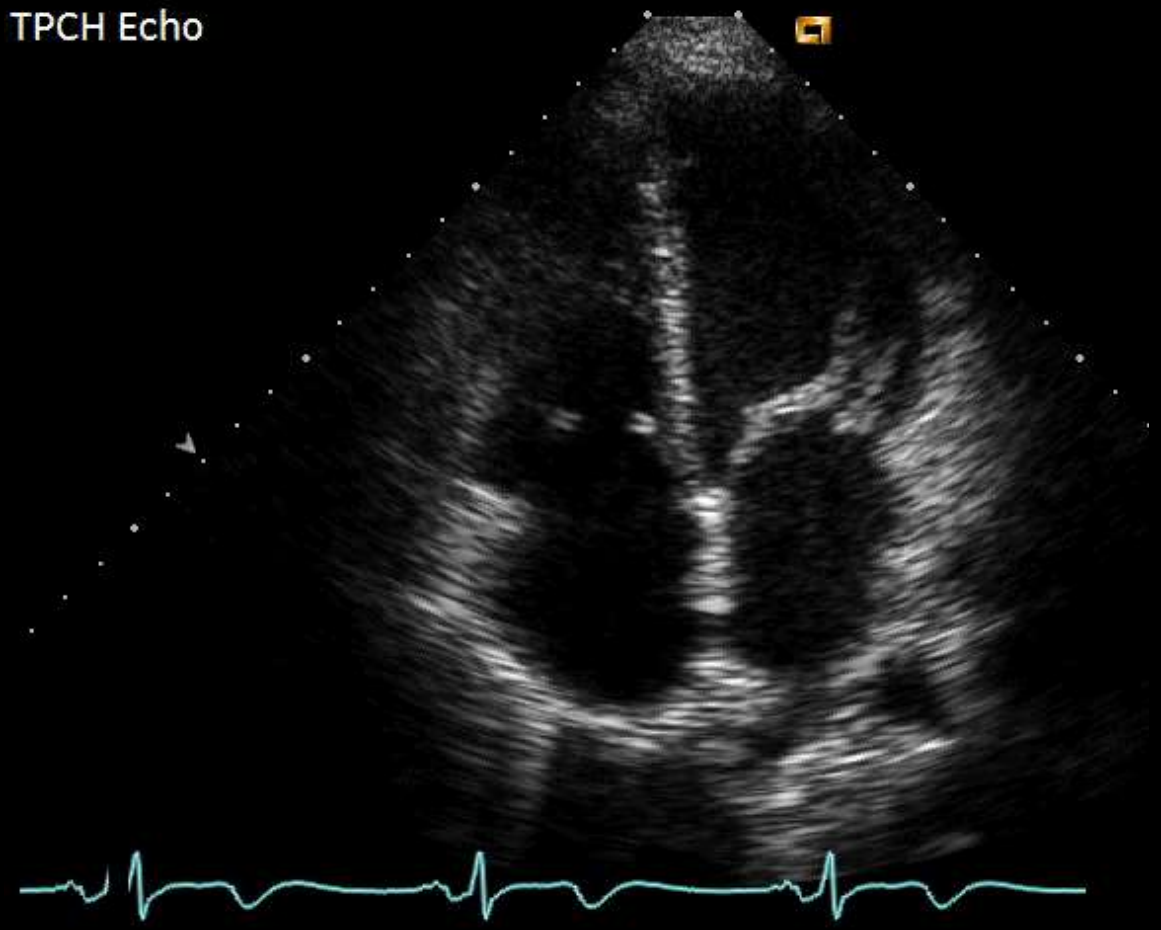
Carcinoid Tricuspid Disease

QUT

Carcinoid Tricuspid Disease

QUT

Rheumatic TS



- Rarely isolated
- Assoc. MS

Imaging the Tricuspid Valve Haemodynamics : Lesion severity (TS)

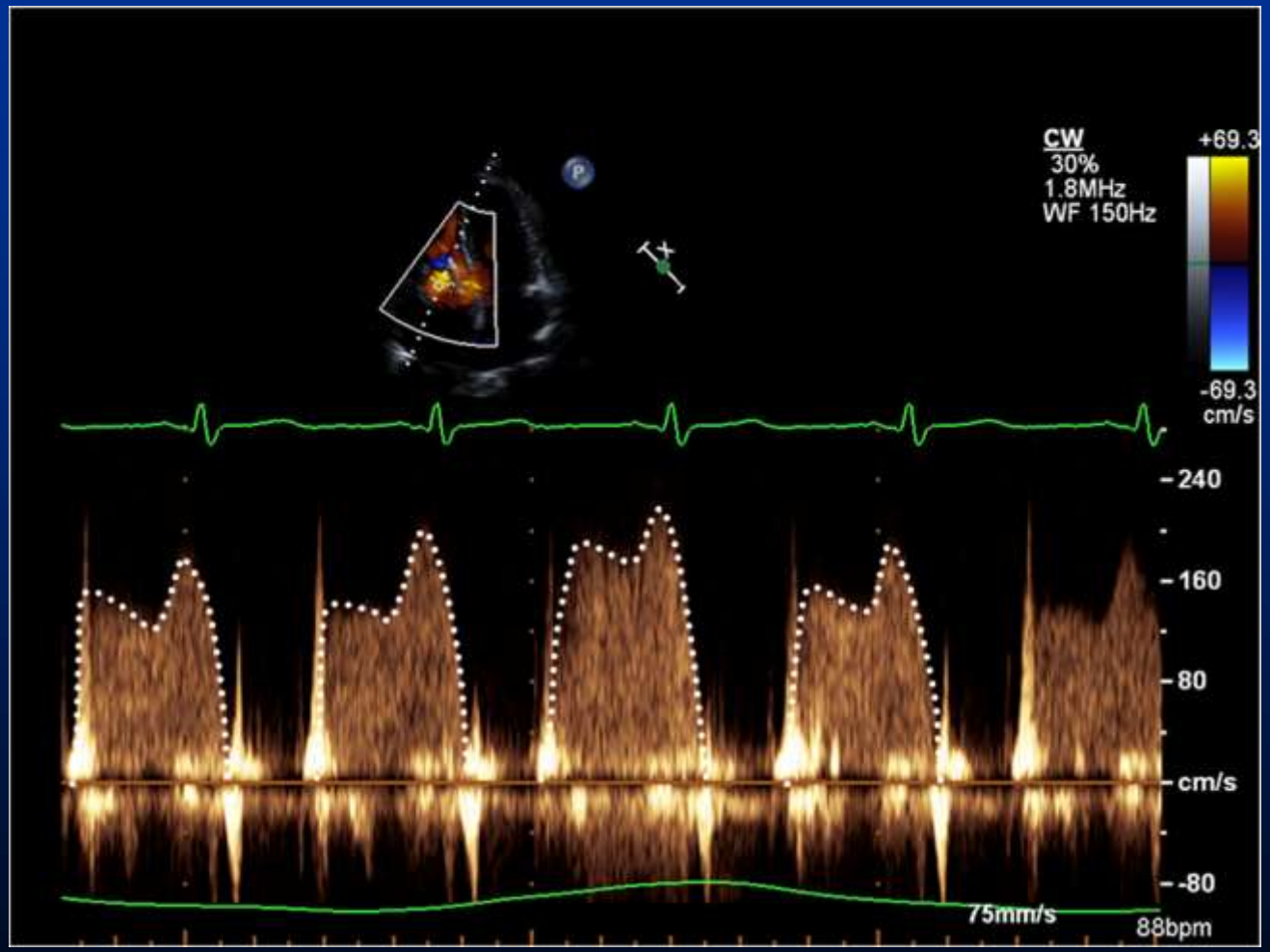
Echocardiographic Assessment of Valve Stenosis: EAE/ASE Recommendations for Clinical Practice

Helmut Baumgartner, MD,† Judy Hung, MD,‡ Javier Bermejo, MD, PhD,†
John B. Chambers, MD,† Arturo Evangelista, MD,† Brian P. Griffin, MD,‡ Bernard Iung, MD,†
Catherine M. Otto, MD,‡ Patricia A. Pellikka, MD,‡ and Miguel Quiñones, MD‡

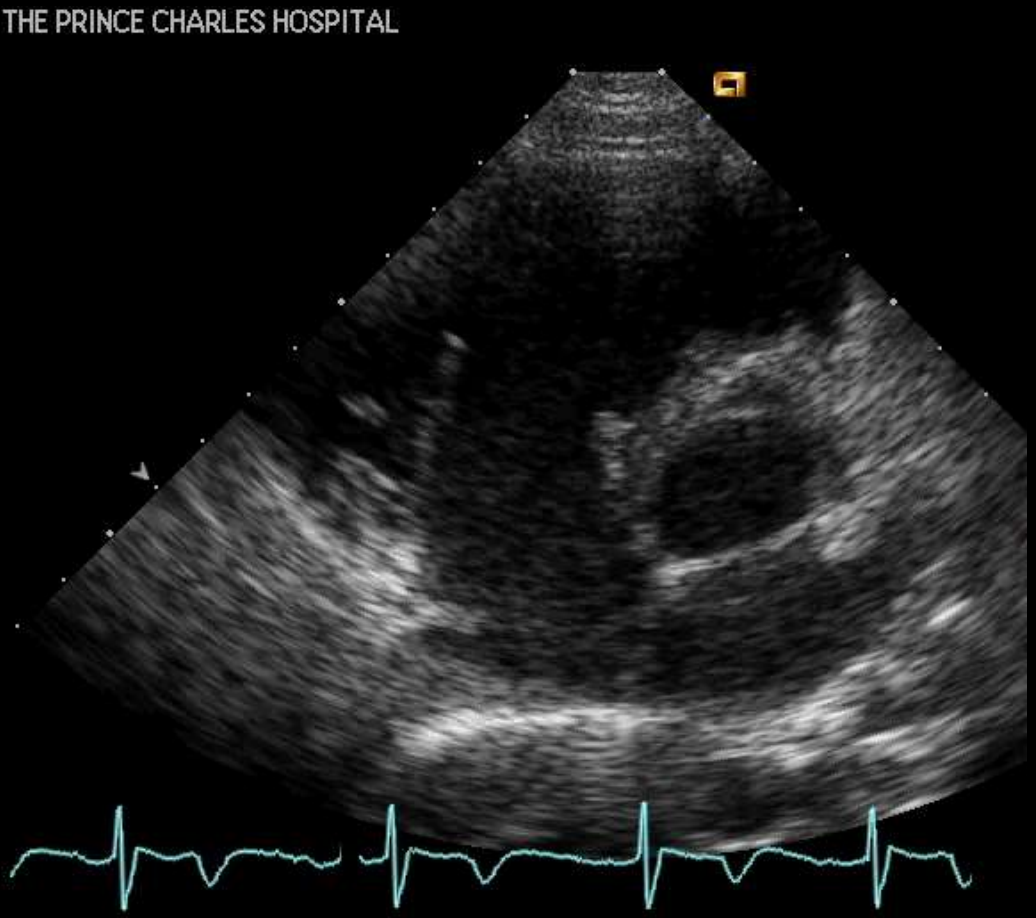
Specific findings	
Mean pressure gradient	≥5 mmHg
Inflow time–velocity integral	>60 cm
$T_{1/2}$	≥190 ms
Valve area by continuity equation[a]	≤1 cm^{2a}
Supportive findings	
Enlarged right atrium ≥moderate	
Dilated inferior vena cava	

J Am Soc Echo Vol 22, No 1. Jan 2009

Imaging the Tricuspid Valve
Haemodynamics : Tricuspid stenosis



Tricuspid Valve Prolapse

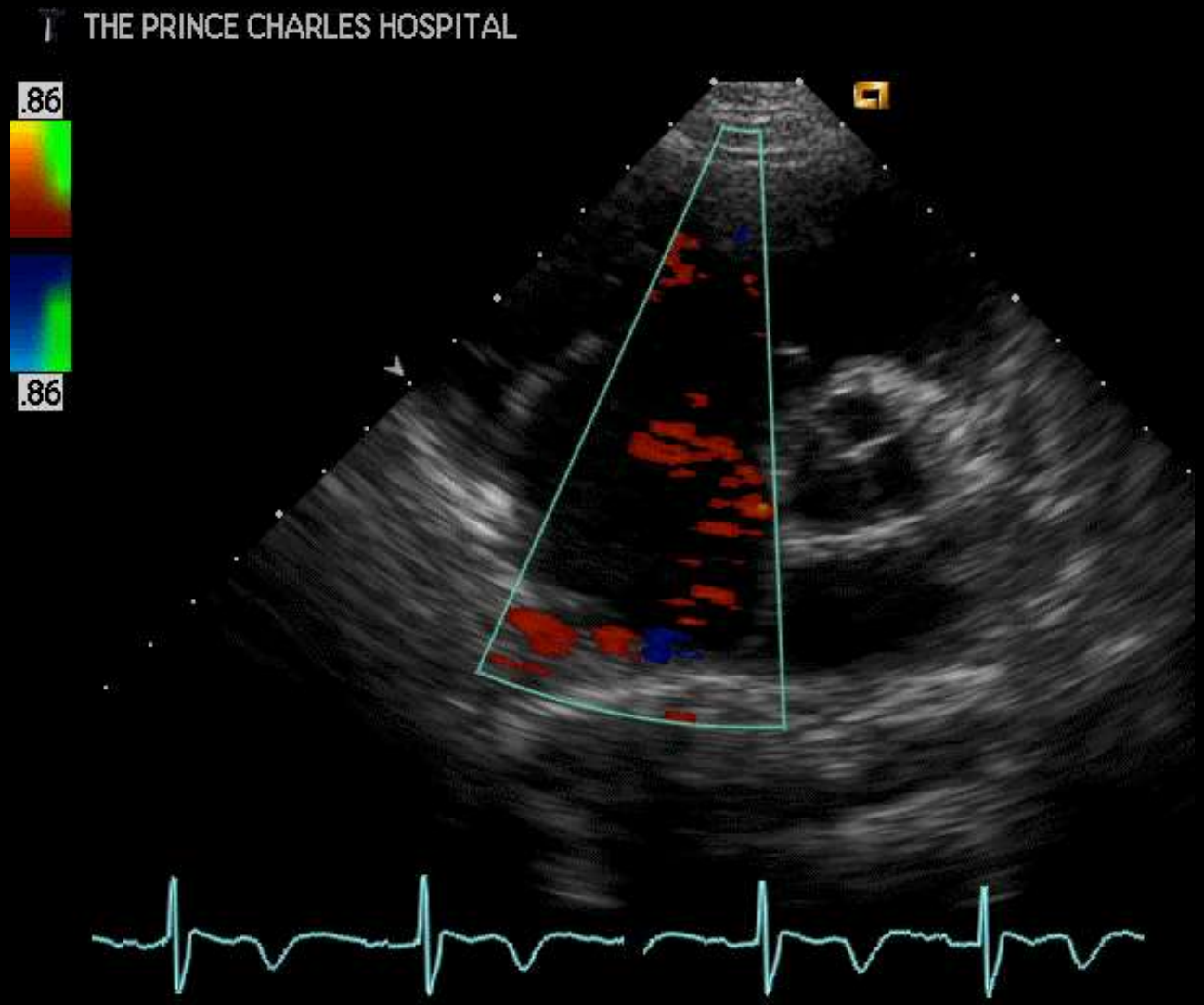


Primarily of anterior & septal leaflets

≈ 0.1 to 5.5 % of general population & ≈ 22 % of pts. with MVP

QUT

Tricuspid Valve Prolapse



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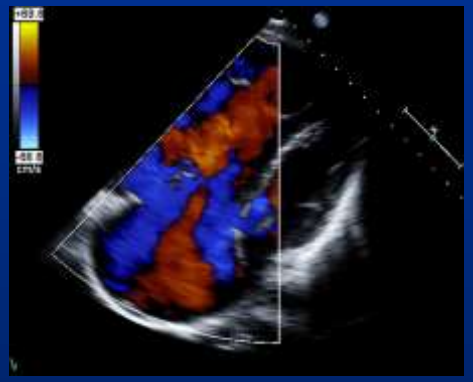
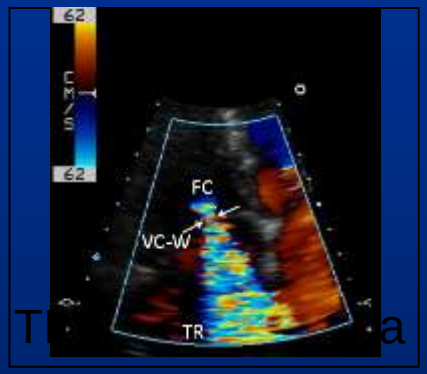
Imaging the Tricuspid Valve
Haemodynamics : Tricuspid regurgitation

Valve lesion

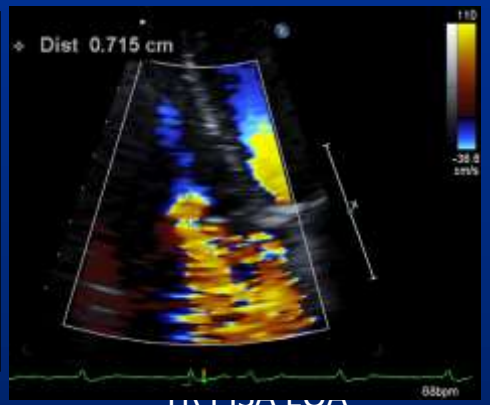
Valve anatomy



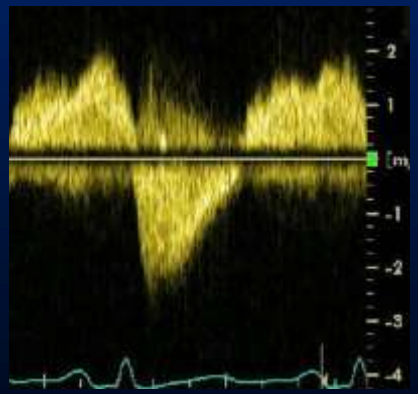
TR jet area CFI



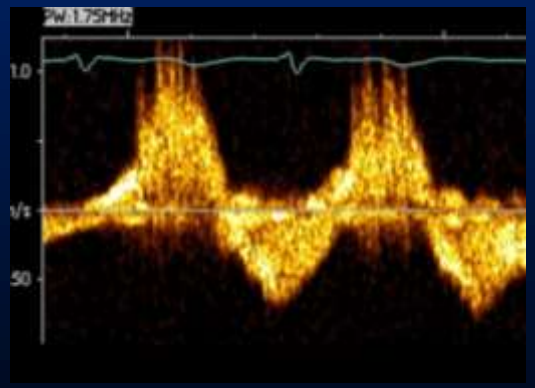
TR vena contracta



Haemodynamic cause (?PHT) and effects (?elevated RAP)



TR velocity & contour



Flow reversal HV

IVC size and reactivity

Imaging the Tricuspid Valve Haemodynamics : Lesion severity (TR)

Multi-parameter approach
TR severity grading

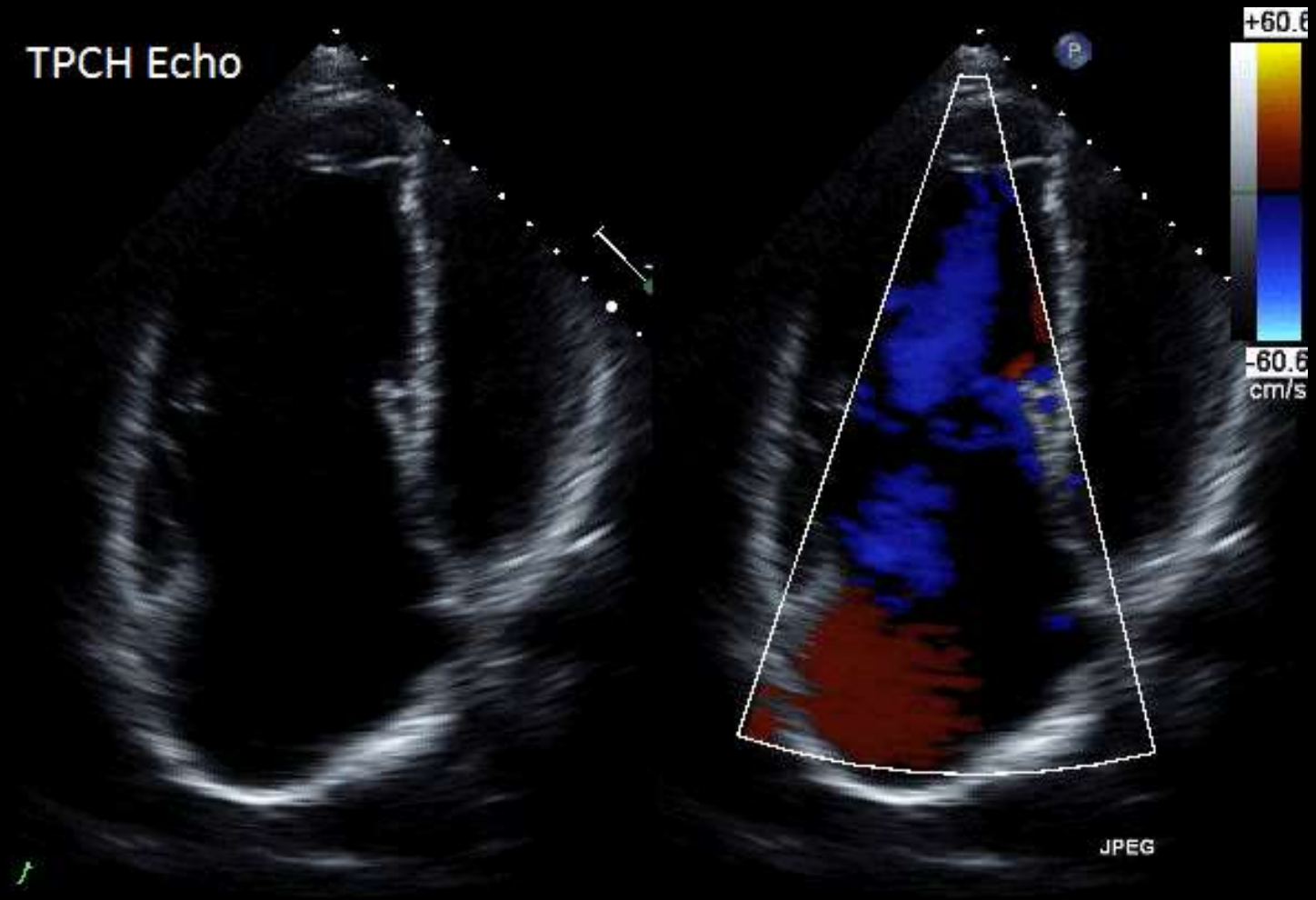
European Journal of Echocardiography (2010) 11, 307–332
doi:10.1093/ejechocard/jeq031

RECOMMENDATIONS

European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspid regurgitation (native valve disease)

Parameters	Mild	Moderate	Severe
Qualitative			
Tricuspid valve morphology	Normal/abnormal	Normal/abnormal	Abnormal/flail/large coaptation defect
Colour flow TR jet[a]	Small, central	Intermediate	Very large central jet or eccentric wall impinging jet
CW signal of TR jet	Faint/Parabolic	Dense/Parabolic	Dense/Triangular with early peaking (peak <2 m/s in massive TR)
Semi-quantitative			
VC width (mm)[a]	Not defined	<7	≥7
PISA radius (mm)[b]	≤5	6–9	>9
Hepatic vein flow[c]	Systolic dominance	Systolic blunting	Systolic flow reversal
Tricuspid inflow	Normal	Normal	*E* wave dominant (≥1 cm/s)[d]
Quantitative			
EROA (mm^2)	Not defined	Not defined	≥40
R Vol (mL)	Not defined	Not defined	≥45
+ RA/RV/IVC dimension[e]			

Ebstein's Anomaly



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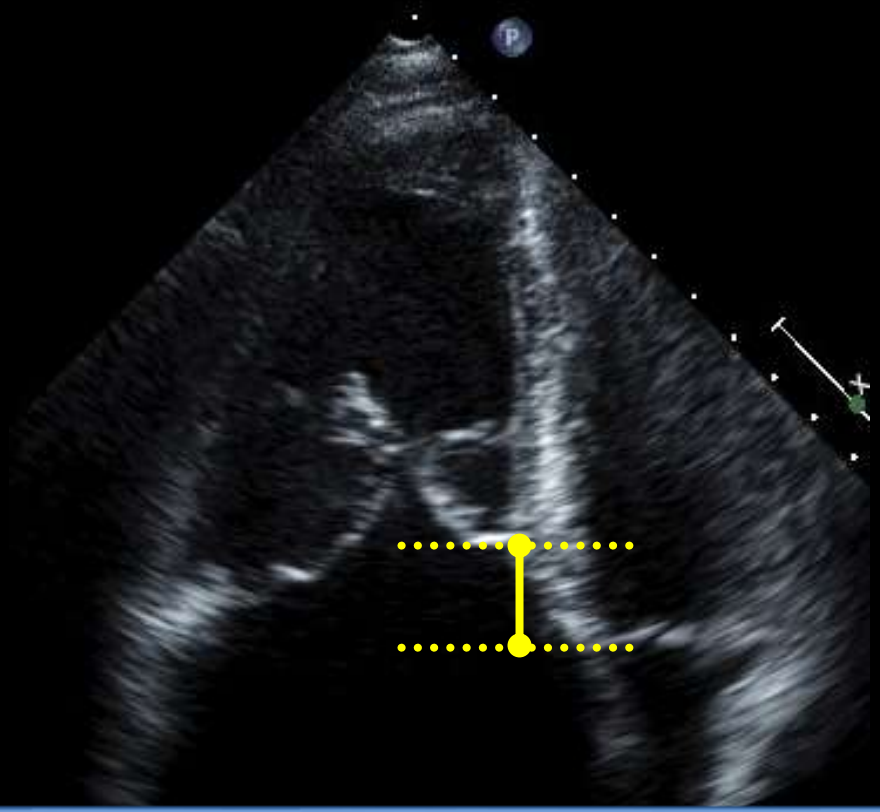
Ebstein's Anomaly



Diagnostic Criteria for Ebstein's:

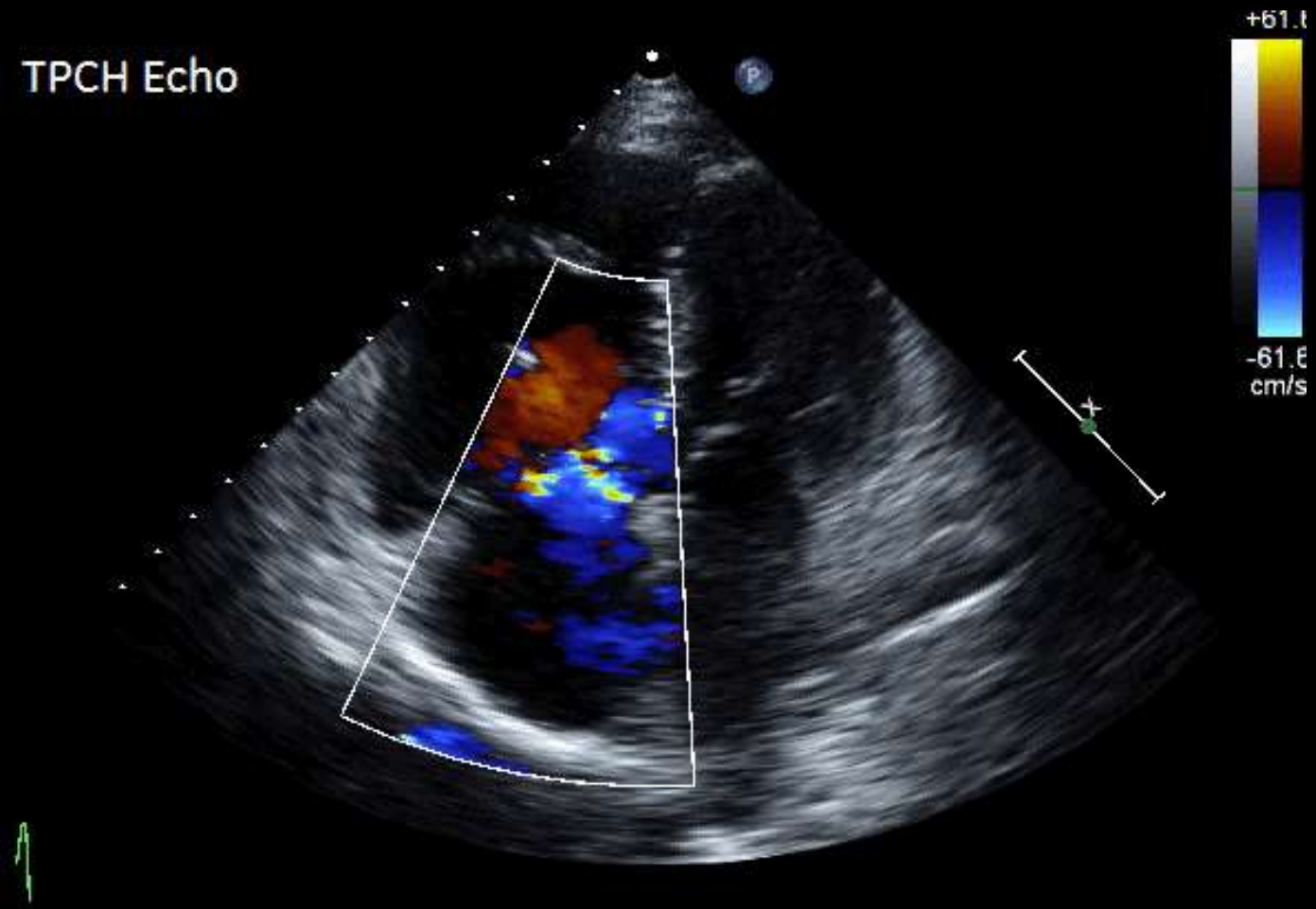
Displacement STVL > 20 mm or 8 mm/m^2

Oechslin, et al. Thorac Cardiovasc Surg 2000;48:209-13

Pulmonary Hypertension

QUT

Pulmonary Hypertension



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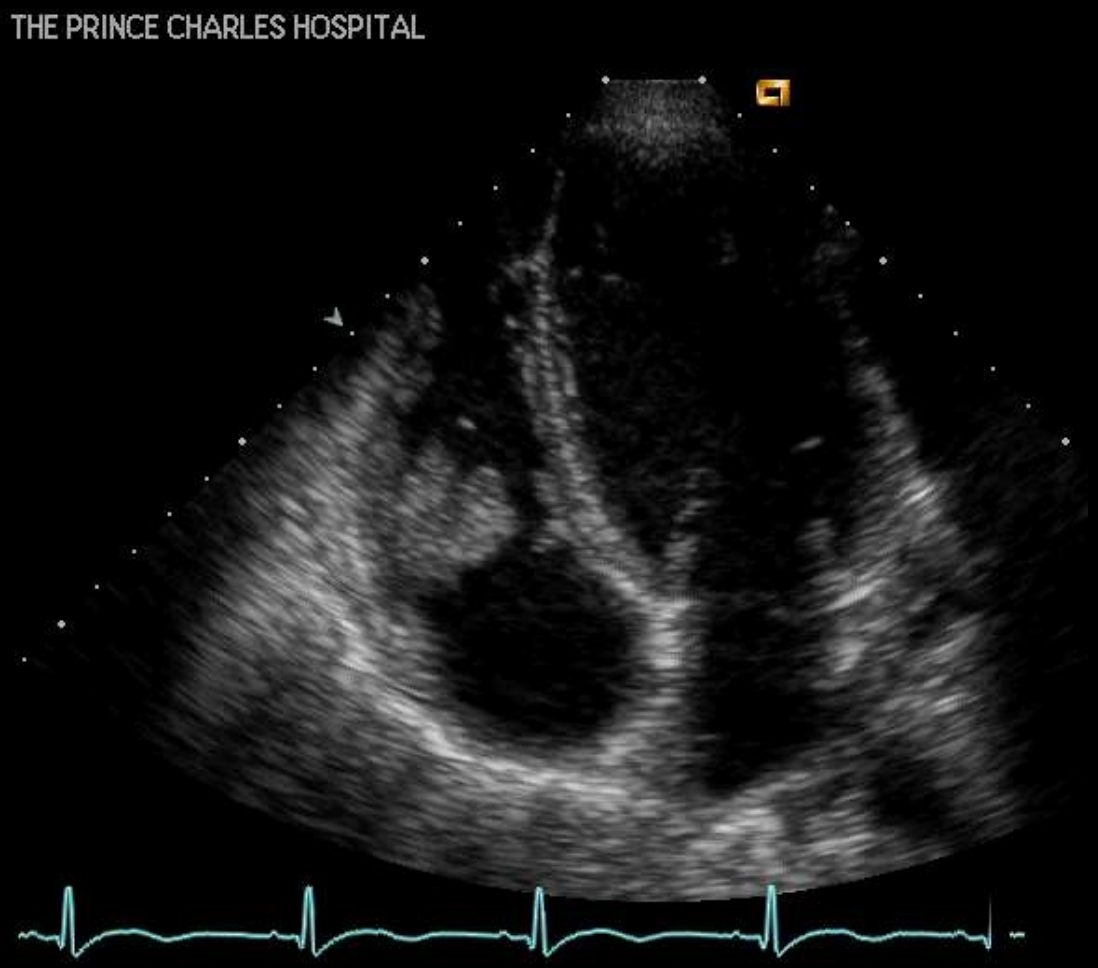
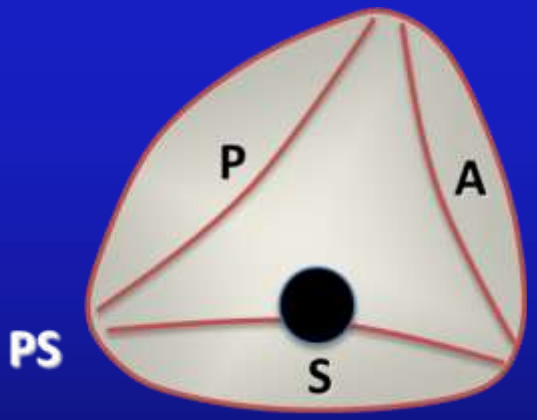
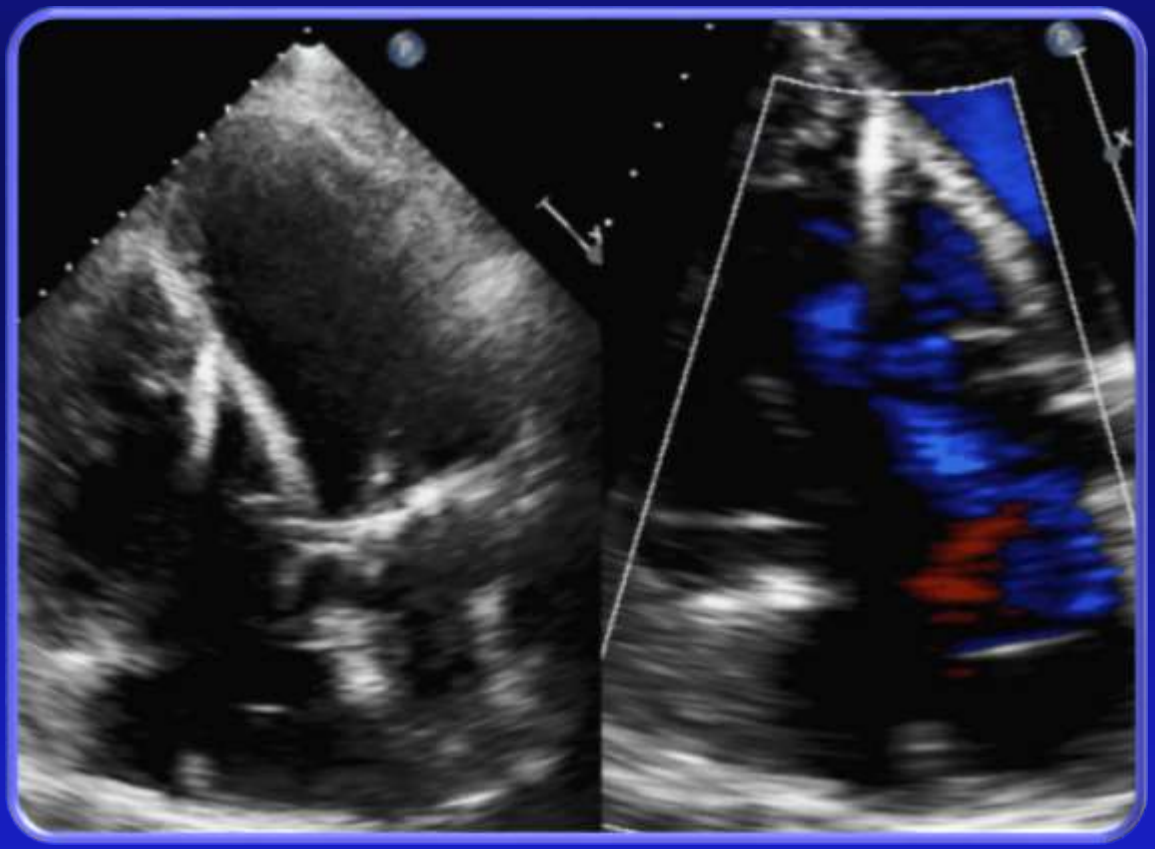
TV Vegetation

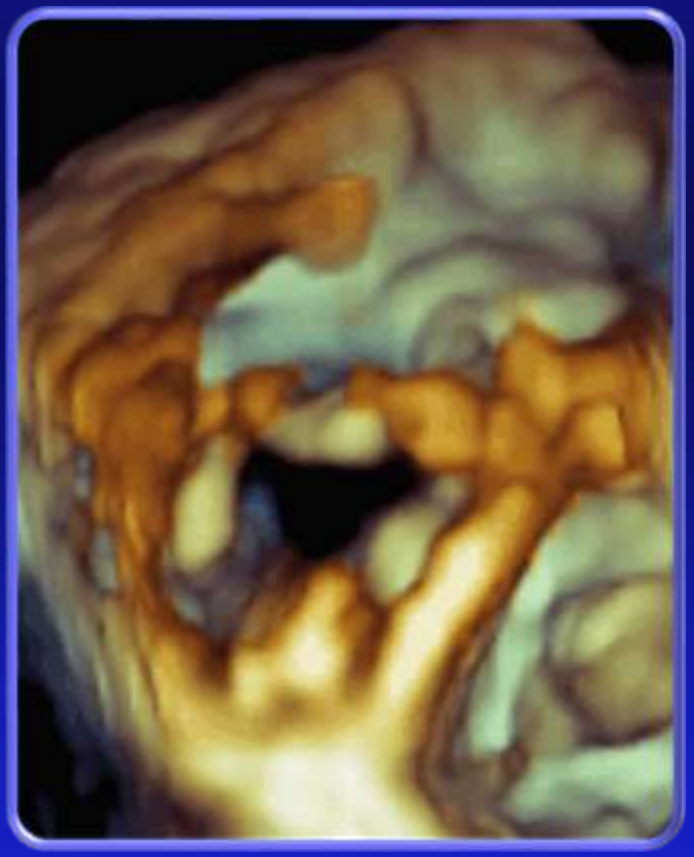


- When large – can cause obstruction to RV inflow
- Functional TS

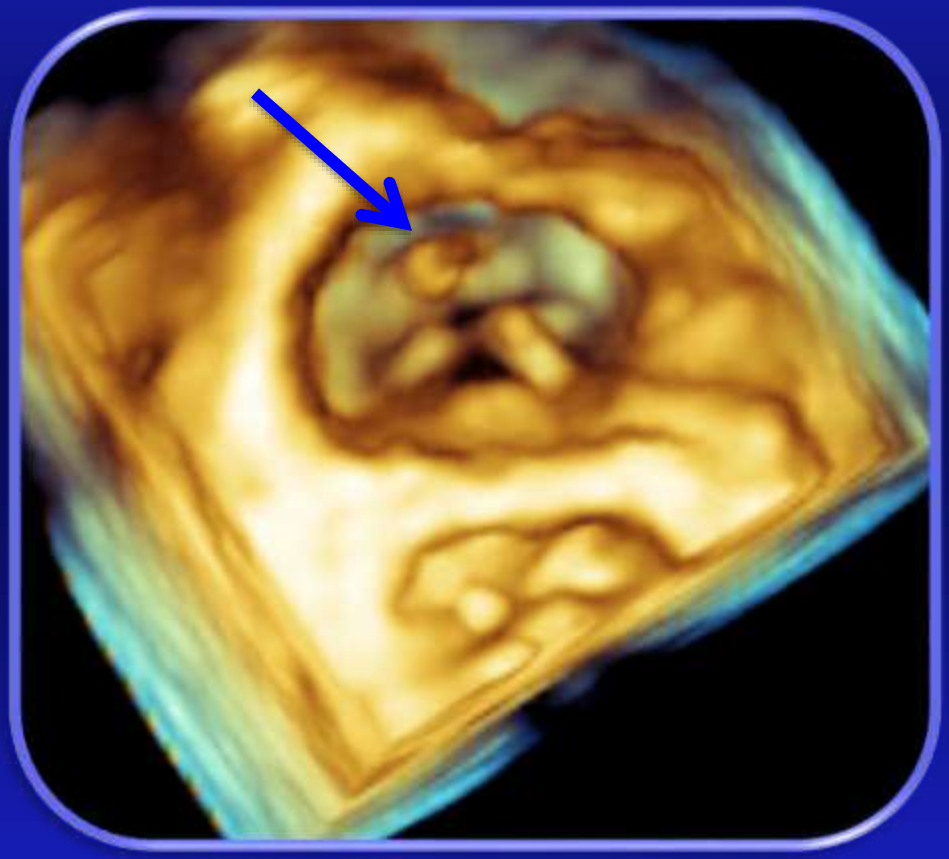
Pacemaker Lead Impingement



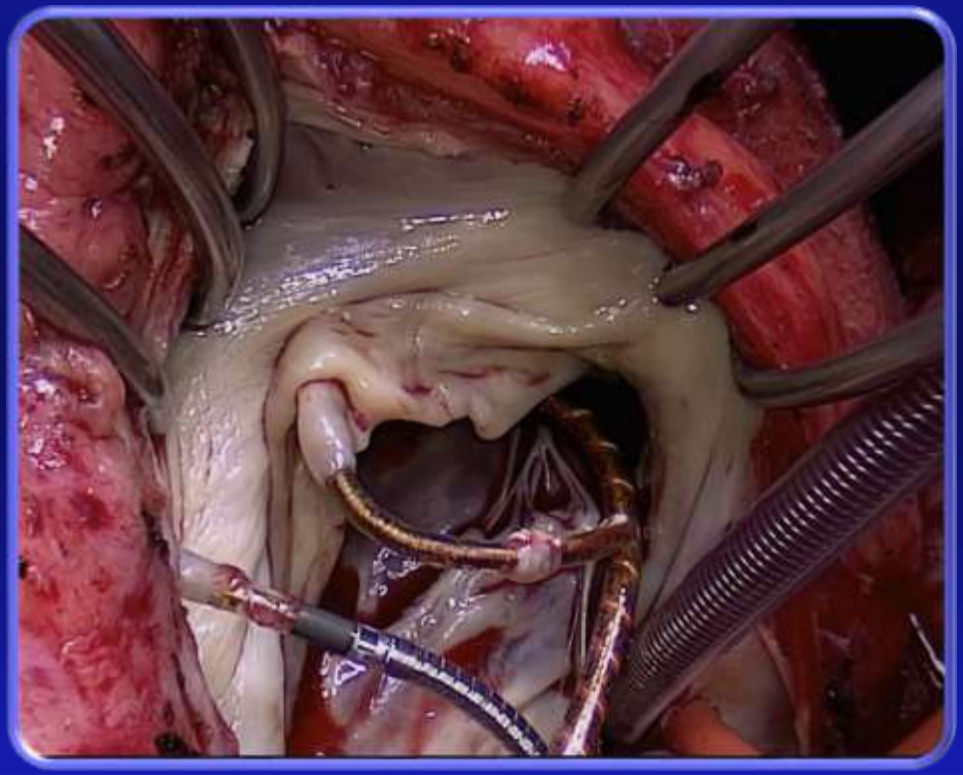


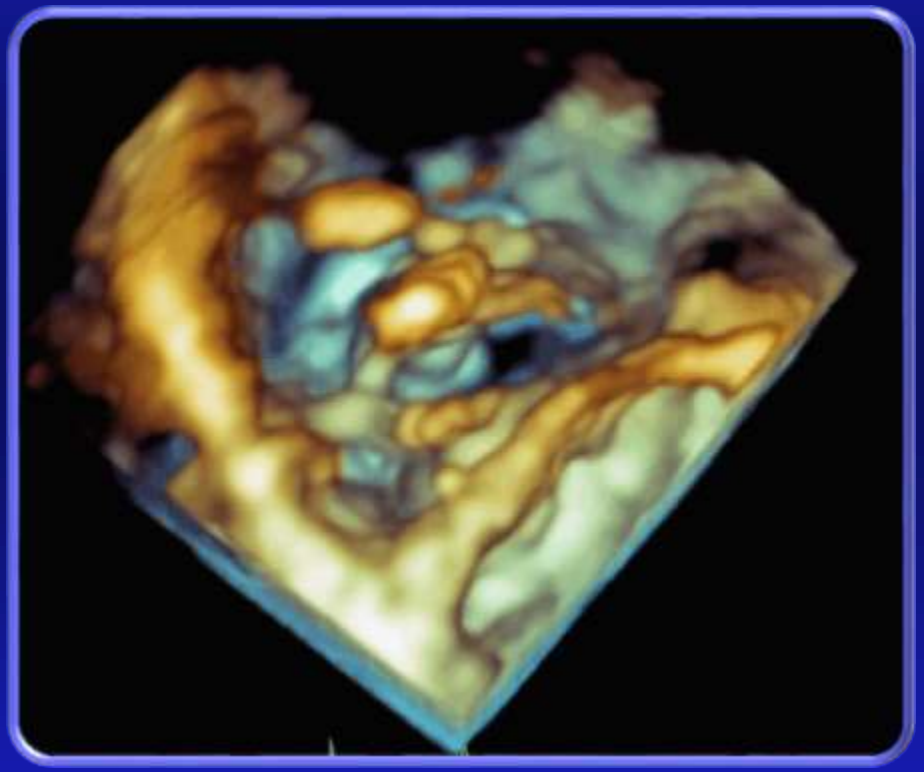


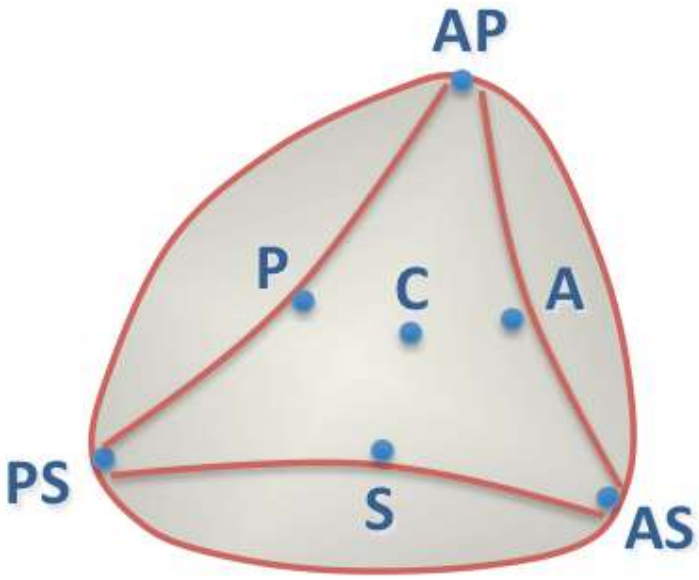
Posterior TV Leaflet Perforation



Pacemaker Lead Impingement



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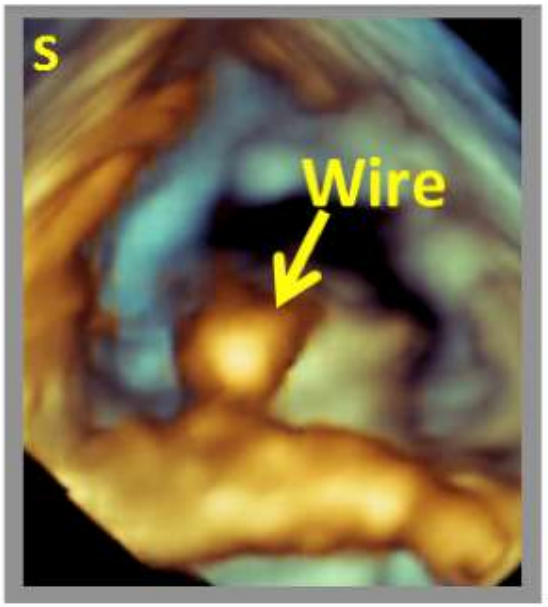
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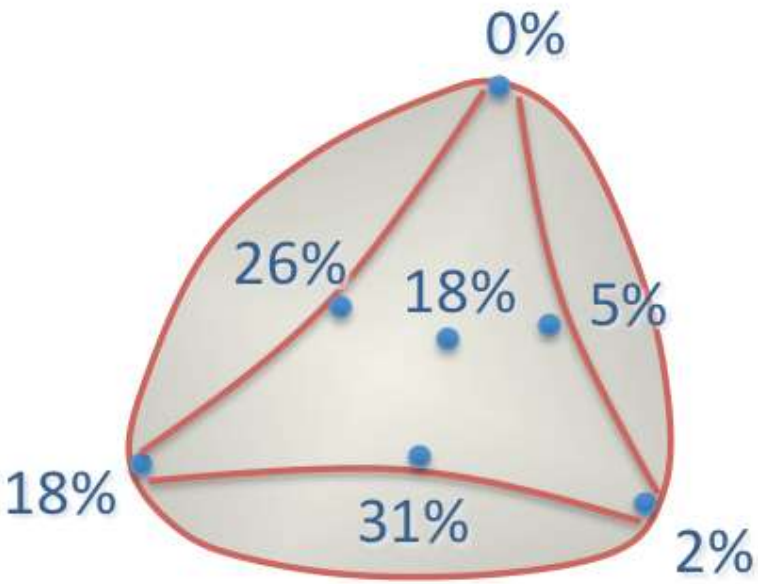
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PS
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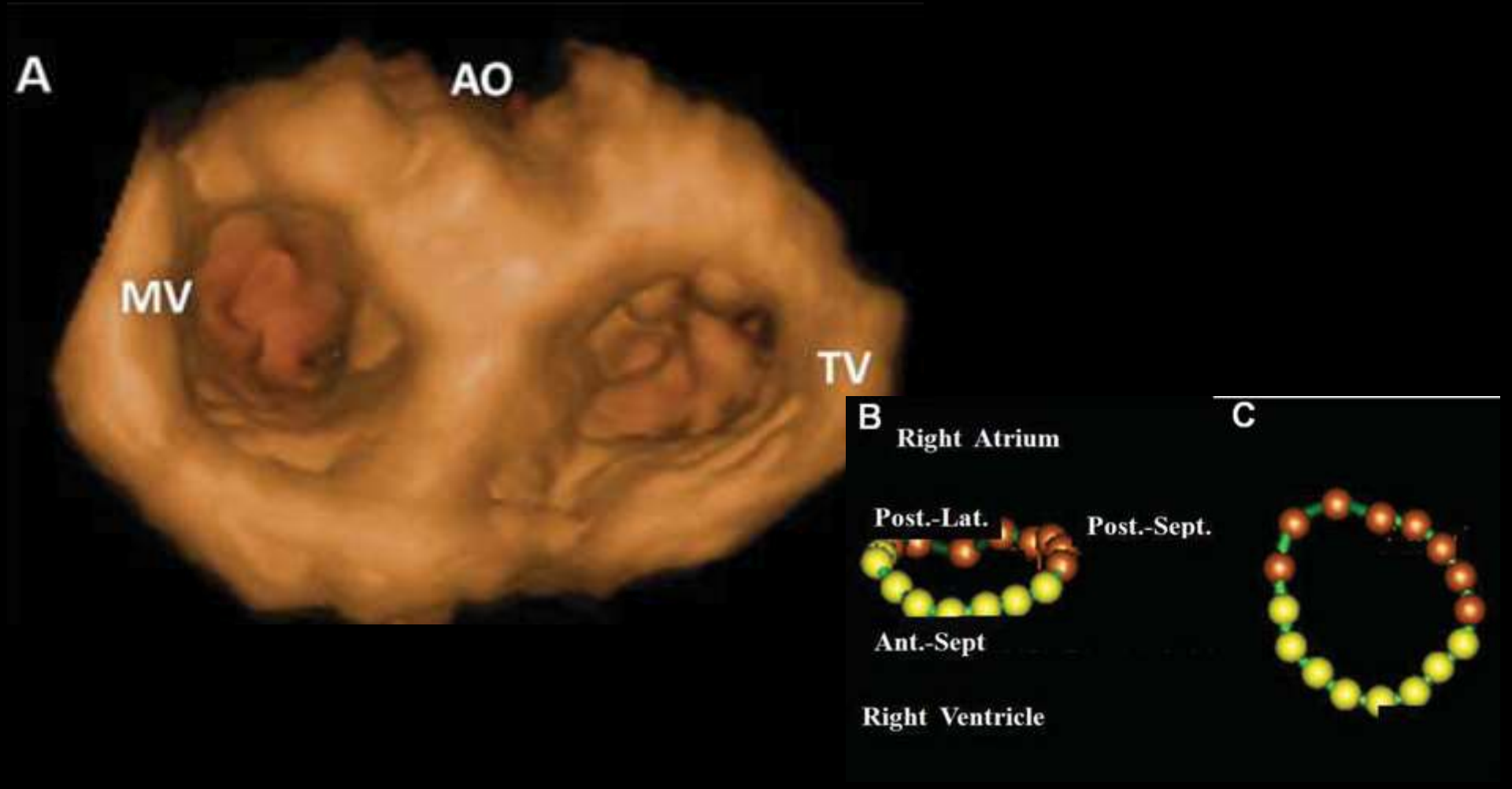
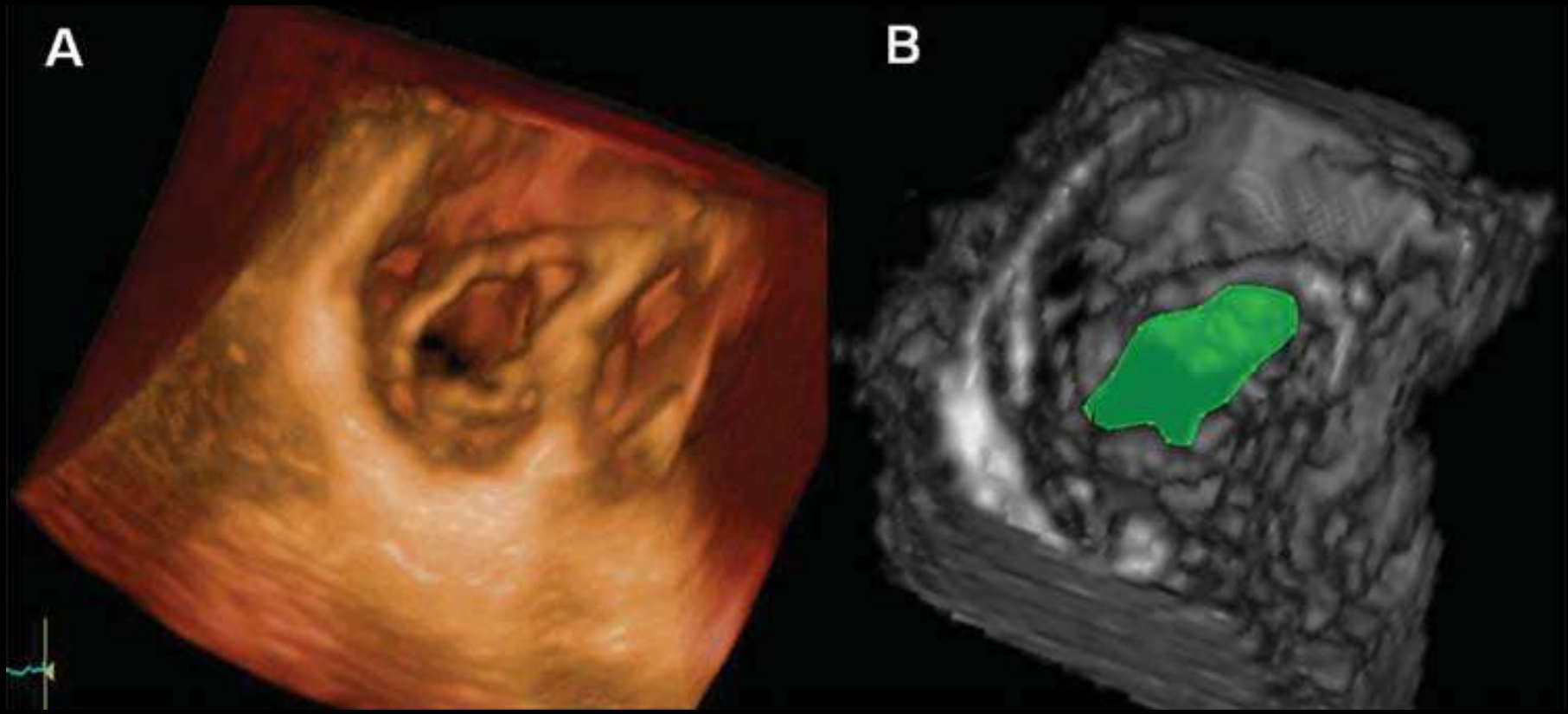
3D anatomy



Evaluation of the tricuspid valve morphology and function by transthoracic real-time three-dimensional echocardiography. Luigi P. Badano1*, Eustachio Agricola2, Leopoldo Perez de Isla3, Pasquale Gianfagna1, and Jose Louis Zamorano. European Journal of Echocardiography (2009) 10, 477–484

Tricspid 3D from below



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When to intervene

Table 16 Indications for tricuspid valve surgery

	Class [a]	Level [b]
Surgery is indicated in symptomatic patients with severe TS.[c]	I	C
Surgery is indicated in patients with severe TS undergoing left-sided valve intervention.[c]	I	C
Surgery is indicated in patients with severe primary or secondary TR undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated primary TR without severe right ventricular dysfunction.	I	C
Surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in patients with mild or moderate secondary TR with dilated annulus (≥40 mm or >21 mm/m²) undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in asymptomatic or mildly symptomatic patients with severe isolated primary TR and progressive right ventricular dilatation or deterioration of right ventricular function.	IIa	C
After left-sided valve surgery, surgery should be considered in patients with severe TR who are symptomatic or have progressive right ventricular dilatation/dysfunction, *in the absence* of left-sided valve dysfunction, severe right or left ventricular dysfunction, and severe pulmonary vascular disease.	IIa	C

When to intervene

Tricuspid Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with TS to assess the anatomy of the valve complex, evaluate severity of stenosis, and characterize any associated regurgitation and/or left-sided valve disease	I	C
Invasive hemodynamic assessment of severity of TS may be considered in symptomatic patients when clinical and noninvasive data are discordant	IIb	C

When to intervene

Tricuspid Stenosis: Intervention

Recommendations	COR	LOE
Tricuspid valve surgery is recommended for patients with severe TS at the time of operation for left-sided valve disease	I	C
Tricuspid valve surgery is recommended for patients with isolated, symptomatic severe TS	I	C
Percutaneous balloon tricuspid commissurotomy might be considered in patients with isolated, symptomatic severe TS without accompanying TR	IIb	C

When to intervene

Stages of Tricuspid Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D	**Symptomatic severe TR**	**Primary** • Flail or grossly distorted leaflets **Functional** • Severe annular dilation (>40 mm or >21 mm/m^2) • Marked leaflet tethering	• Central jet area >10 cm^2 • Vena contracta width >0.70 cm • CW jet density and contour: dense, triangular with early peak • Hepatic vein flow: systolic reversal	• RV/RA/IVC dilated with decreased IVC respirophasic variation • Elevation RA pressure with "c-V" wave • Diastolic interventricular septal flattening • Reduced RV systolic function in late phase	• Fatigue, palpitations, dyspnea, abdominal bloating, anorexia, edema

When to intervene

Tricuspid Regurgitation: Intervention

Recommendations	COR	LOE
Tricuspid valve surgery is recommended for patients with severe TR (stages C and D) undergoing left-sided valve surgery	I	C
Tricuspid valve repair can be beneficial for patients with mild, moderate, or greater functional TR (stage B) at the time of left-sided valve surgery with either 1) tricuspid annular dilation or 2) prior evidence of right HF	IIa	B
Tricuspid valve surgery can be beneficial for patients with symptoms due to severe primary TR that are unresponsive to medical therapy (stage D)	IIa	C

When to intervene

Tricuspid Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Tricuspid valve repair may be considered for patients with moderate functional TR (stage B) and pulmonary artery hypertension at the time of left-sided valve surgery	IIb	C
Tricuspid valve surgery may be considered for asymptomatic or minimally symptomatic patients with severe primary TR (stage C) and progressive degrees of moderate or greater RV dilation and/or systolic dysfunction	IIb	C

When to intervene

Tricuspid Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Reoperation for isolated tricuspid valve repair or replacement may be considered for persistent symptoms due to severe TR (stage D) in patients who have undergone previous left-sided valve surgery and who do not have severe pulmonary hypertension or significant RV systolic dysfunction	IIb	C

When to intervene