



ECOCARDIOCHIRURGIA.it

Milano, 28 Febbraio 2013

Ecocardiografia: cosa, dove e come misurare

Troppi ecocardiogrammi ancora eseguiti senza metodo....

Emanuele Catena

Anche un esame il cui esito potrebbe essere sintetizzato nel commento come

“esame normale”,

non può prescindere dal riportare, se tecnicamente misurabili, un set minimo di parametri che permettano di verificare la completezza e la accuratezza dell'esame.

Elementi indispensabili in ogni referto ecocardiogramma bidimensionale color Doppler

- Dati generali
- Dimensioni delle camere sinistre
- Spessori di parete del ventricolo sinistro e massa miocardica
- Frazione di eiezione del VS
- Descrizione della cinetica regionale del VS
- Valutazione degli apparati valvolari
- Dimensioni dell'aorta ascendente
- Analisi del flusso di riempimento del VS
- Dimensioni atrio sinistro e destro
- Descrizione della funzione del ventricolo destro

Valutazione degli apparati valvolari

1. Descrizione anatomica dell'apparato valvolare
2. Meccanismo anatomo-funzionale
3. Valutazione dell'entità del vizio valvolare
4. Valutazione del peso emodinamico

Apparati valvolari: insufficienza mitralica

Ruolo dell'ecocardiografia:

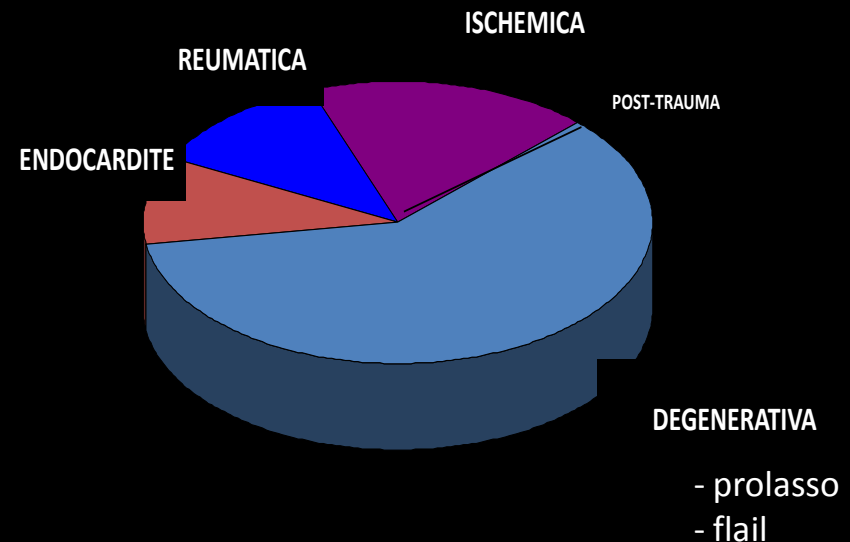
Rilievo dell'insufficienza

1. **Descrizione anatomica** dell'apparato valvolare (deg. mixomatosa, fibroelastica, neoformazioni)
2. **Meccanismo anatomo funzionale** dell'insufficienza (flail, prolasso, retrazione, studio anello)
3. Valutazione dell'**entità del rigurgito** (VC, ERO, studio jet,...)
4. valutazione del **peso emodinamico**:
 - dimensioni VS
 - FE
 - dimensioni atrio sinistro
 - PAP e funzione VD

"Peso clinico"



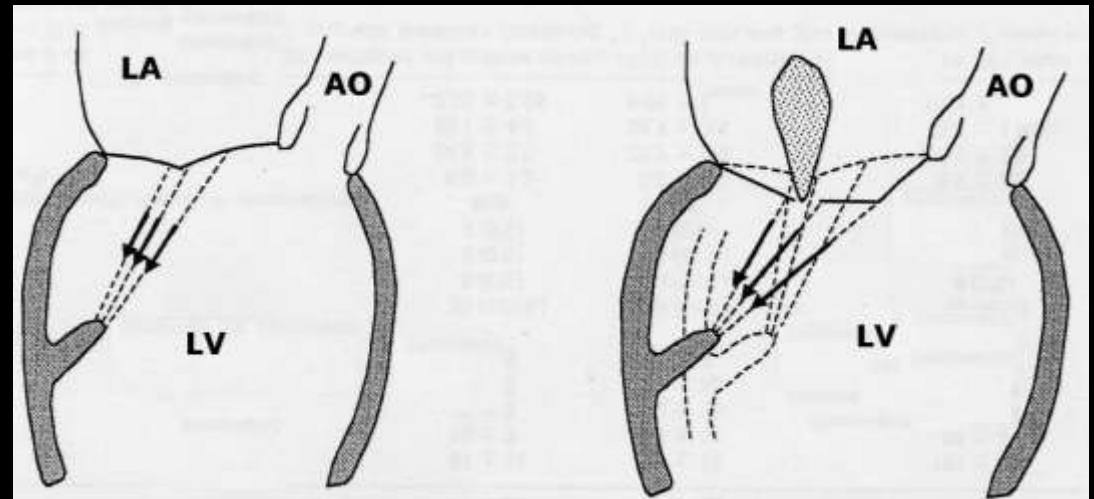
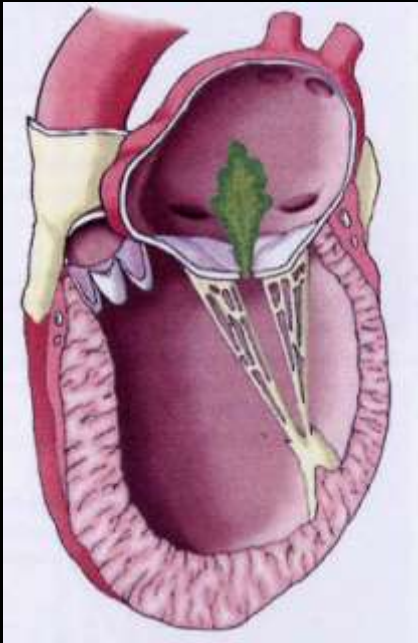
Insufficienza mitralica



Identificare i pazienti che richiedono un percorso differenziato rispetto a quelli con IM non significativa

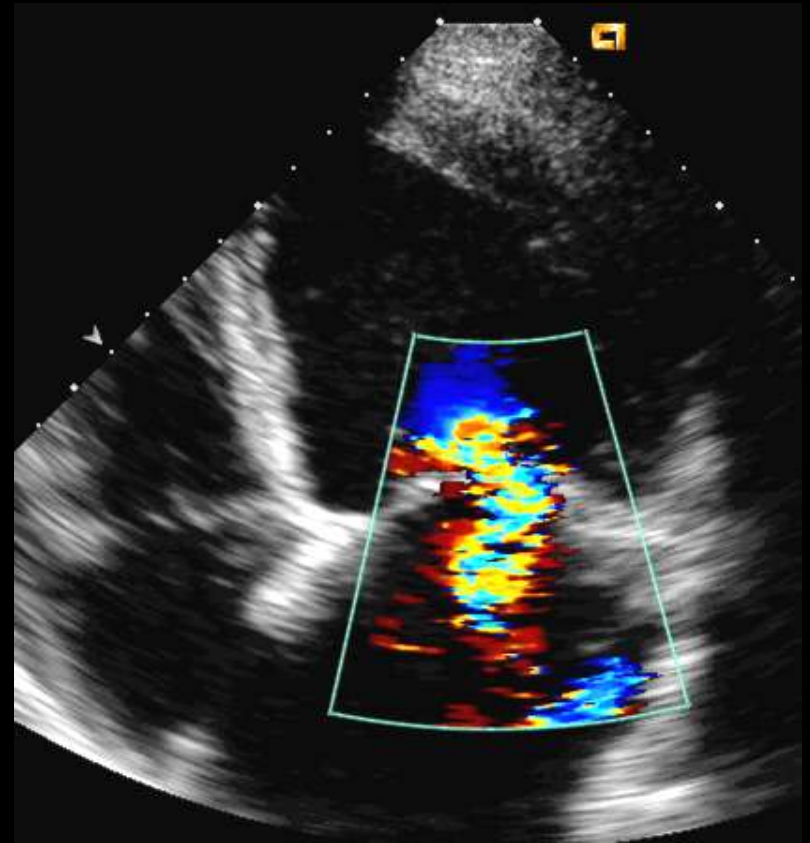
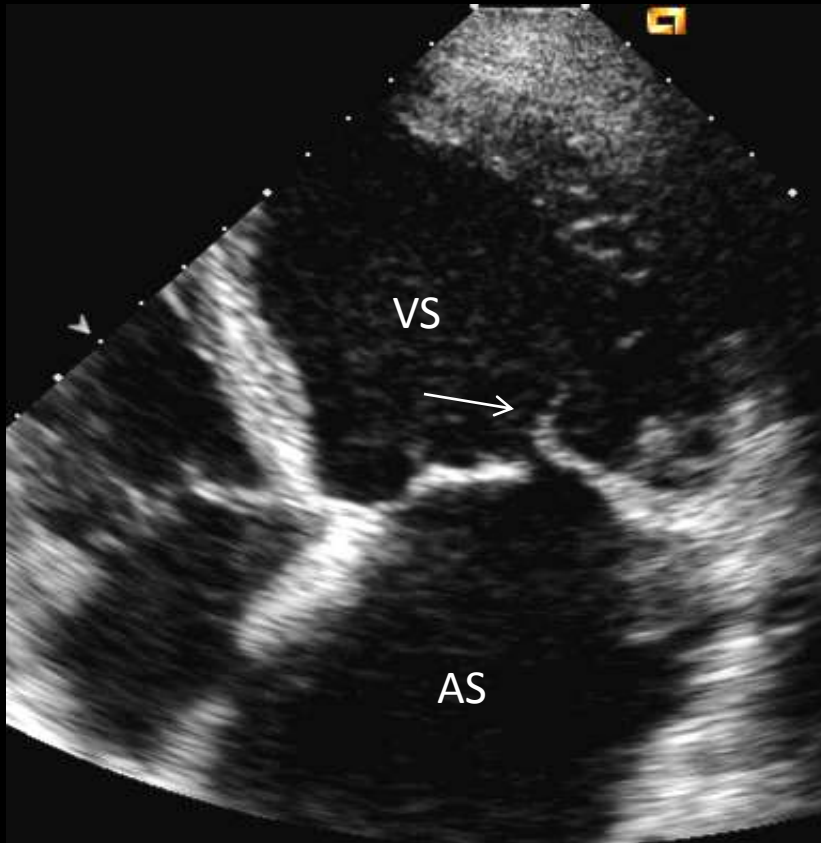
Insufficienza mitralica ischemica

(lambi mitralici anatomicamente normali)

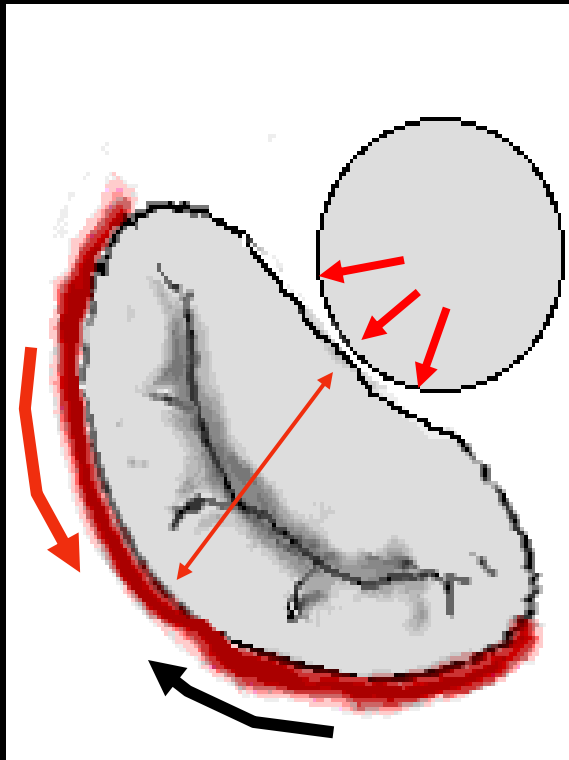


La IM ischemica è da considerare un epifenomeno della malattia del VS, correlato alla presenza di rimodellamento locale o globale del ventricolo con dislocazione apicale del punto di coaptazione del tessuto valvolare mitralico.

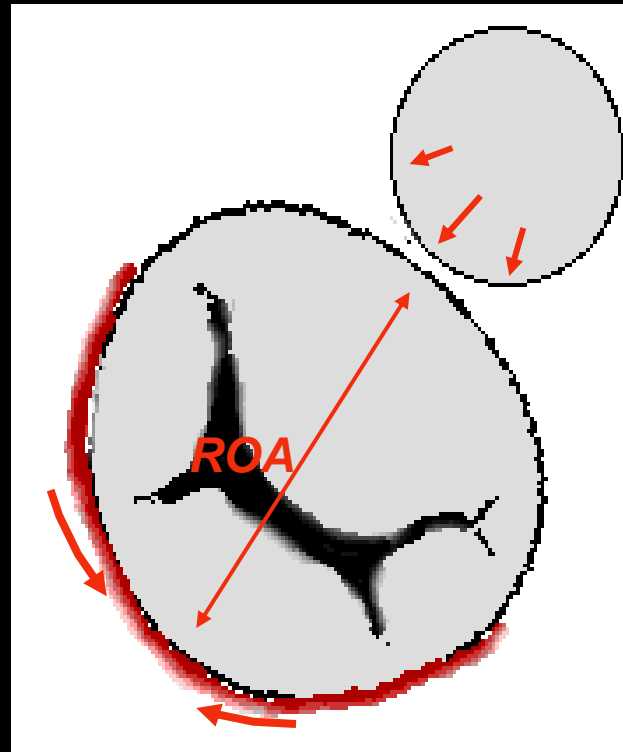
Insufficienza mitralica ischemica: restrizione del movimento del lembo posteriore della mitrale



Mechanisms of annular dilatation in Functional MR



Normal

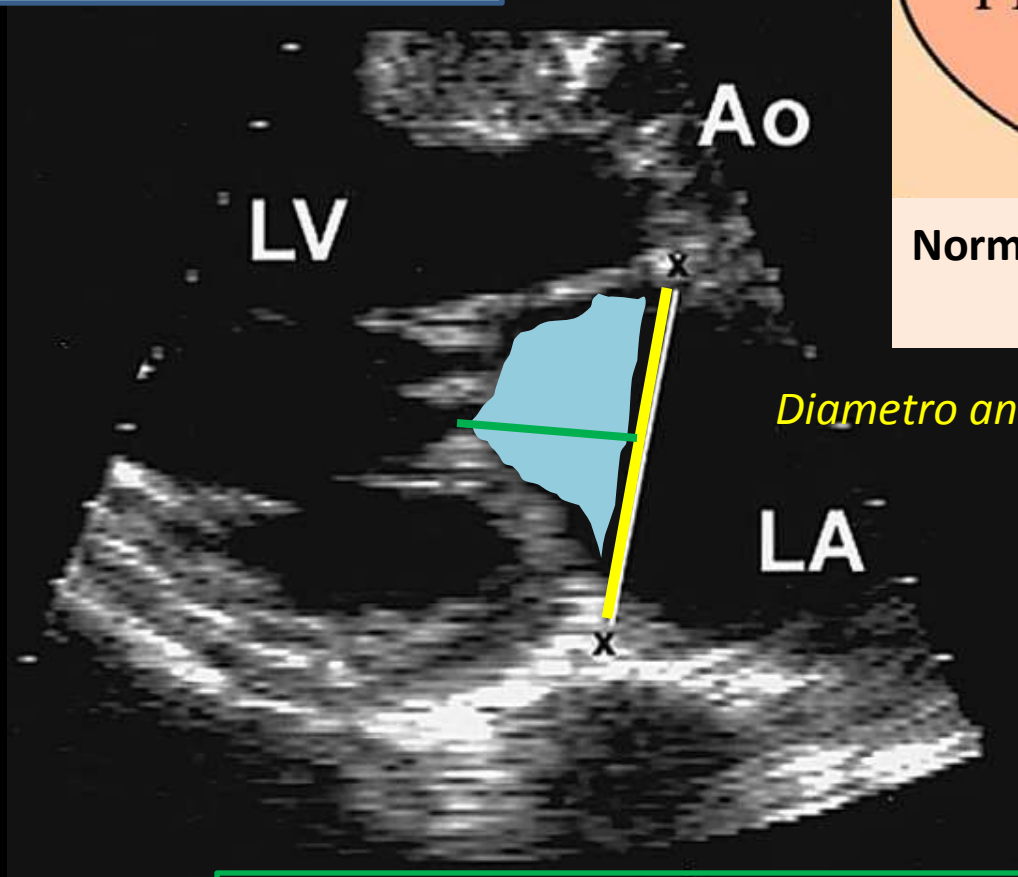


Functional MR

- **Increased Sep-lat diameter**
- **Loss of systolic annular contraction**
- **Reduced systolic aortic expansion**
- **Reduced saddle-shape configuration**

“tenting area” definita dall’area di malapposizione dei lembi al di sotto del piano dell’anello.

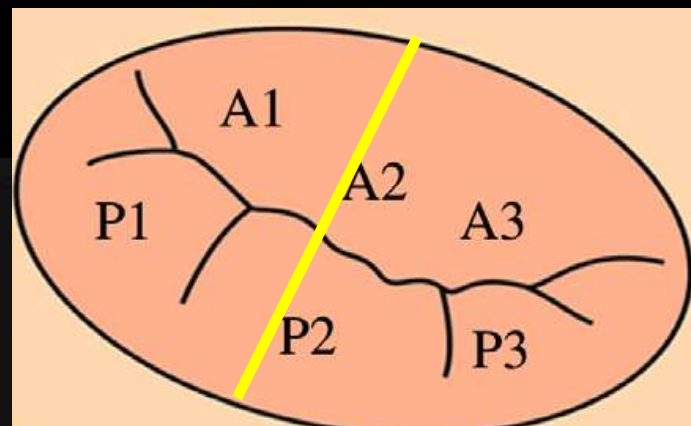
VN: 0.8 cm²



Diametro antero-posteriore

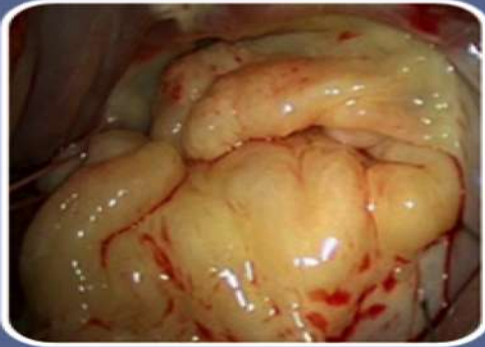
Normale: ≤ 3.0 cm
 $\leq 1.7 - 1.8$ cm/m²

Distanza di coaptazione tra il piano anulare e il punto di coaptazione. **VN: 0.5 cm**



Mitrale degenerativa: caratterizzazione valvola

(descrizione anatomica della valvola)



Myxomatous degeneration

- Middle aged pt, long-lasting history of MR
- Excess tissue
- Myxoid appearance
- Annular dilatation
- Chordae thickened
- Diffuse type II lesions



Fibroelastic Deficiency

- Elderly pt, recent onset MR
- No excess tissue
- Thickening of prolapsing area, remaining valve thinner and transparent
- Mild annular dilatation
- Chordae thinner
- Segmental lesions



(riparazione difficile)

Insufficienza mitralica degenerativa

(meccanismo del rigurgito)



Prolapse of thin posterior leaflet.



Prolapse with myxomatous disease



Flail of the posterior leaflet



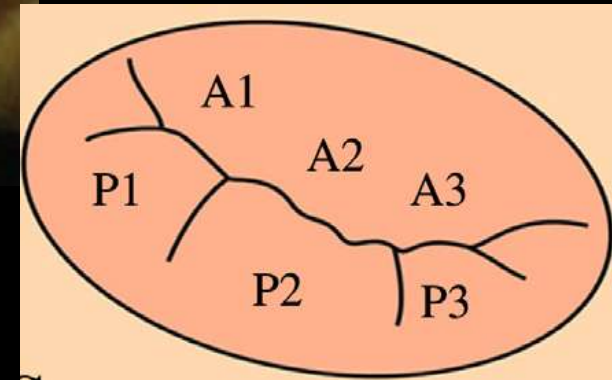
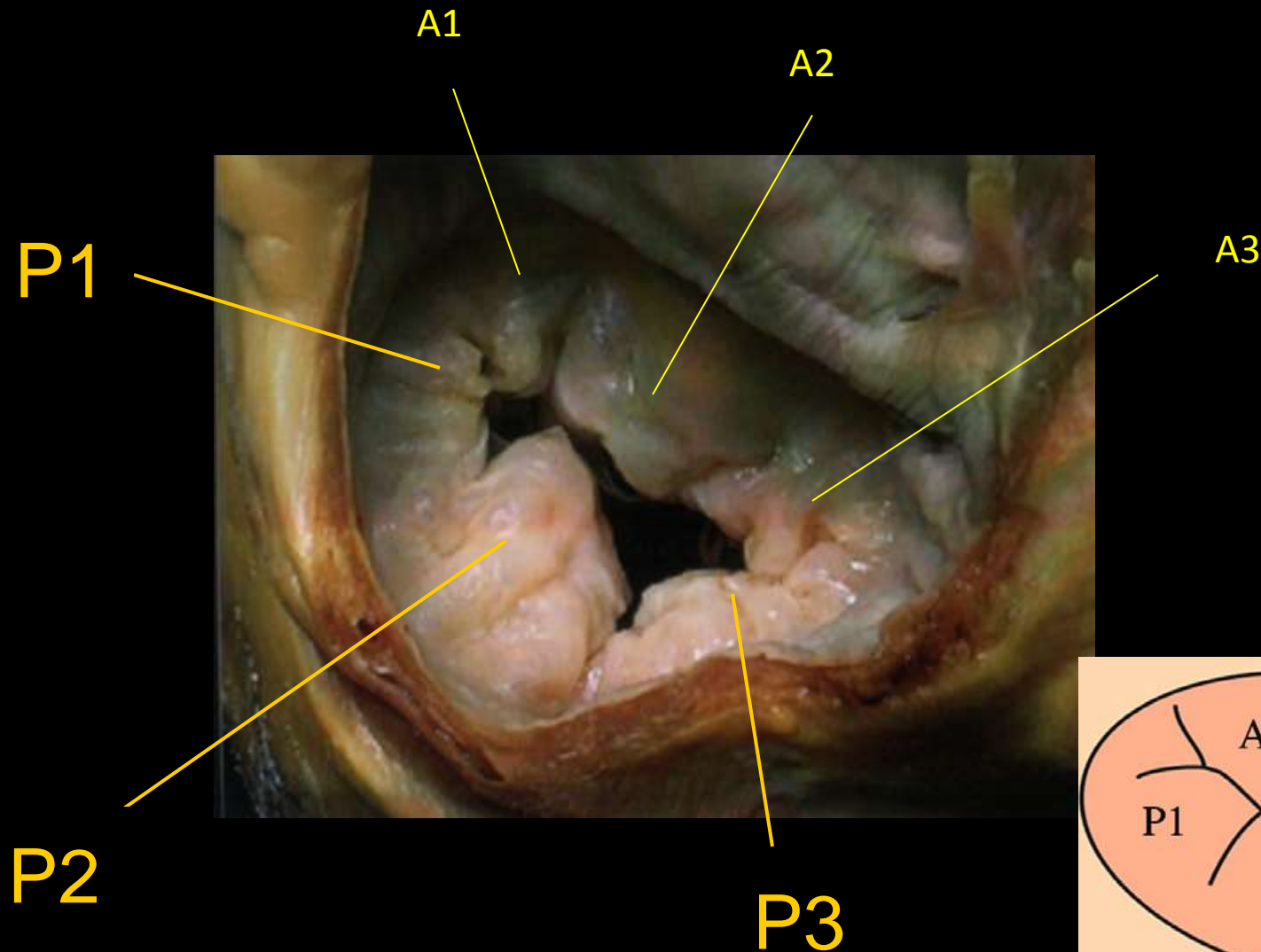
Focal calcification of the anterior leaflet

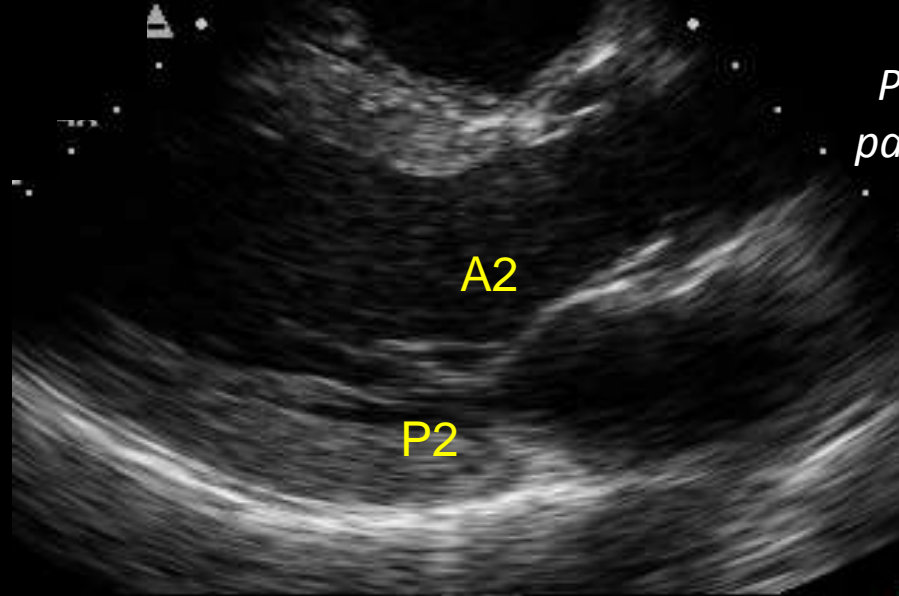


Prolapse of both anterior and posterior leaflets

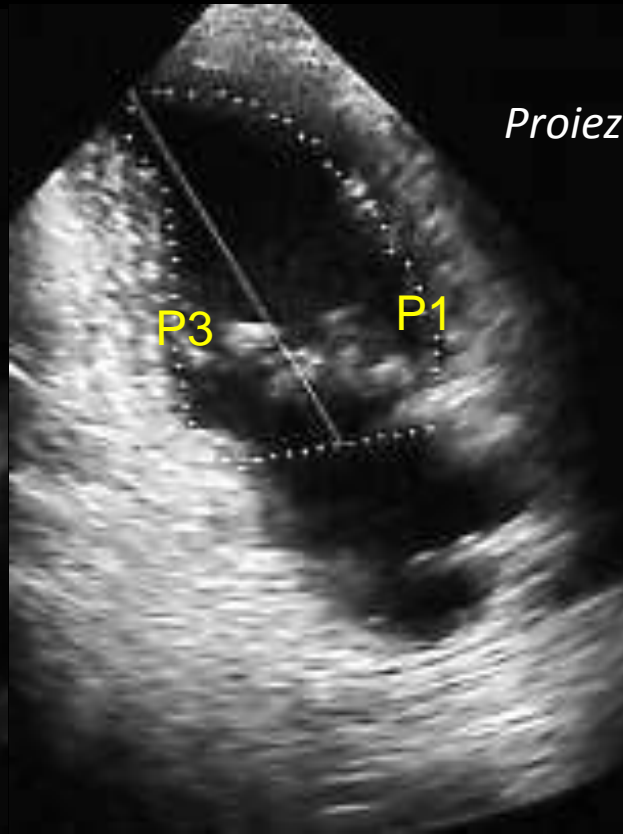
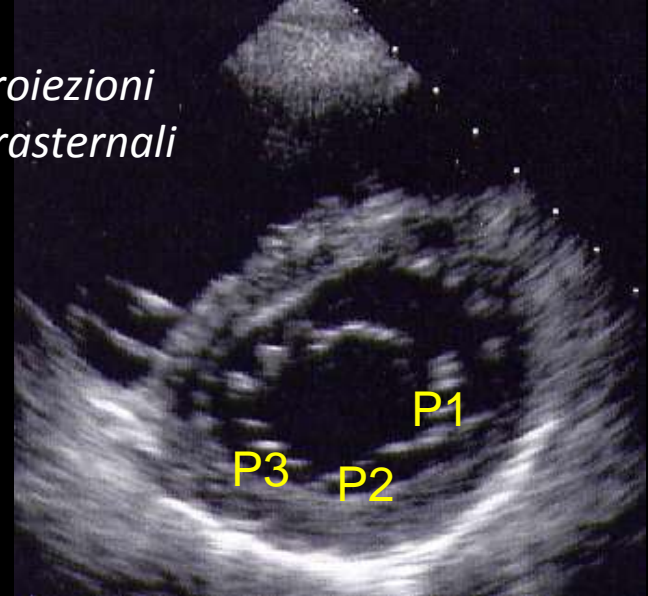
- ispessimento
- calcificazioni lembi e anello
- prolasso
- flail
- commissure
- corde tendinee e papillari

Posterior (and anterior) leaflet can be separated into three scallops:

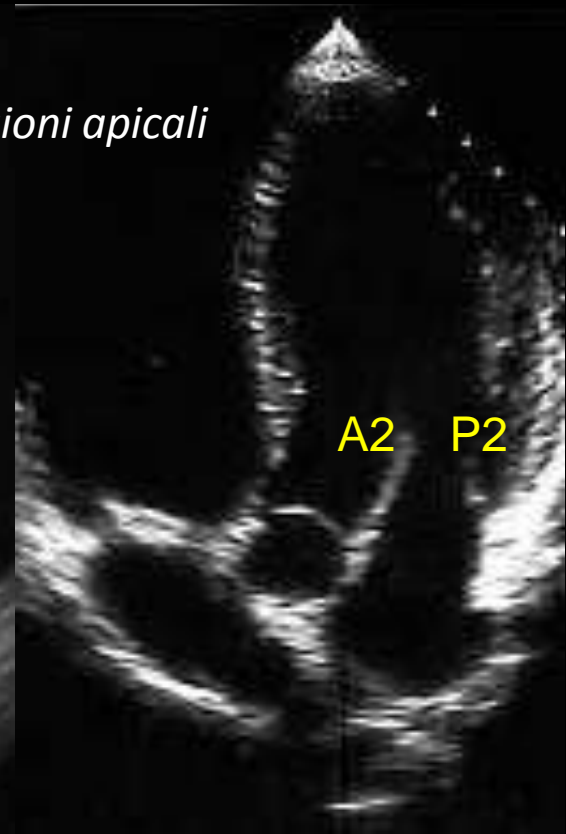




*Proiezioni
parasternali*

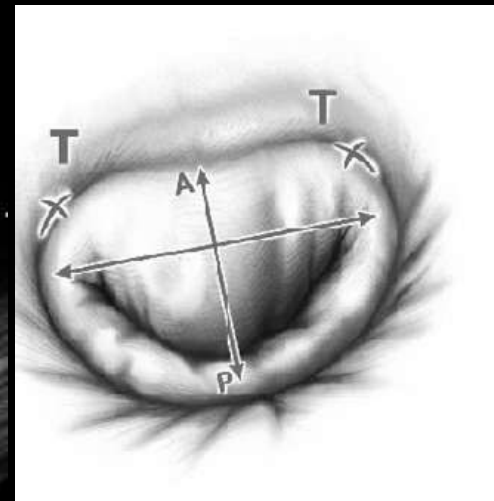
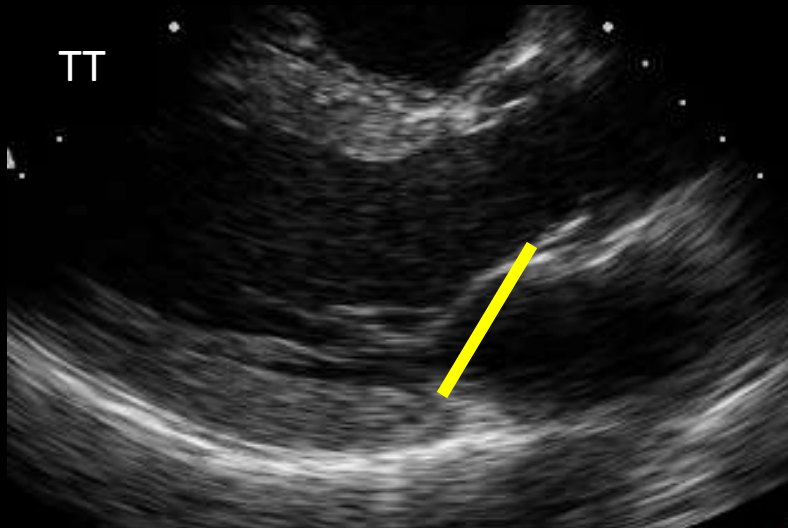
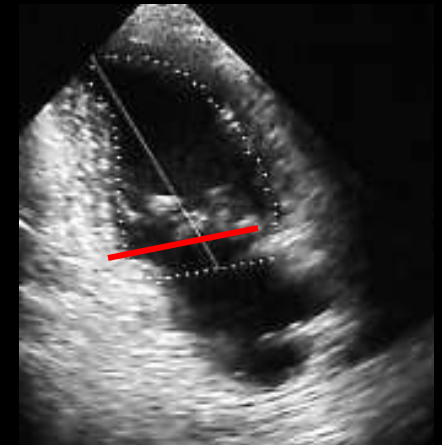
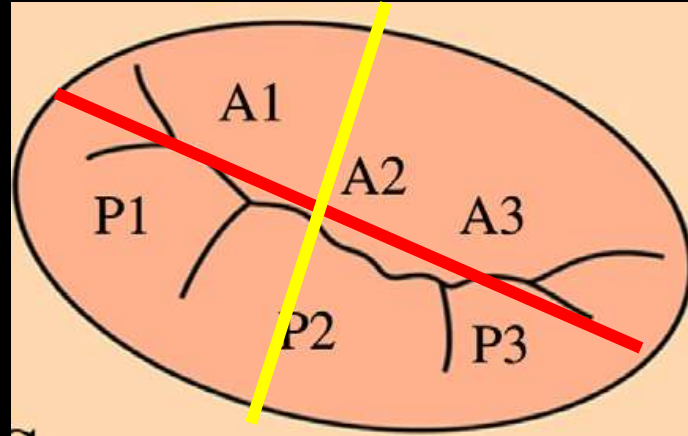
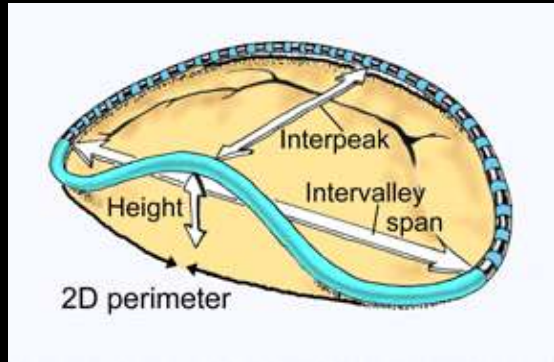


*Proiezioni
apicali*

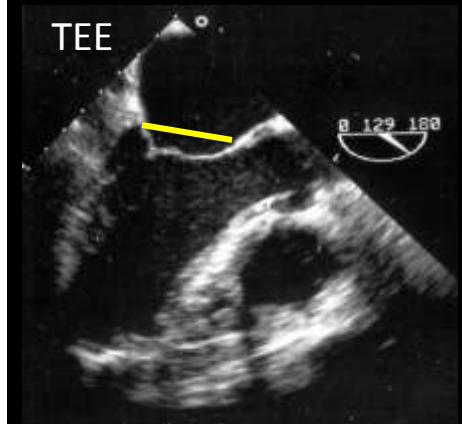


ANNULUS

The average annular diameter is no more than 3.0 cm.
A normal indexed MV diameter is 1.7 to 1.8 cm/m²

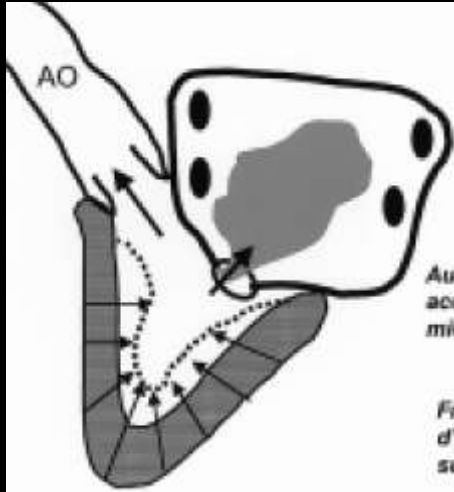


Diametro antero-posteriore

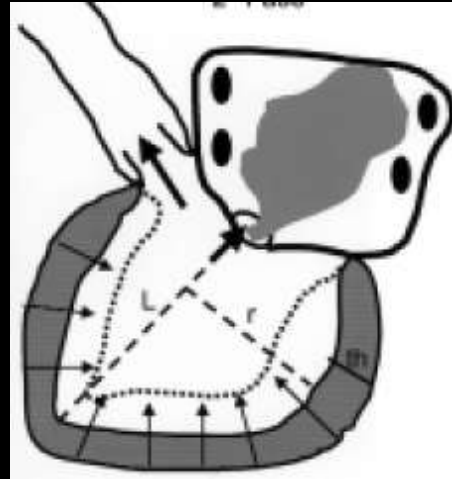


Funzione ventricolare sinistra e studio dell'atrio sinistro

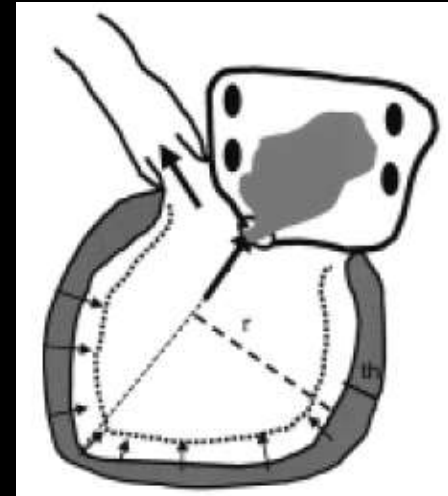
(valutazione del peso emodinamico)



1 PHASE



2 PHASE



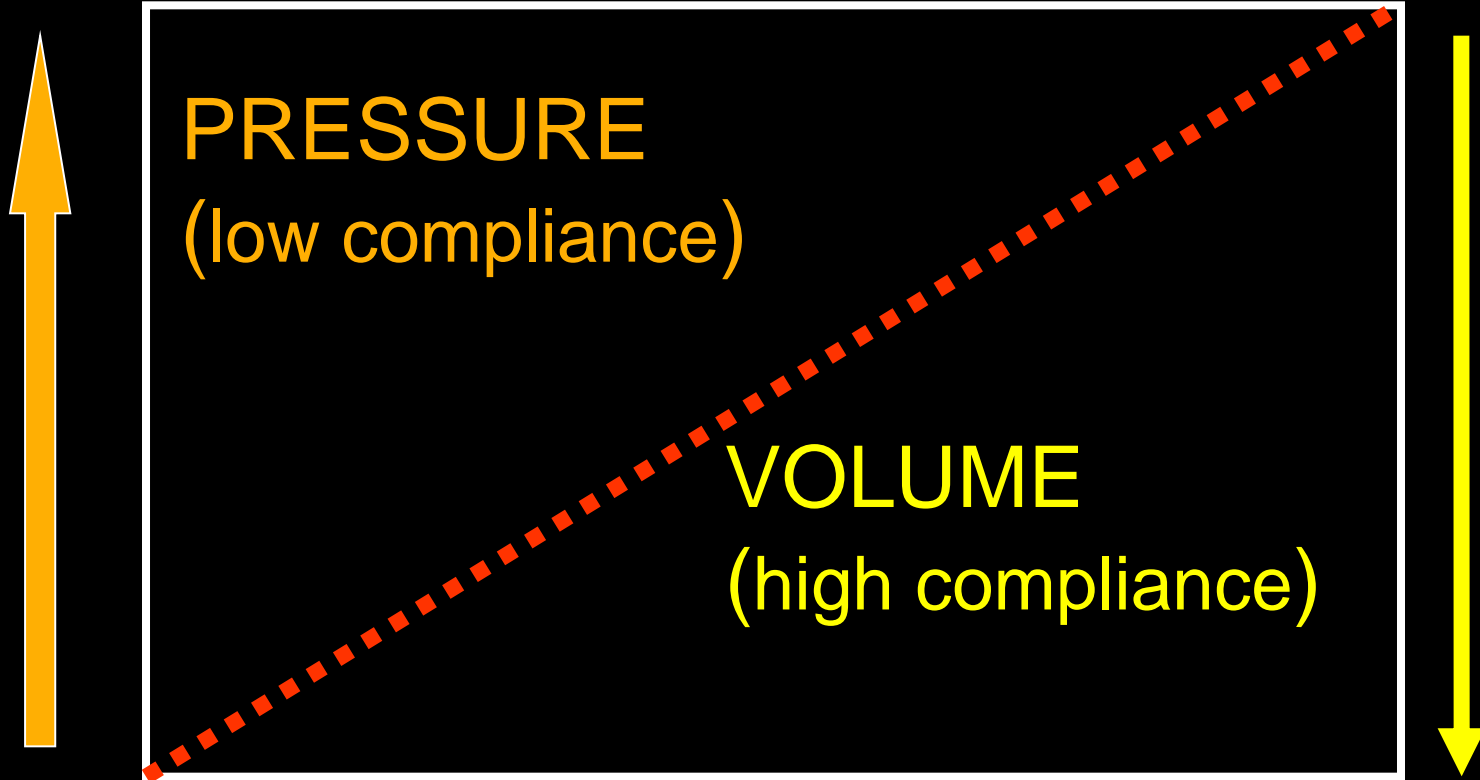
3 PHASE

Deterioramento funzionale del VS: - DTSVS > 40-45 mm
- FE < 60%

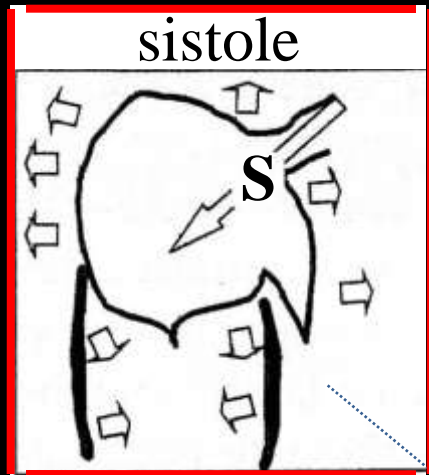
*Diametro tele-sistolico VS \neq diametro tele-eiettivo VS
(eiezione post-sistolica)*

Adattamento dell'atrio sinistro

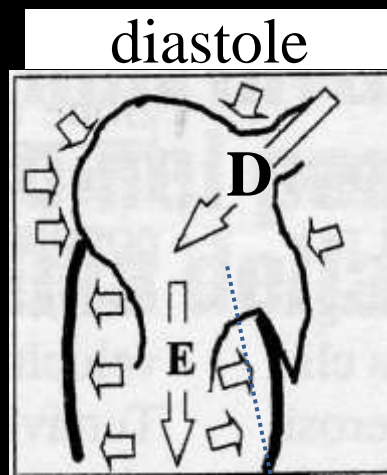
DYSPNEA / PULMONARY HYPERTENSION



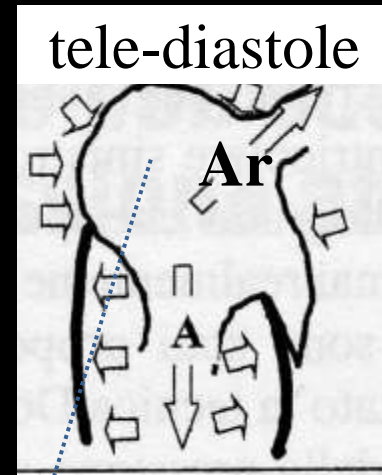
ATRIAL FIBRILLATION



Reservoir durante sistole ventricolare

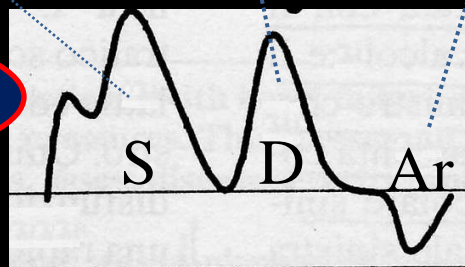


Condotto di passaggio durante la diastole

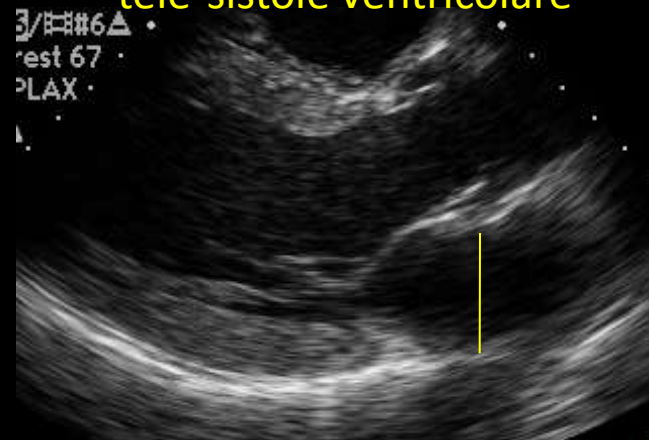


Riempimento ventricolare

Inversione sistolica flusso venoso polmonare



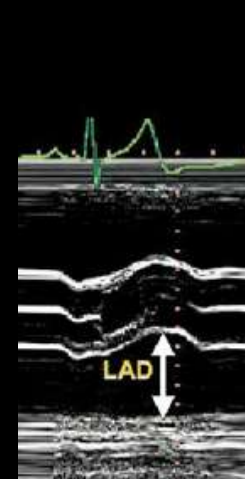
Diametro Antero-Posteriore in tele-sistole ventricolare



Diametro supero-inferiore



Diametro Medio-Laterale in tele-sistole ventricolare



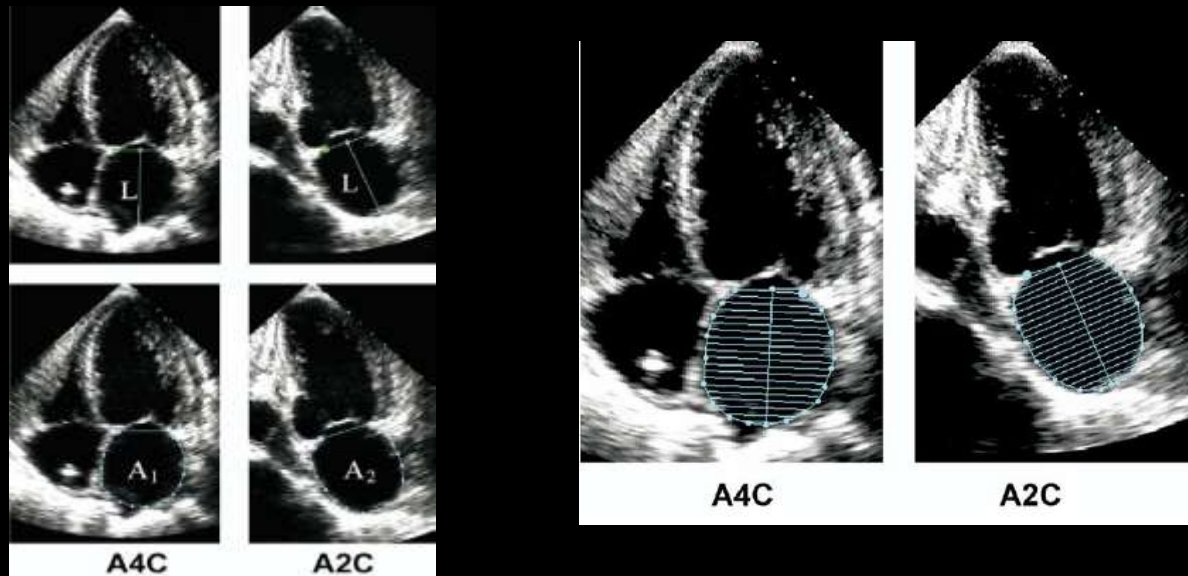
Atrio sinistro: area e volume

	Women				Men				
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	
Atrial dimensions									
LA diameter, cm	Diametro A-P	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
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

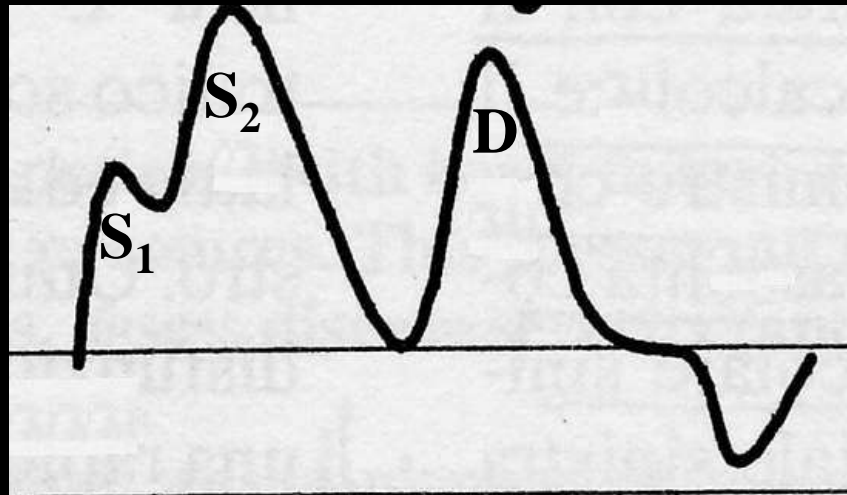
Left Atrial Volume =

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

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



Situazioni che modificano il pattern delle vene polmonari:



- FIBRILLAZIONE ATRIALE
assenza S1
assenza Ar
- ETA'
aumenta S
diminuisce D
aumenta Ar
- FE DEPRESSA
riduzione S2

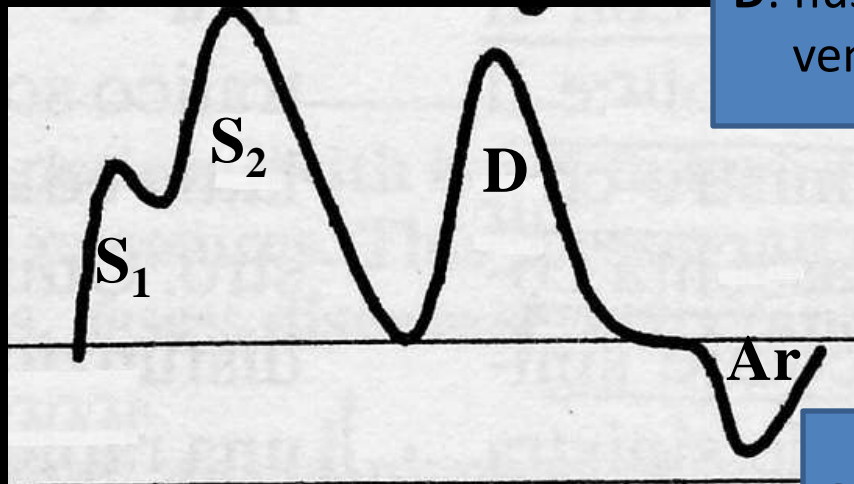
Il flusso atriale iniziale (S1) è generato inizialmente dalla diminuzione della LAP dovuta al rilasciamento atriale che consegue alla contrazione atriale.

La FA determinerà assenza di rilasciamento atriale, aumento della LAP in sistole e conseguente riduzione dell'onda S del flusso venoso polmonare (e ingrandimento atriale e/o congestione venosa polmonare)

Per smascherare un pattern pseudonormalizzato:
necessità di integrare i dati ricavati dal flusso transmitralico
con quelli ricavati dal **flusso venoso polmonare**

S_1 : rilasciamento atrio sx
 S_2 : spostamento sistolico dell'annulus
mitralico verso l'apice in sistole

Onda S 0.59 ± 0.1 m/s
Onda D 0.40 ± 0.13
Onda Ar 0.21 ± 0.7



D: flusso durante la diastole
ventricolare

Ar: onda retrograda
durante la sistole atriale

La patologia tricuspидale è un fattore prognostico importante nei pazienti con malattia della valvola mitrale e/o aortica

ITr quando si associa a disfunzione del VD tende a diventare sintomatica e a determinare una evoluzione clinica più sfavorevole

(descrizione anatomica della valvola e meccanismo del rigurgito)

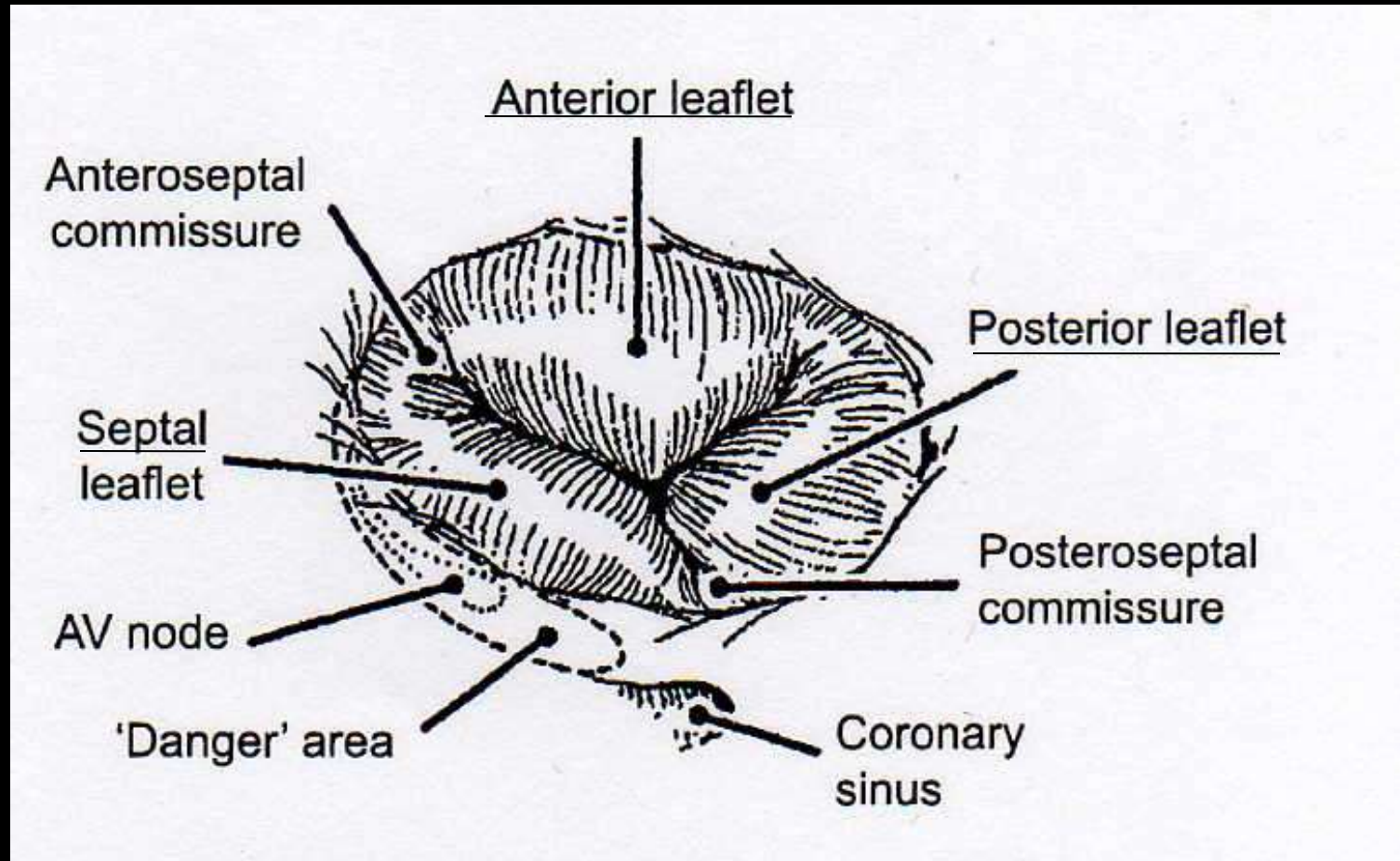


ITr funzionale (la più comune)



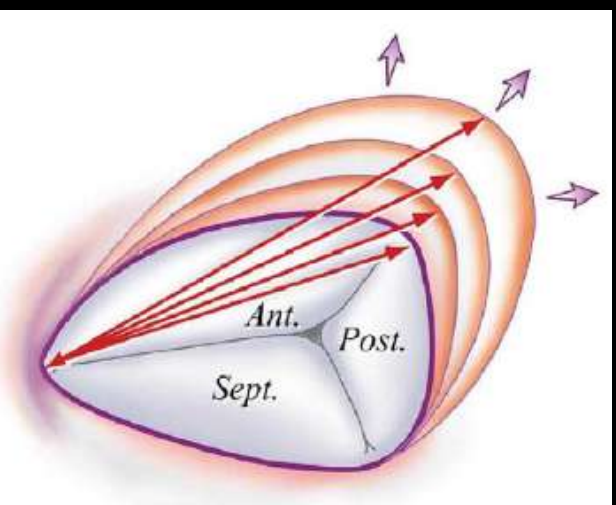
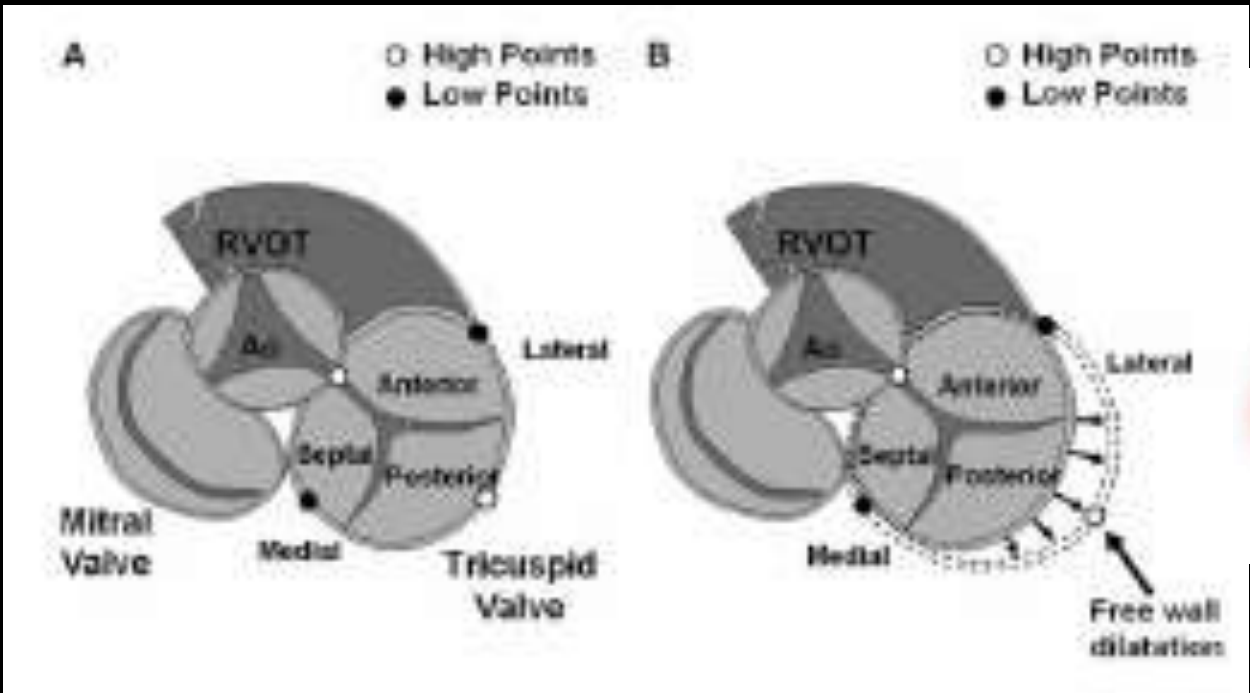
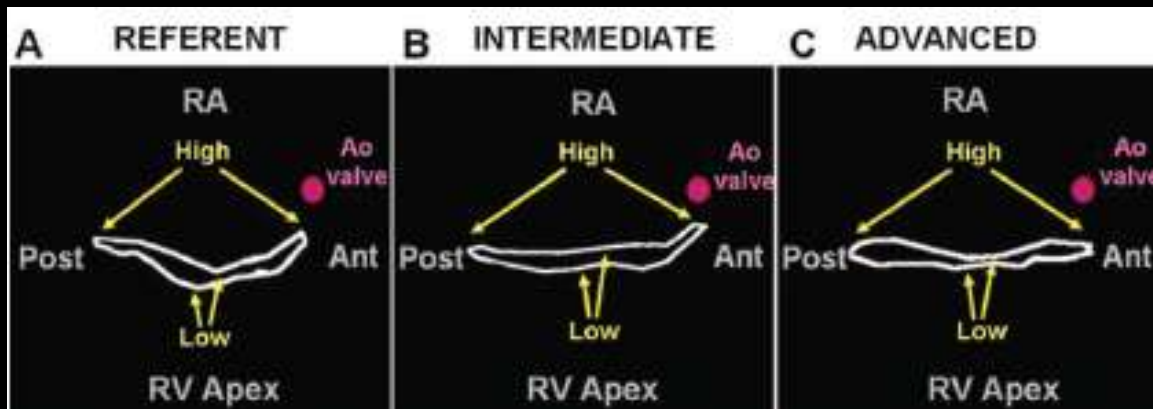
ITr organica (più rara): rottura cordale del lembo settale

Tricuspid valve

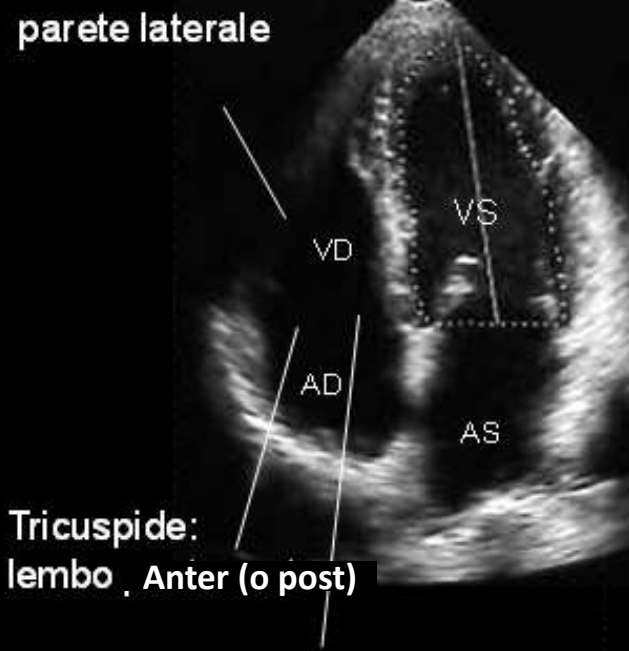
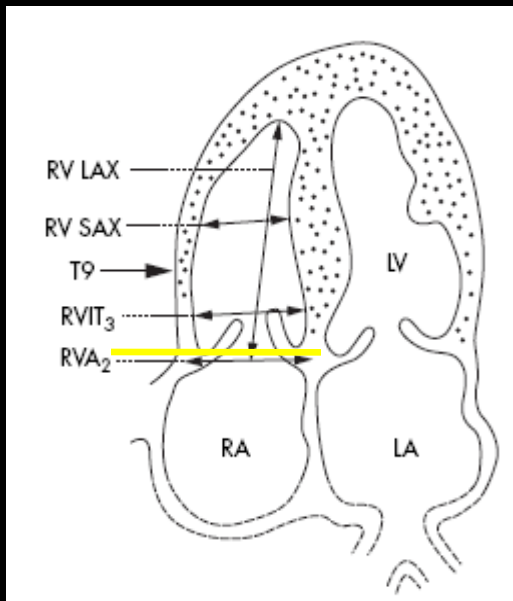
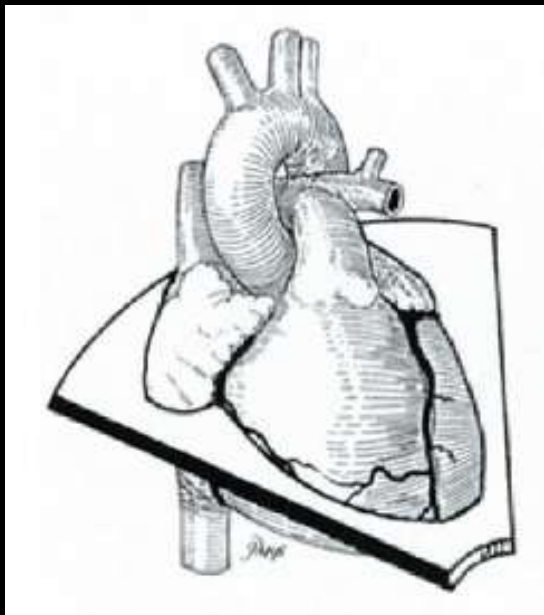


All leaflets are very thin

Dilatazione dell'annulus: perdita della conformazione a "sella"



Apical four chamber view:



Diametro medio-laterale dell'annulus

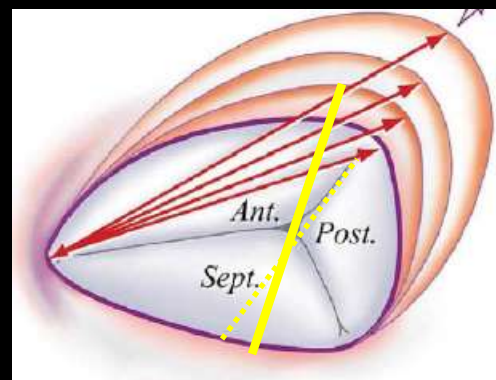
Normal subjects (absolute values):

Mean 2.4 cm (range 1.6-3.1 cm)

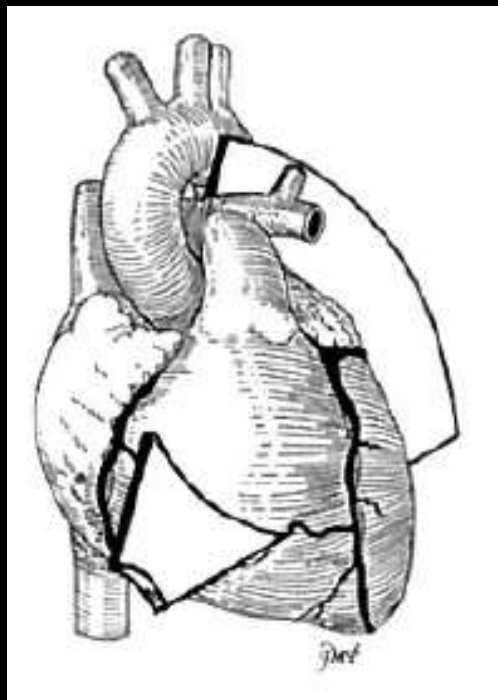
Corrected for BSA (cm²):

Mean 1.5 (range 1.1-1.8)

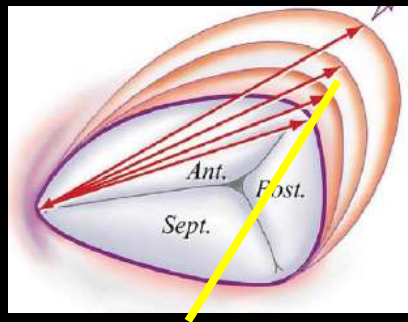
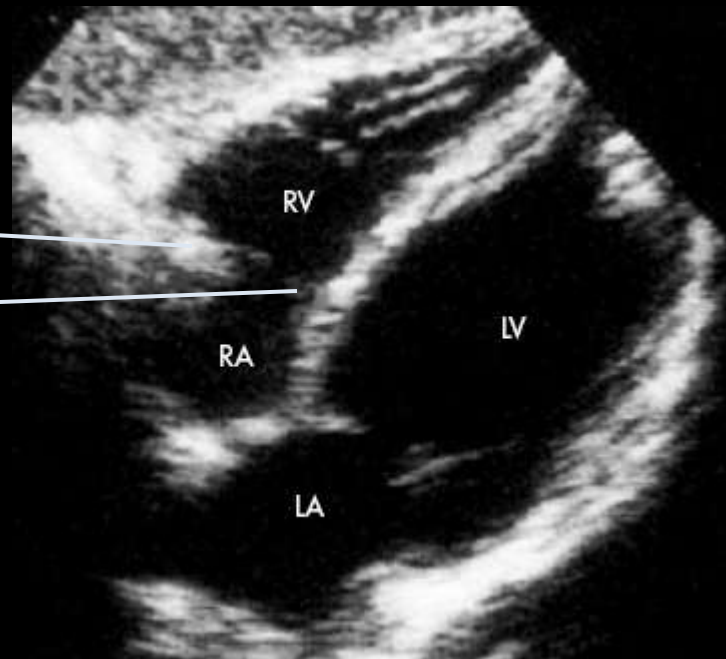
Dilatazione:
 > 40 mm (21 mm/m²)
 Acc. fraz < 25%



Subcostal four chamber view

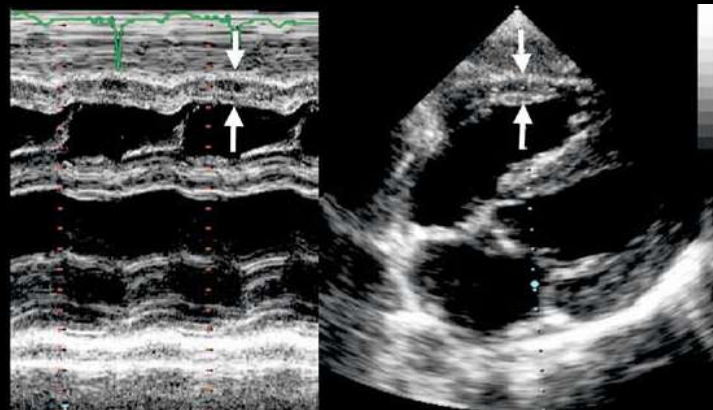


TRICUSPIDE:
Lembo posteriore
Lembo settale

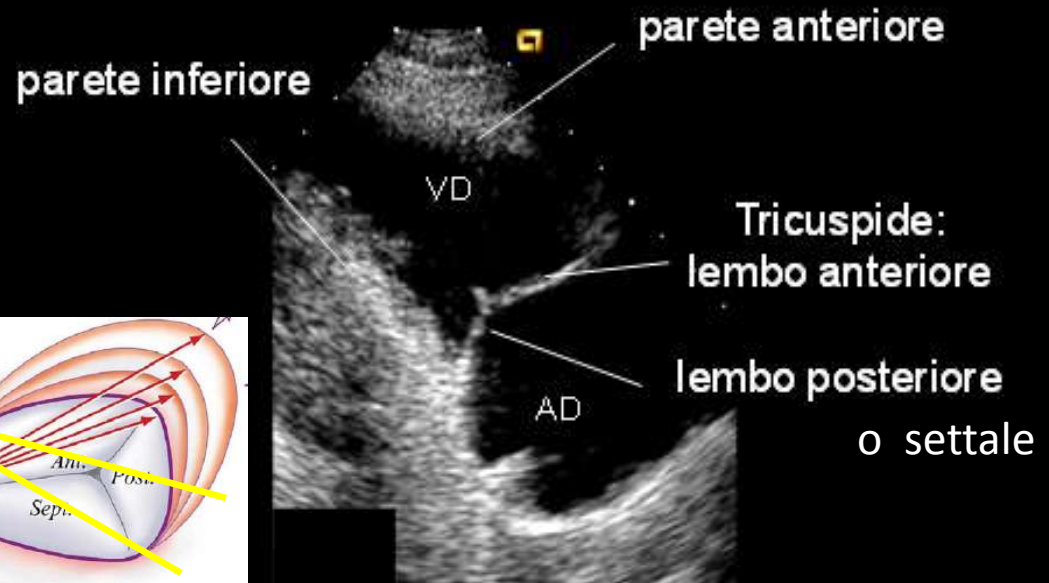
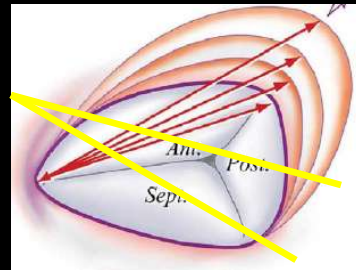
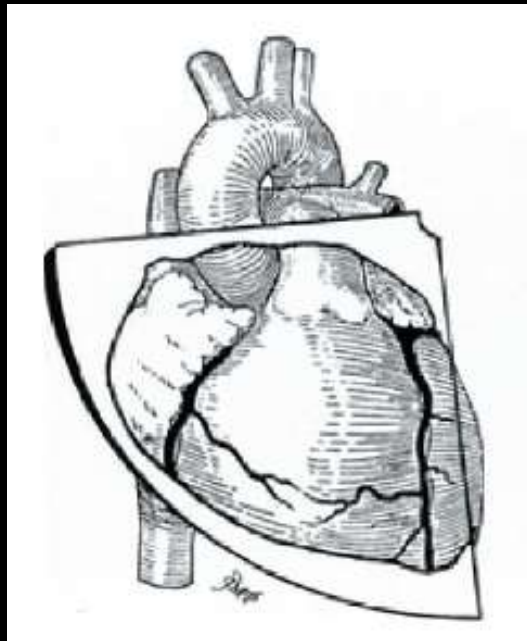


Spessore della parete laterale ≤ 5 mm

dimensioni della camera di afflusso possono essere minori rispetto all'approccio apicale



Parasternal long axis view of the right ventricular inflow tract:



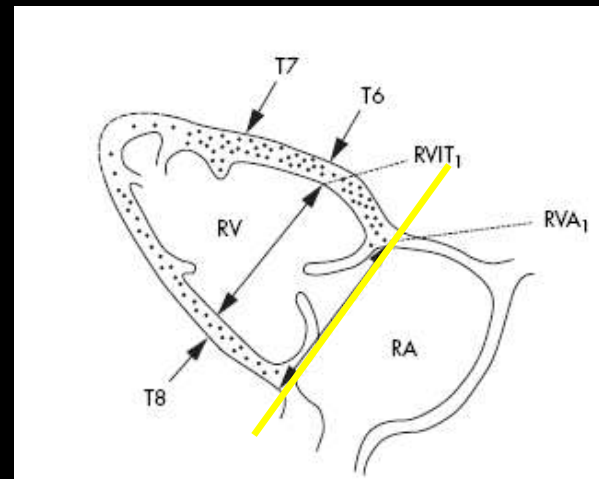
Diametro antero-posteriore dell'annulus

Normal subjects (absolute values):

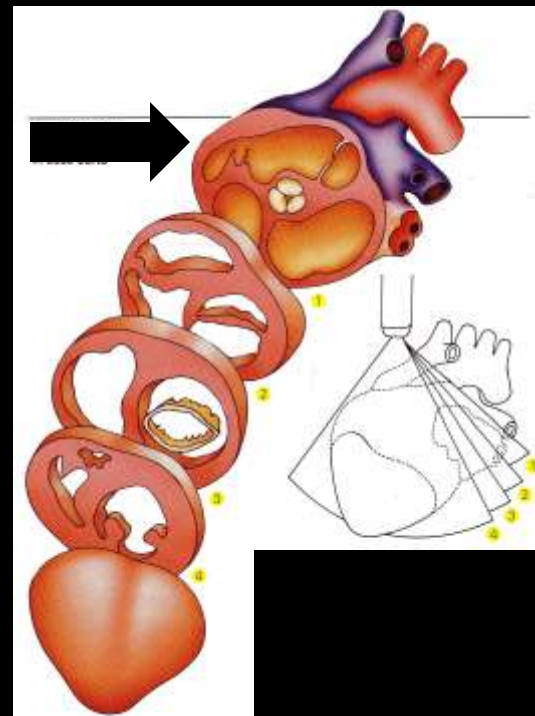
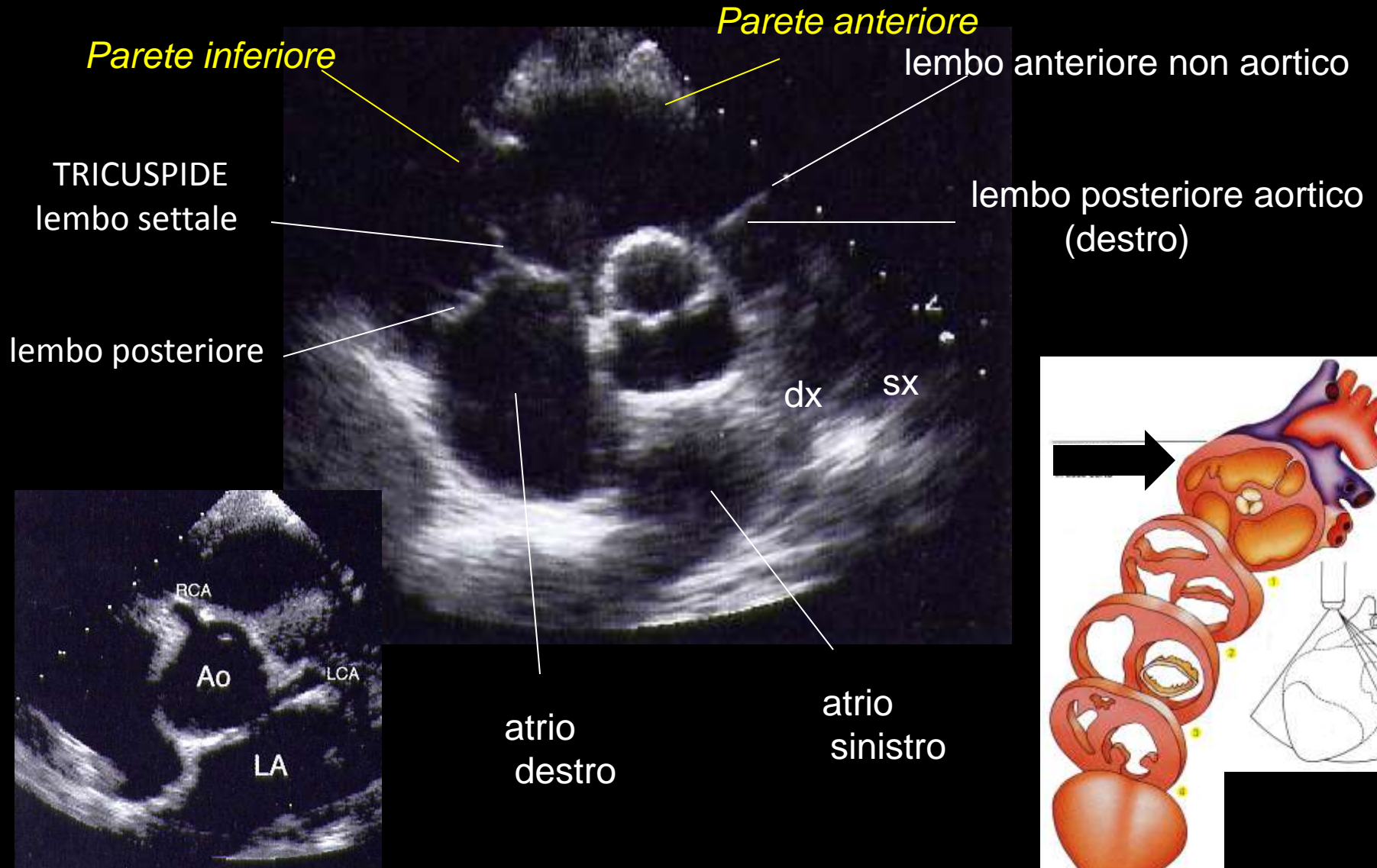
Mean 3.4 cm (range 2.5-4.0 cm)

Corrected for BSA (cm²):

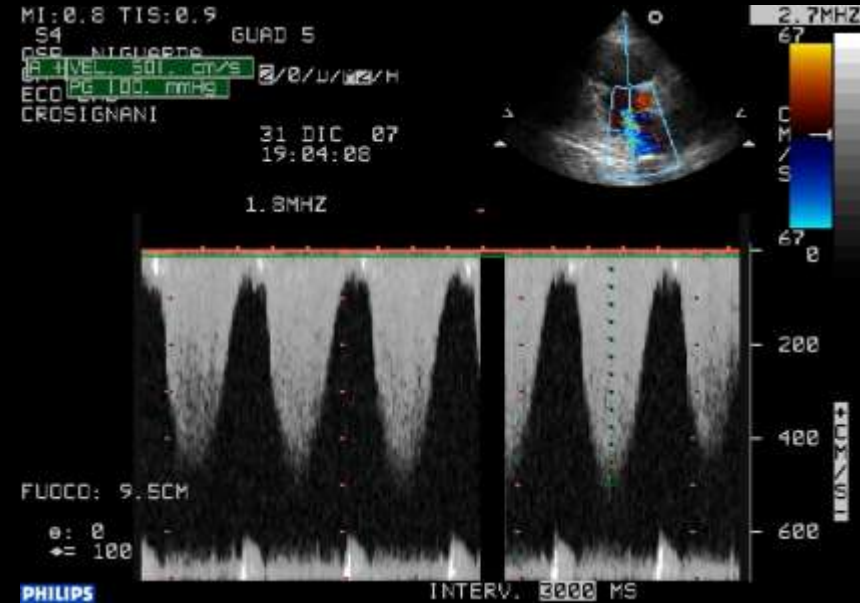
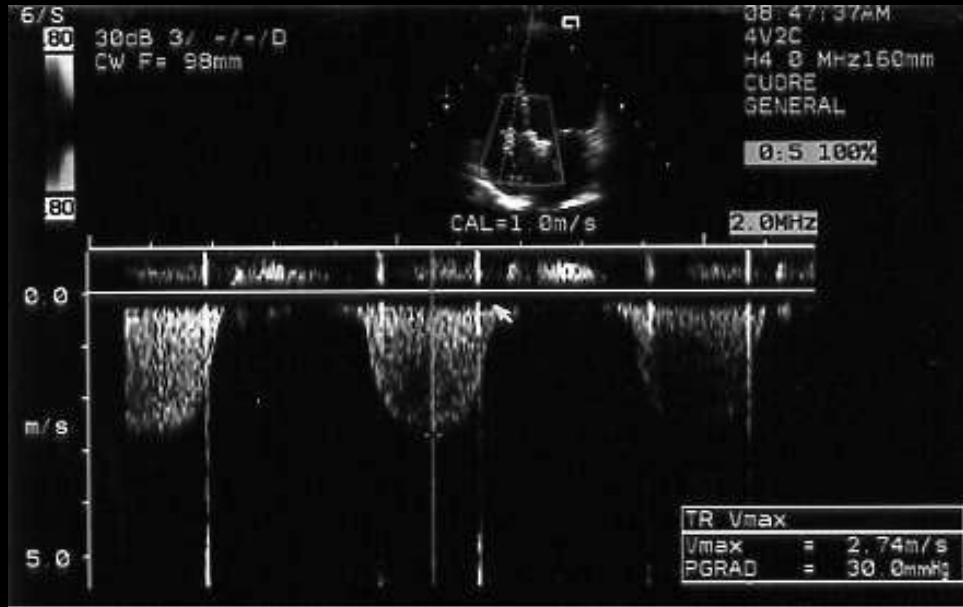
Mean 2.0 (range 1.6-2.4)



Tratto di efflusso del ventricolo destro:



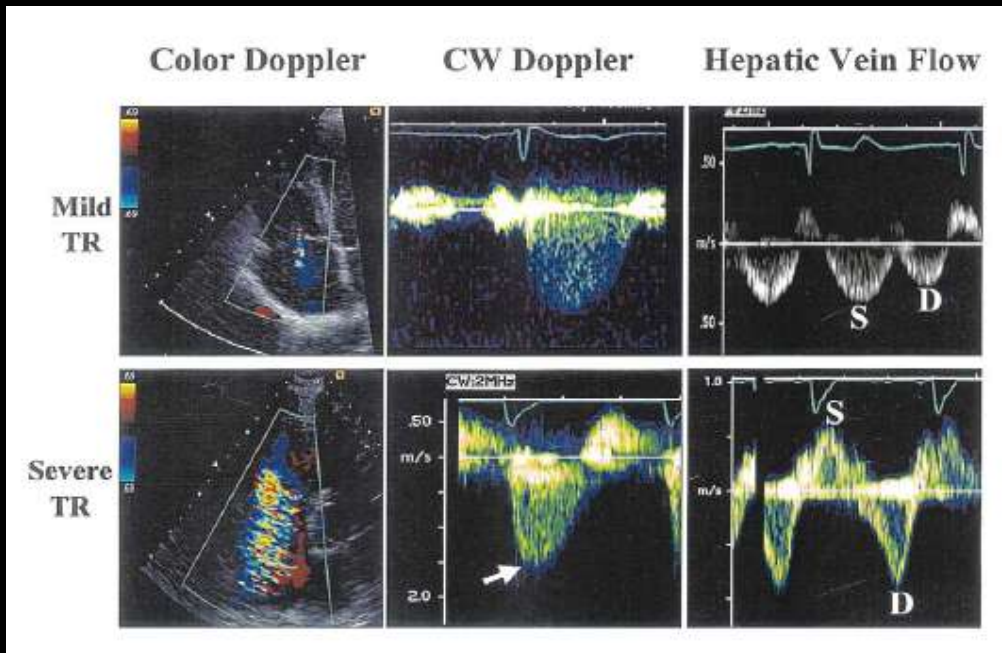
Insufficienza tricuspидale



L'itr lieve mostra un profilo Doppler parabolico e poco denso.

L'itr significativa mostra un profilo triangolare e molto denso, con un picco di V max precoce

Insufficienza tricuspидale



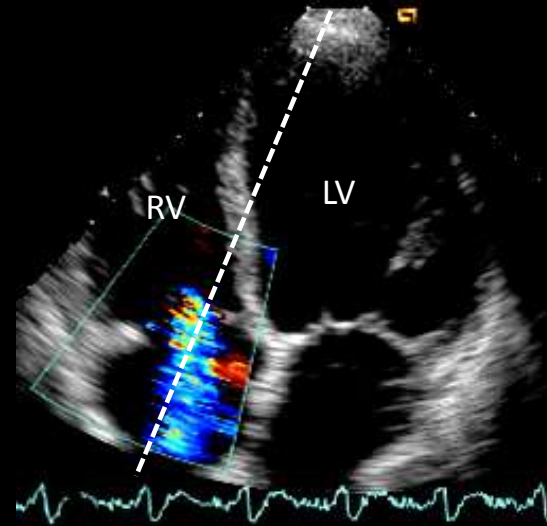
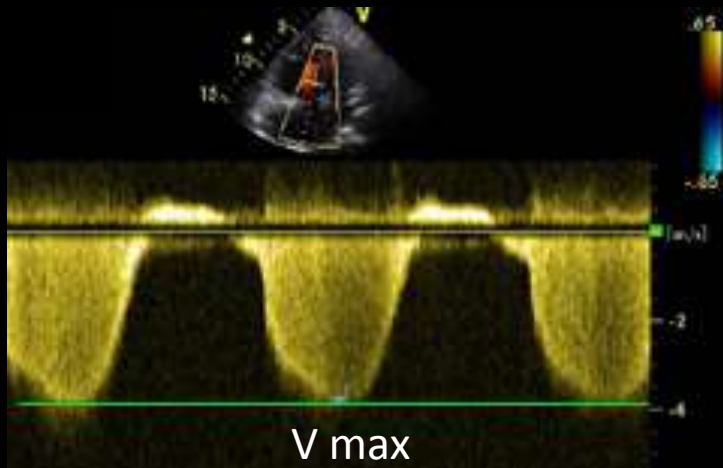
Fattori che influenzano l'area di turbolenza (area del jet):

- contrattilità del VD e postcarico
- tempo di rigurgito
- direzione del jet

	lieve	moderata	severa
Area jet(cm ²) centrale in AD	5	5-10	>10
Area jet/area AD	< 1/3	1/3 – 2/3	> 2/3

	lieve	moderata	severa
Dimensioni di VD – AD – vena cava inf	Normali	Normali o dilatati	dilatati
VC (cm)	Non definita	< 0.7	> 0.7
Valvola tricuspидale	normale	Normale o anormale	anormale

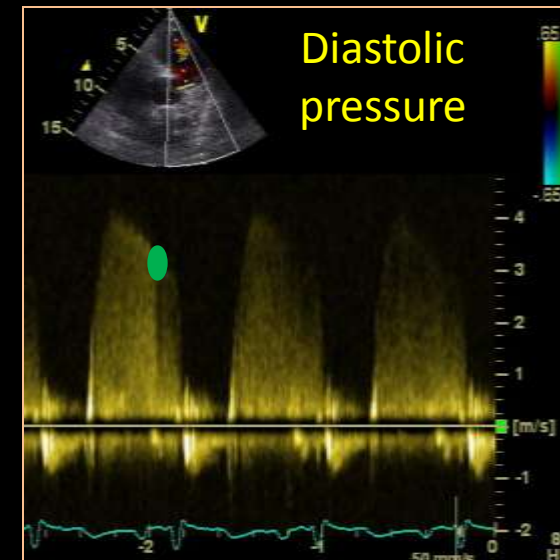
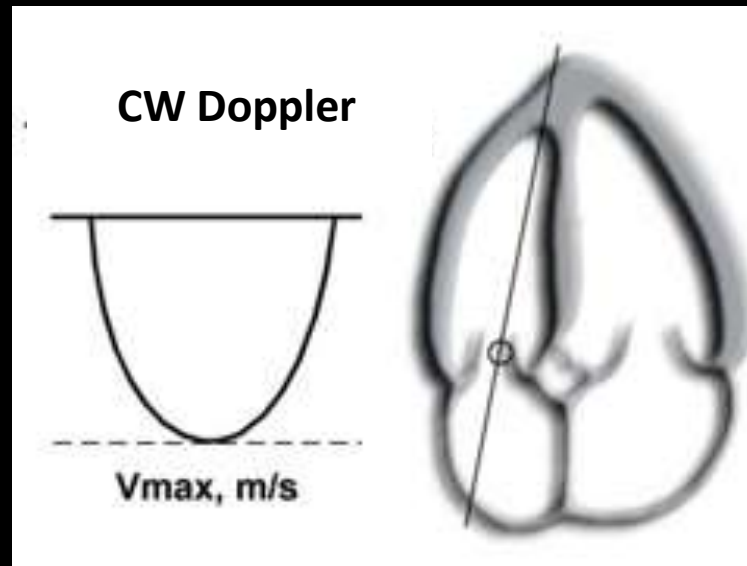
Systolic pulmonary pressure



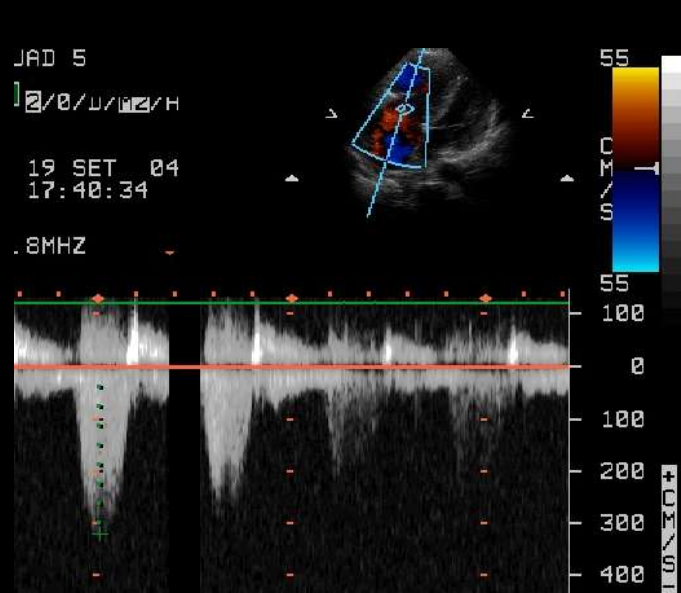
$$\Delta P = 4 V^2$$

+

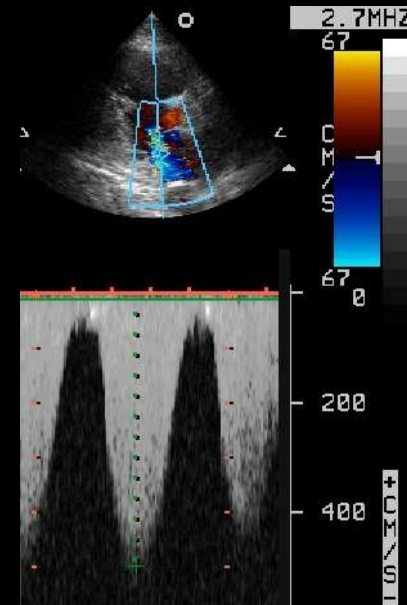
RAP



Evento agudo/evento cronico



V max 3.2 m/s
P max 41 mmHg

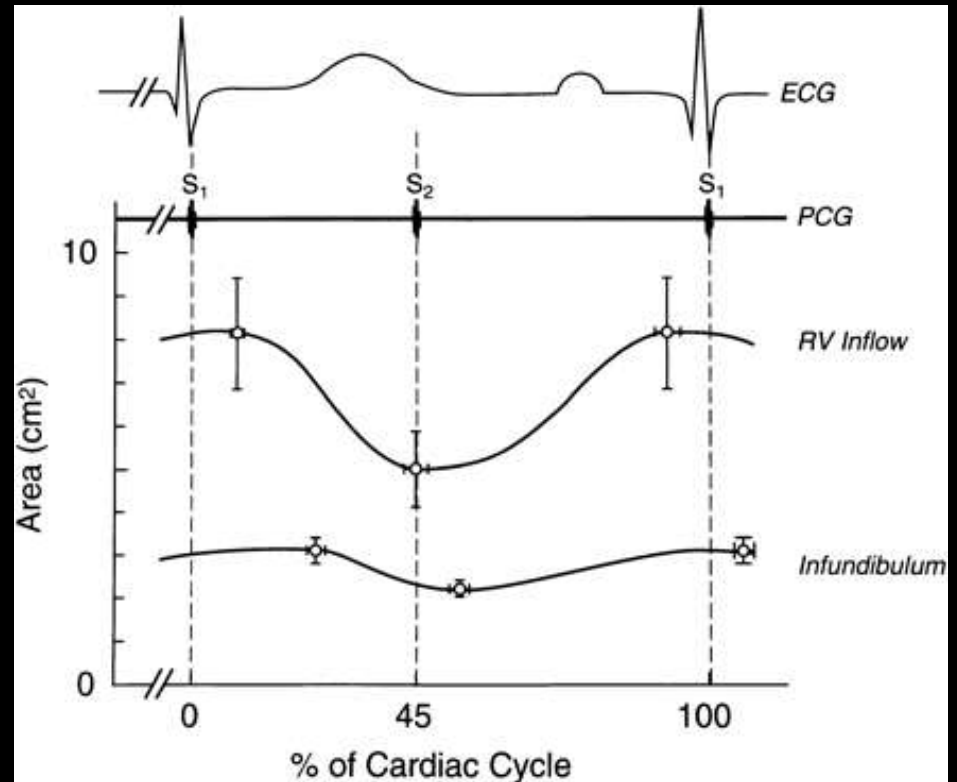
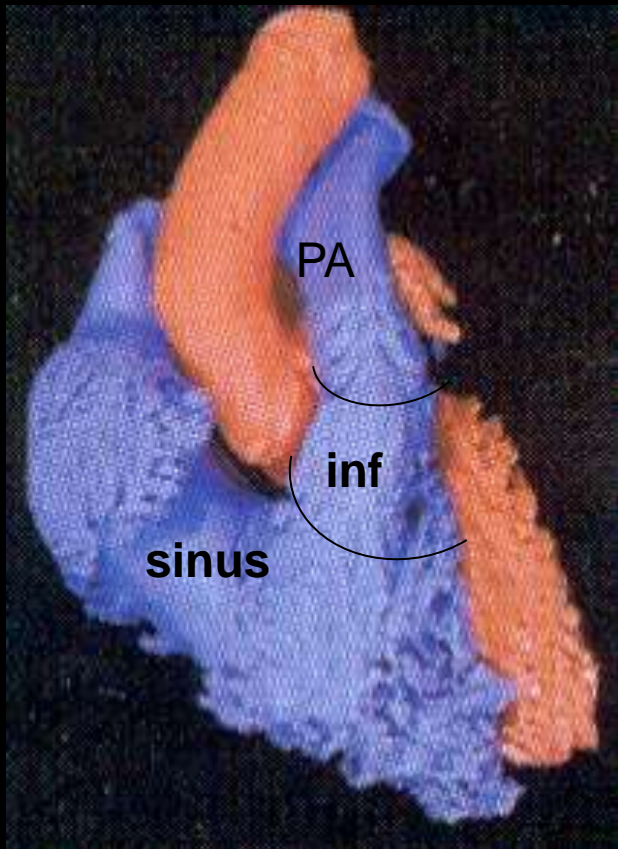


V max 5 m/s
P max 100 mmHg

Systolic RV pressures in acute pulmonary embolism range from 30 to 60 mmHg.

The right ventricle is not conditioned to generate pressures in excess to 60-70 mmHg. Therefore, if pressures of 70 mmHg or more are detected in a suspected pulmonary embolus, an acute on chronic thromboembolic disease or a pulmonary embolus superimposed on previously pre-existing pulmonary hypertension has to be considered.

Right ventricle

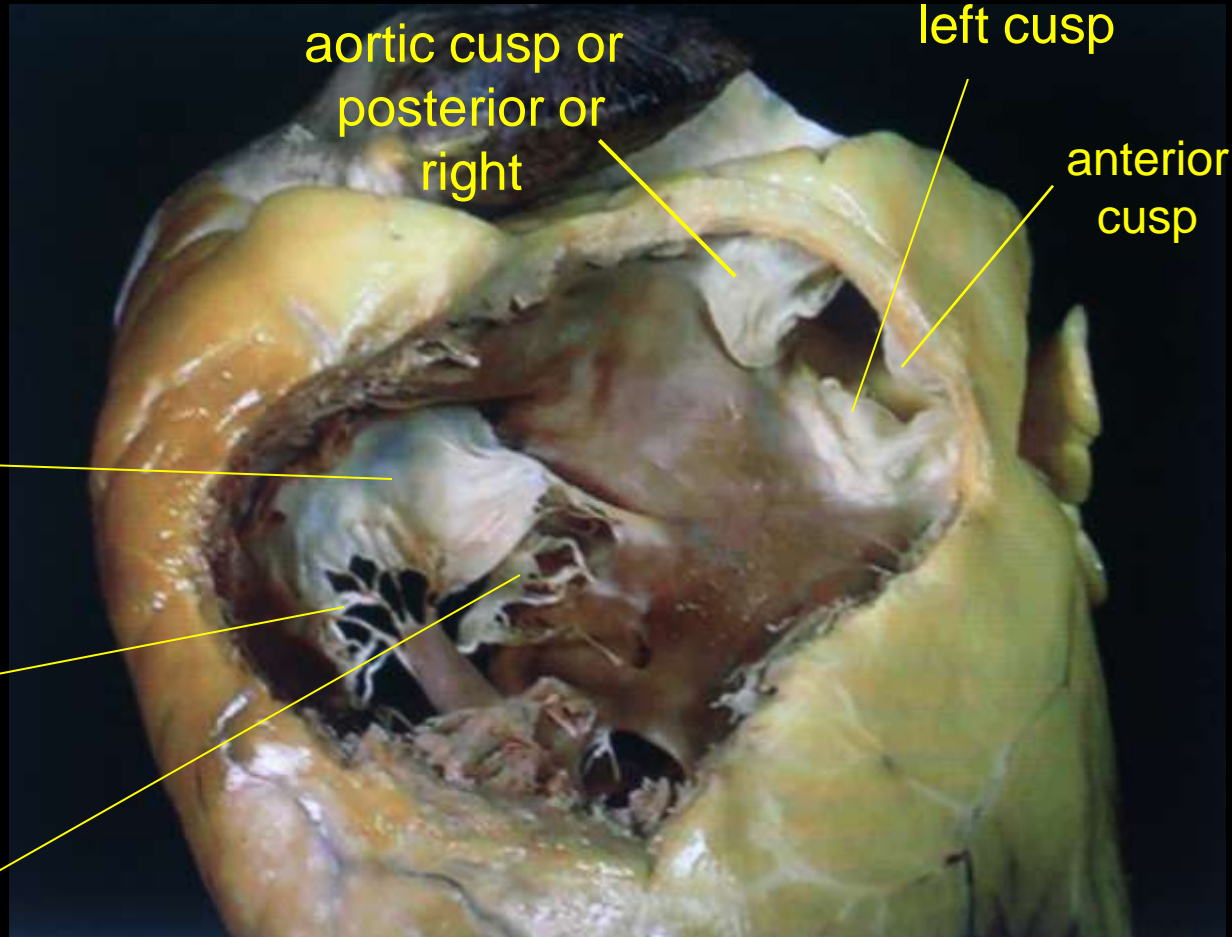
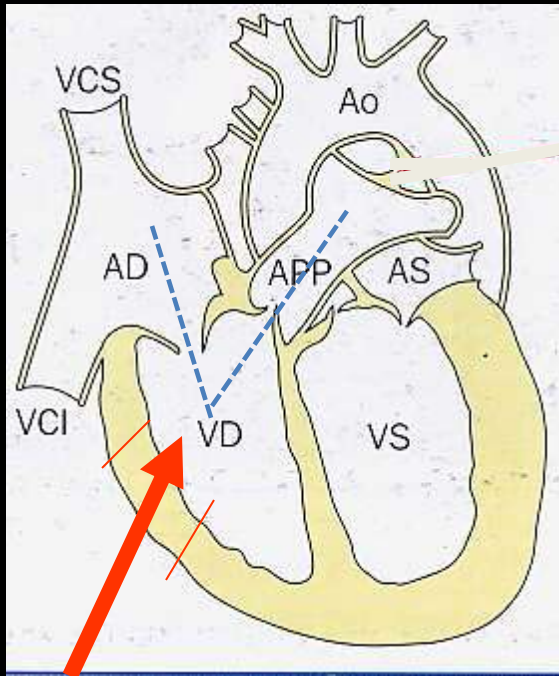


RV: "U" shape

"peristaltic contraction"

Sinus supports 80-85% pump function

RV: complex geometry



anterior leaflet

posterior leaflet
or inferior

septal leaflet or medial

aortic cusp or
posterior or
right

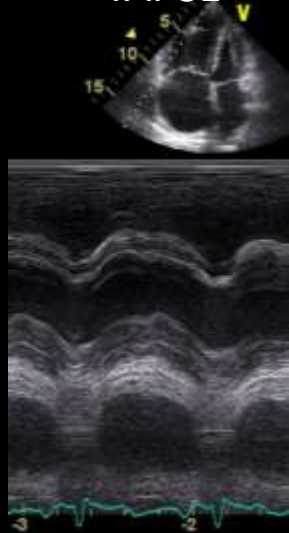
left cusp

anterior
cusp

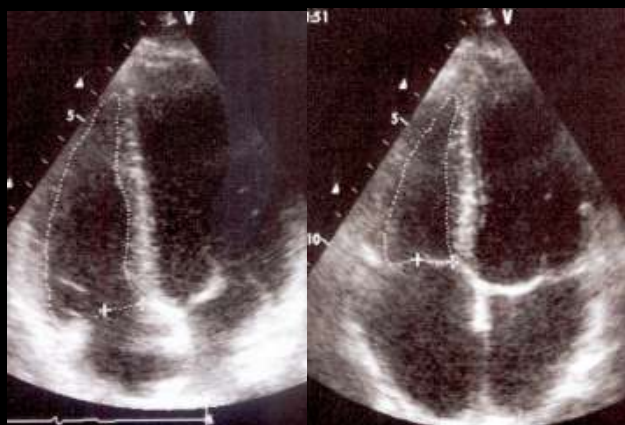
Table 3. Selected Indices of RV Contractility

Functional Parameters	Normal Value	Load Dependence*	Clinical Utility
RVEF, %	$61 \pm 7\%$ (47%–76%) ⁸ >40%–45%	+ + +	Clinical validation, wide acceptance Prognostic value in cardiopulmonary disorders ⁹
RVFAC, %	>32% ⁴⁸	+ + +	Good correlation with RVEF Prognostic value in MI and bypass surgery ⁴⁸
TAPSE, mm	>15 ⁴⁸	+ + +	Simple measure not limited by endocardial border recognition: Good correlation with RVEF
Sm annular, cm/s	>12 ⁶³	+ + +	Good sensitivity and specificity for RVEF <50% ⁶³
Strain	Basal: 19 ± 6 ⁶⁸ Mid: 27 ± 6 Apical: 32 ± 6	+ + +	Correlates with stroke volume ^{69,70}
Strain rate, s ⁻¹	Basal: 1.50 ± 0.41 ⁶⁸ Mid: 1.72 ± 0.27 Apical: 2.04 ± 0.41	+ +	Correlates with contractility ^{69,70}

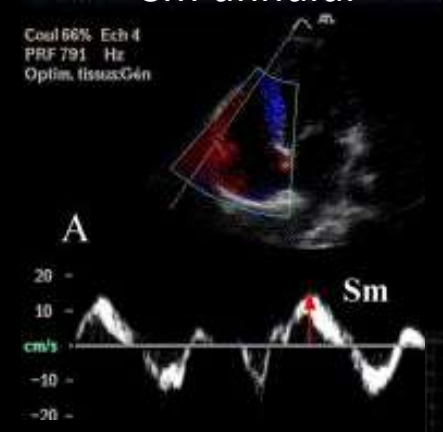
TAPSE



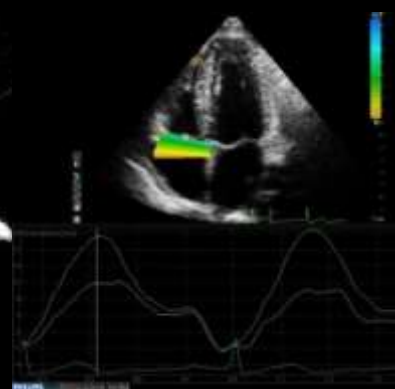
RVFAC



Sm annular



Strain



RVFAC (right ventricular fractional area change)

$$RVFAC = \frac{EDA - ESA}{EDA} \cdot 100$$

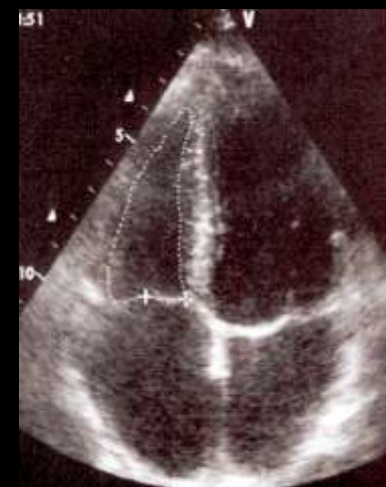
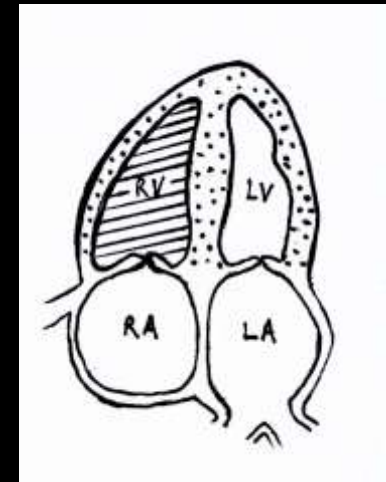
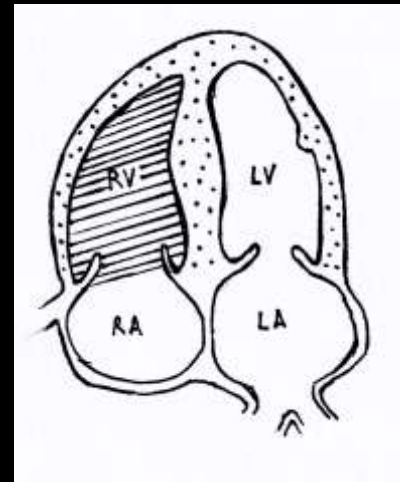
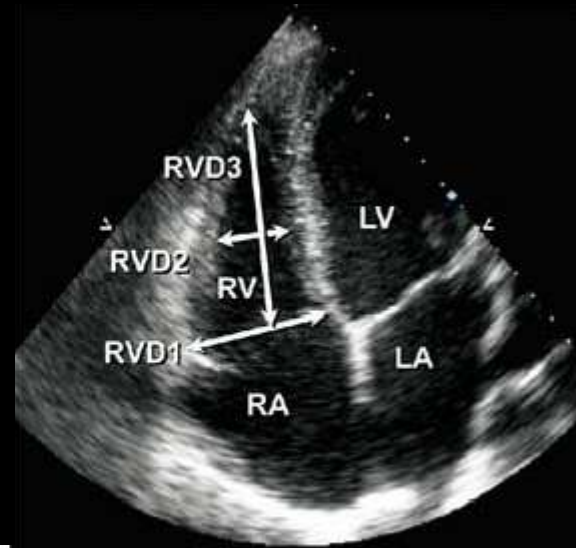
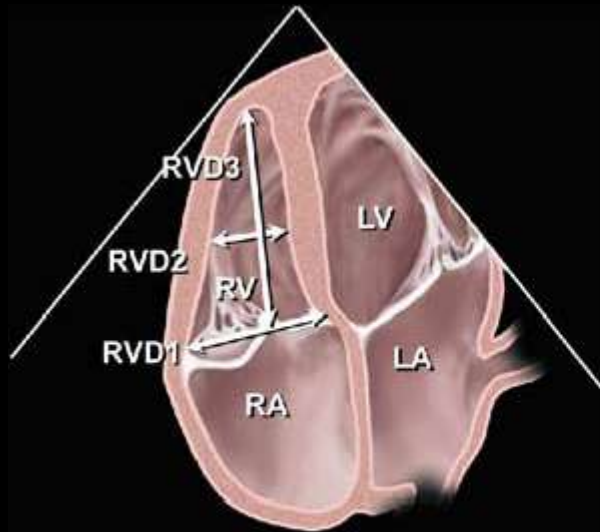


Table 8 Reference limits and partition values of right ventricular size and function as measured in the apical 4-chamber view

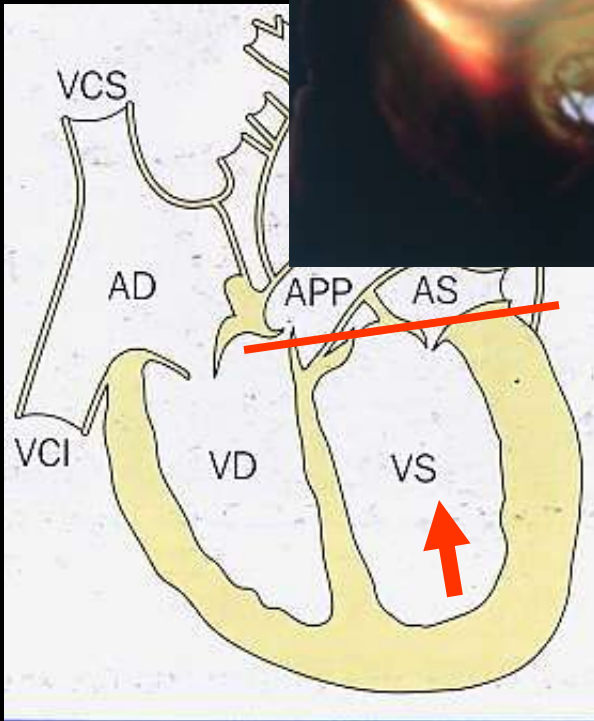
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
RV diastolic area, cm ²	11–28	29–32	33–37	≥38
RV systolic area, cm ²	7.5–16	17–19	20–22	≥23
RV fractional area change, %	32–60	25–31	18–24	≤17

Dimensioni del VD

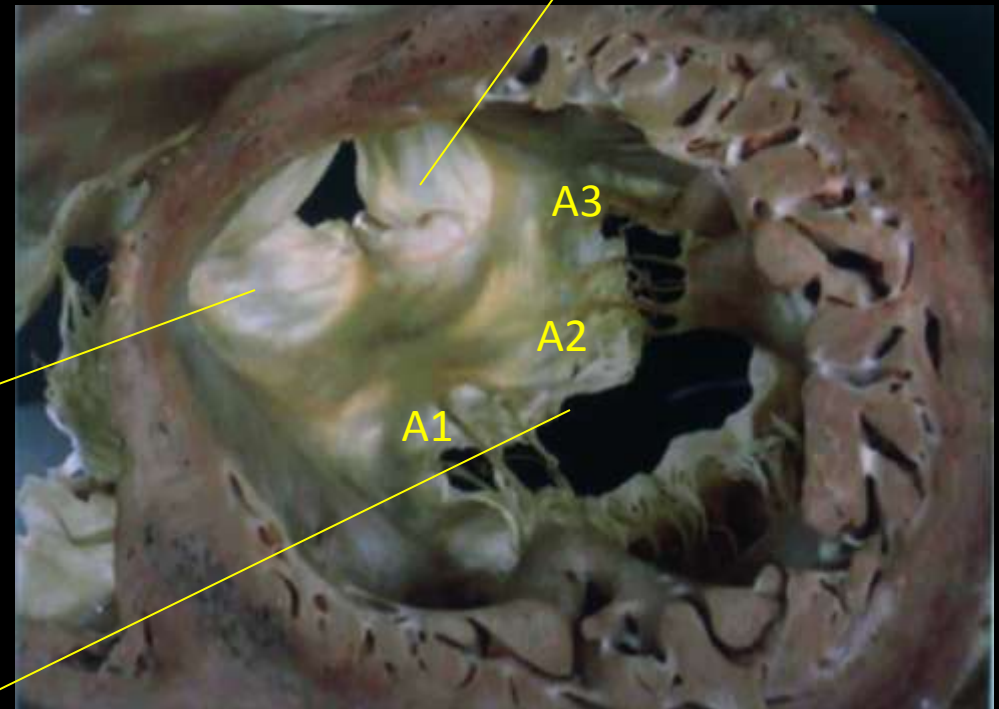


	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
RV dimensions (Figure 12)				
Basal RV diameter (RVD 1), cm	2.0–2.8	2.9–3.3	3.4–3.8	≥3.9
Mid-RV diameter (RVD 2), cm	2.7–3.3	3.4–3.7	3.8–4.1	≥4.2
Base-to-apex length (RVD 3), cm	7.1–7.9	8.0–8.5	8.6–9.1	≥9.2

MV anterior leaflet is shared with the left and noncoronary cusps of the aortic valve:



AV posterior cusp



AV left cusp

MV anterior leaflet

Valvola aortica

(descrizione anatomica della valvola)

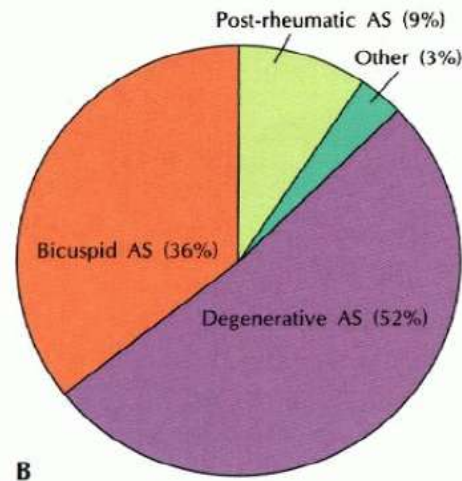
Calcified Aortic Valve

calcific, degenerative, thick stiff leaflets,
base of cusps calcified
no commissural fusion



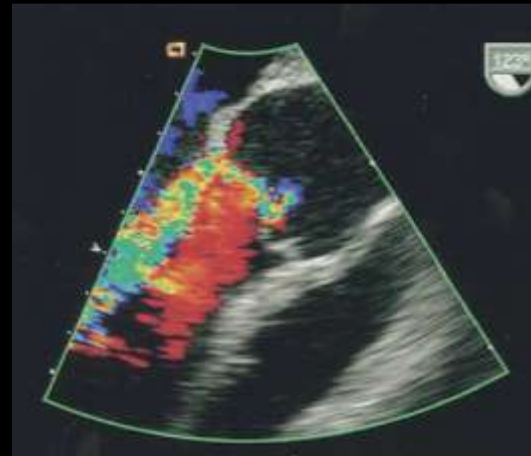
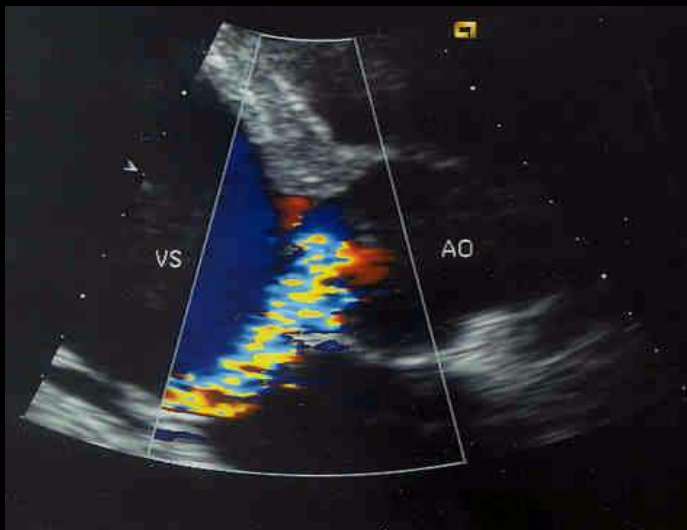
Rheumatic Aortic Valve

commissural fusion
free borders calcified
calcific nodules on both surfaces

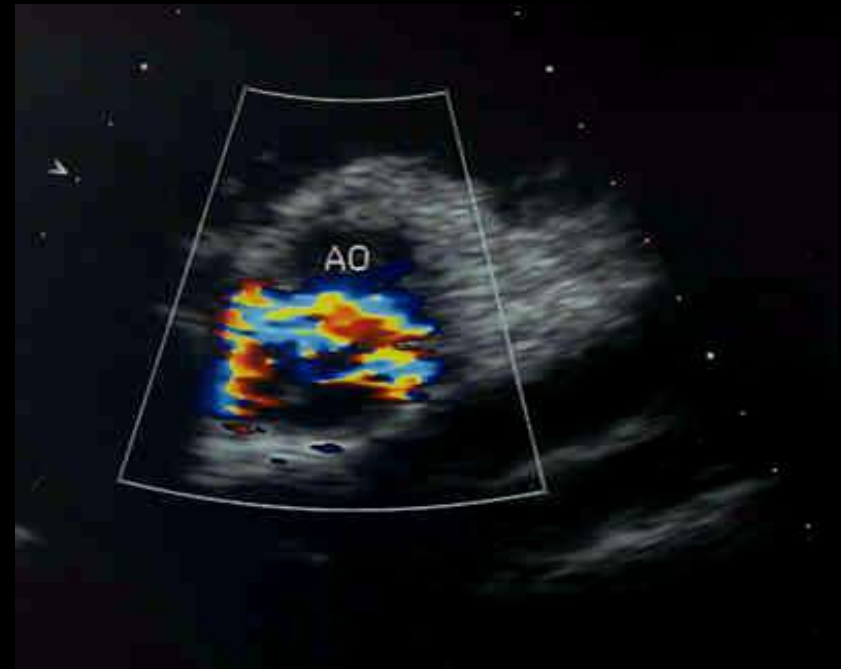


Prolasso della cuspidi destra

(meccanismo del rigurgito)



Insufficienza aortica in valvola bicuspid

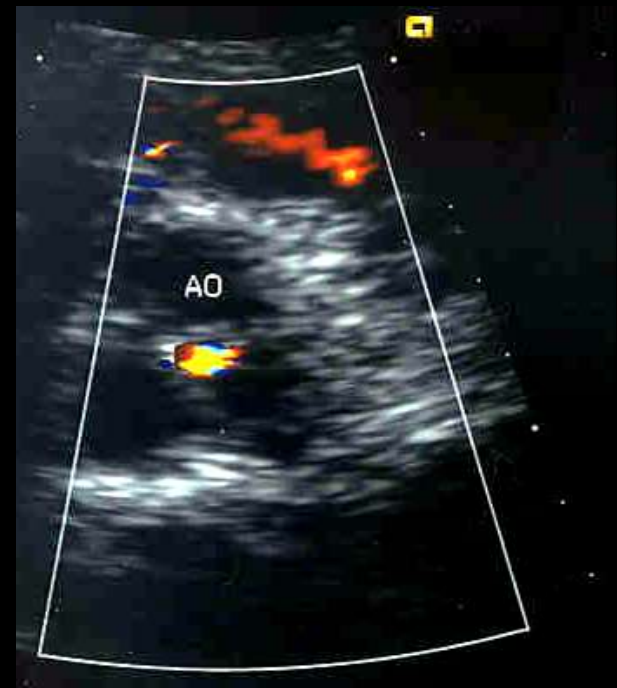


endocardite



Aortic insufficiency

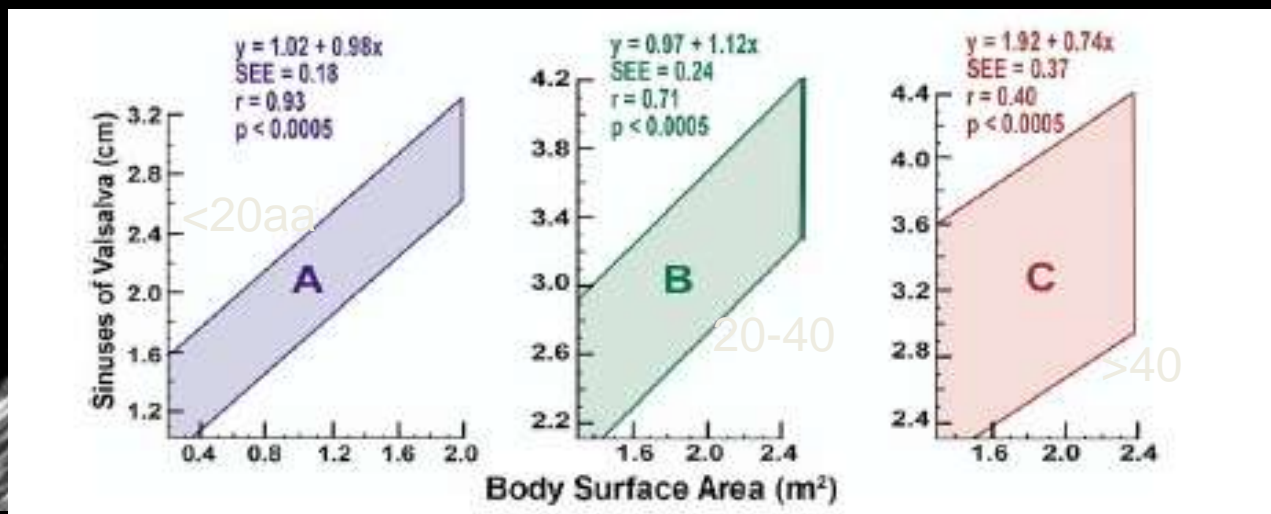
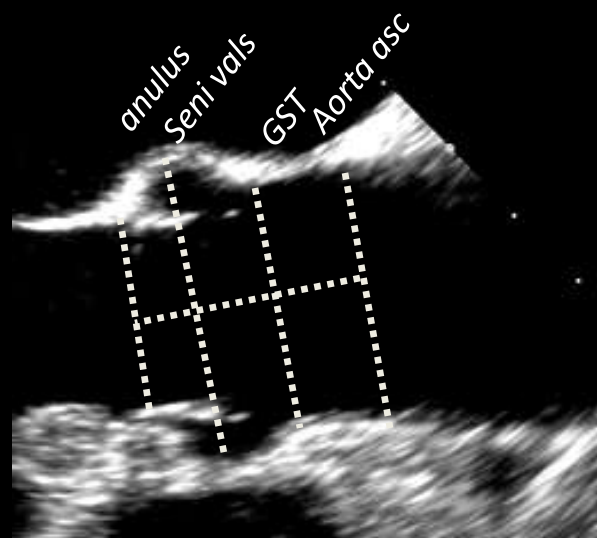
central regurgitation orifice



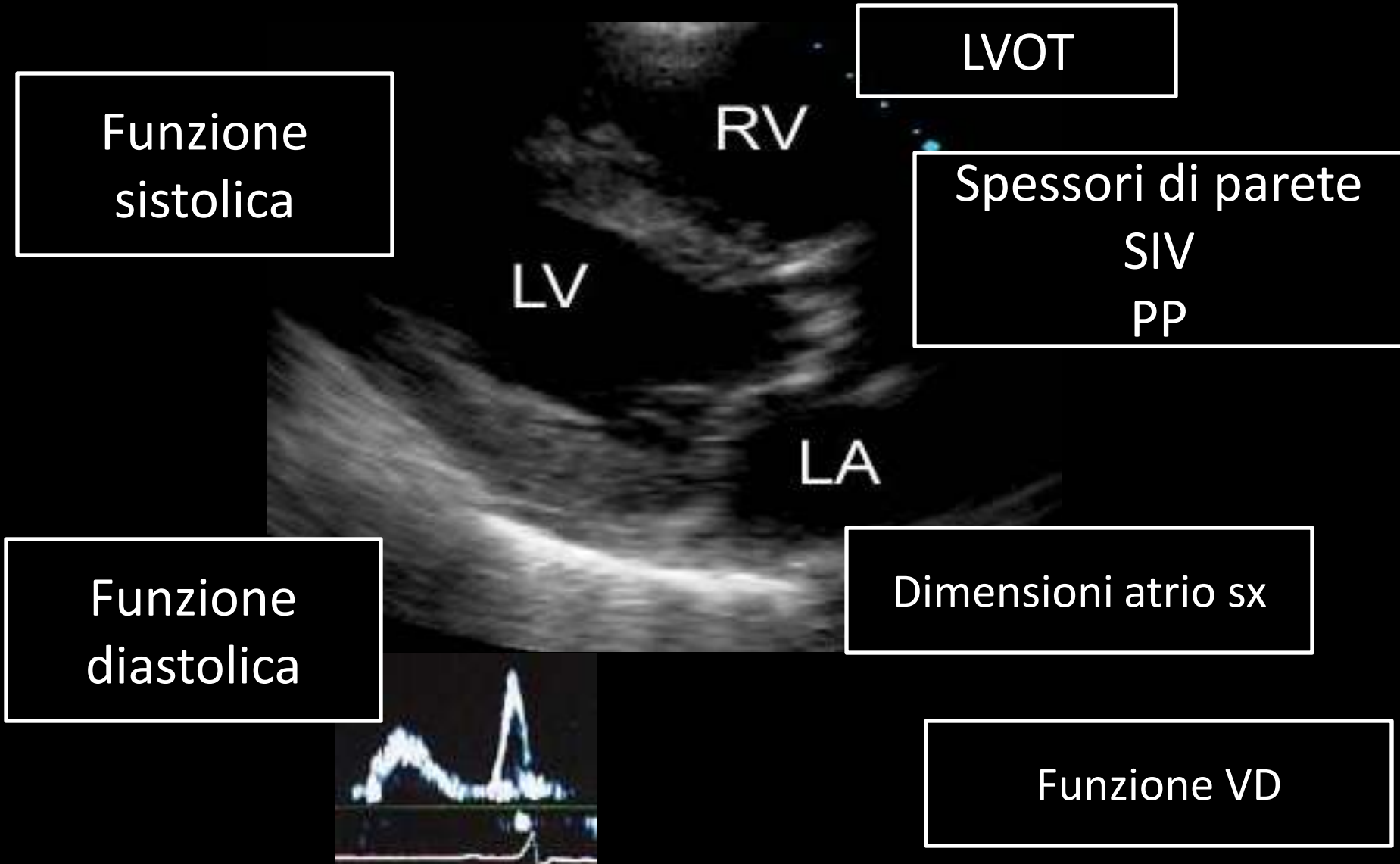
Giant aortic aneurysm



- L'aorta ascendente è normale fino a 35 mm
- Il diametro dell'arco aortico è normalmente di 2.5-3.0 cm nei giovani adulti e può raggiungere 3.5 cm negli ultrasessantenni
- Il calibro dell'aorta discendente è inferiore a quello dei segmenti aortici prossimali e va da 2.0 a 2.5 cm



Stenosi aortica



A.D. anni 65, Kg 72

DTDVS SIV

DTSVS PP

FE > 60%

AS: 44 mm

V. MITRALE: IM severa

v. AORTICA: IAO lieve

v. TRICUSPIDE: Itr moderata

PAPs 42 mmHg

CONCLUSIONI:

Insufficienza mitralica di
grado severo
secondaria a prolasso
del lembo posteriore.

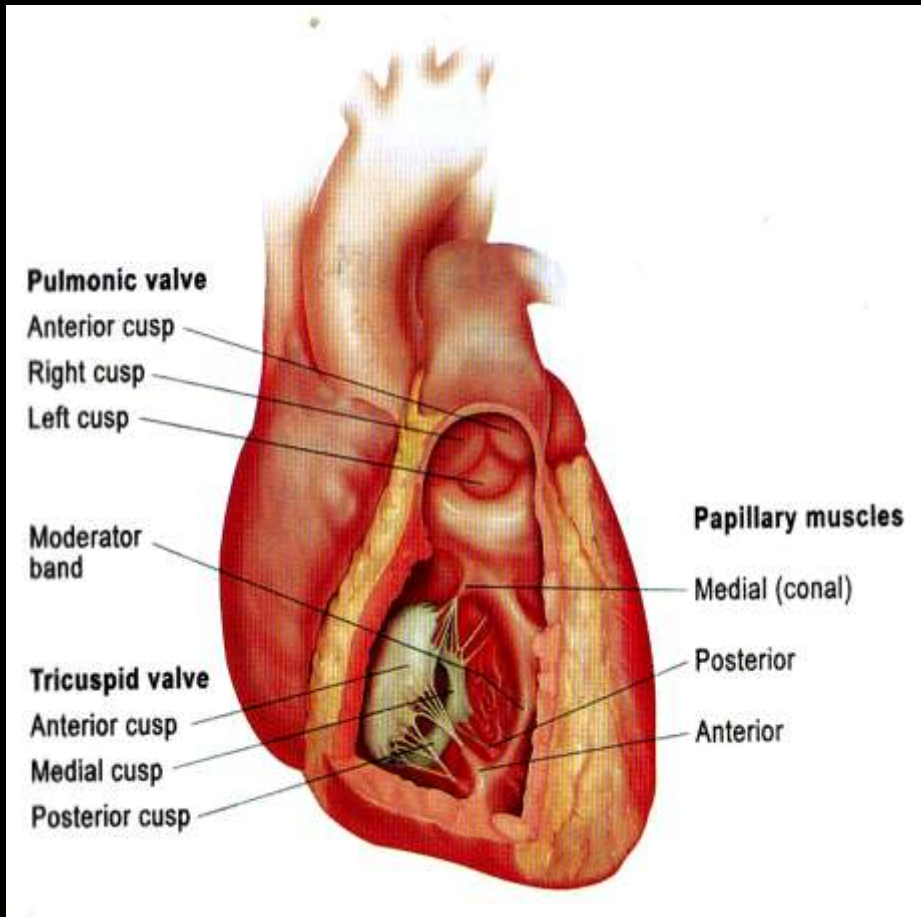
CD con clips?



grazie



Tricuspid valve and right ventricle



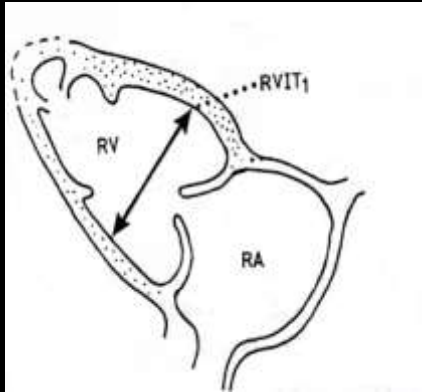
The **SEPTAL** or **MEDIAL leaflet** has multiple tendinous cords attaching it directly to the ventricular septum.

The **ANTERIOR** or **SUPERIOR leaflet** is large and supported in its mid portion by a large papillary muscle that usually arises from the moderator band close to its insertion to the parietal wall.

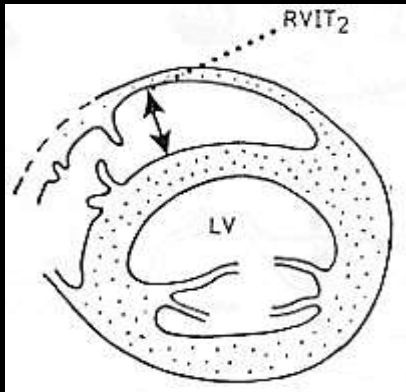
It may show 3 scallops

The **POSTERIOR** or **INFERIOR leaflet** is supported by several small papillary muscles which arise from the diaphragmatic wall.

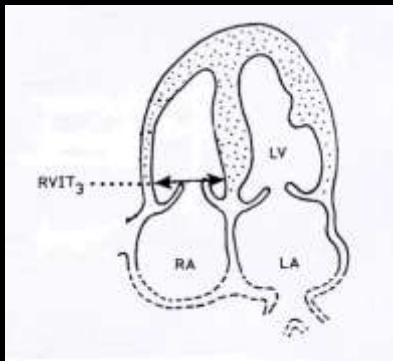
RIGHT VENTRICULAR INFLOW TRACT: sinus



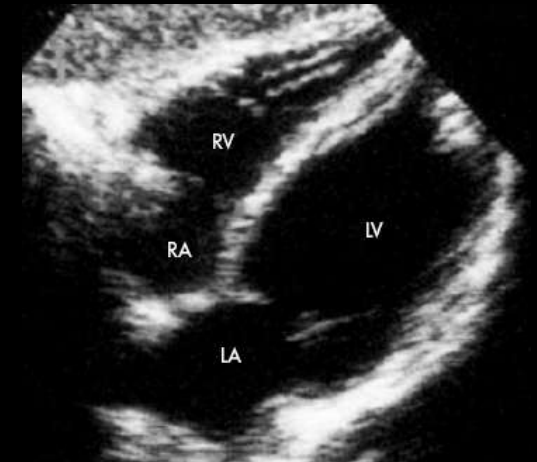
Parasternal RV inflow



Parasternal short axis

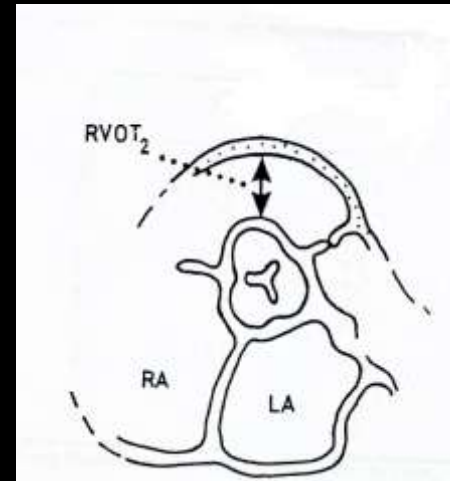
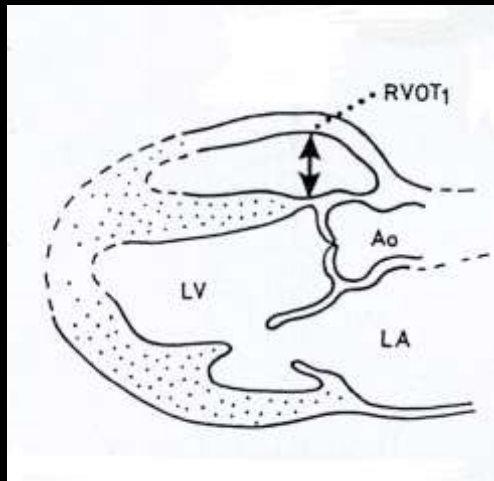


Apical
4 chamber



Subcostal 4 chamber

RIGHT VENTRICULAR OUTFLOW TRACT: infundibulum



Parasternal long axis view



Parasternal short axis view

La correzione della ITr funzionale è raccomandata contemporaneamente alla correzione di una valvulopatia sinistra quando è moderata o severa. La non correzione può influenzare negativamente la prognosi a distanza.

Quando operare la tricuspide?

- Itr severa
- Itr moderata con dilatazione anello (40 mm)
- Atrio destro ingrandito
- FA cronica

Possibilità chirurgiche:

- 1) Anuloplastica (De Vega) con anulus moderatamente dilatato
- 2) Anello protesico se anulus > 42 mm
- 3) Sostituzione valvolare

Quando operare la tricuspide?

La funzione del VD è uno dei principali parametri di valutazione del rischio operatorio:

- Diam VD > 4 cm in 4 camere apicale
- TAPSE: < 14 mm disfunzione moderata
< 8 mm disfunzione severa
- TDI: S < 11.5 cm/s correla con FE <45%
< 5 cm/s correla con FE <30%

Quando è presente una disfunzione del VD secondaria ad un aumento delle resistenze polmonari, l'intervento sulla tricuspide presenta un elevato rischio operatorio e non garantisce alcun miglioramento della prognosi e della qualità di vita.

Quando la Itr è secondaria a malattia della valvola mitrale e/o aortica, l'intervento principale è spesso sufficiente per ottenere una significativa riduzione del grado di Itr grazie al calo della wedge pressure e della pressione polmonare

ACC/AHA Guidelines support concomitant tricuspid repair

ACC/AHA PRACTICE GUIDELINES

ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease)

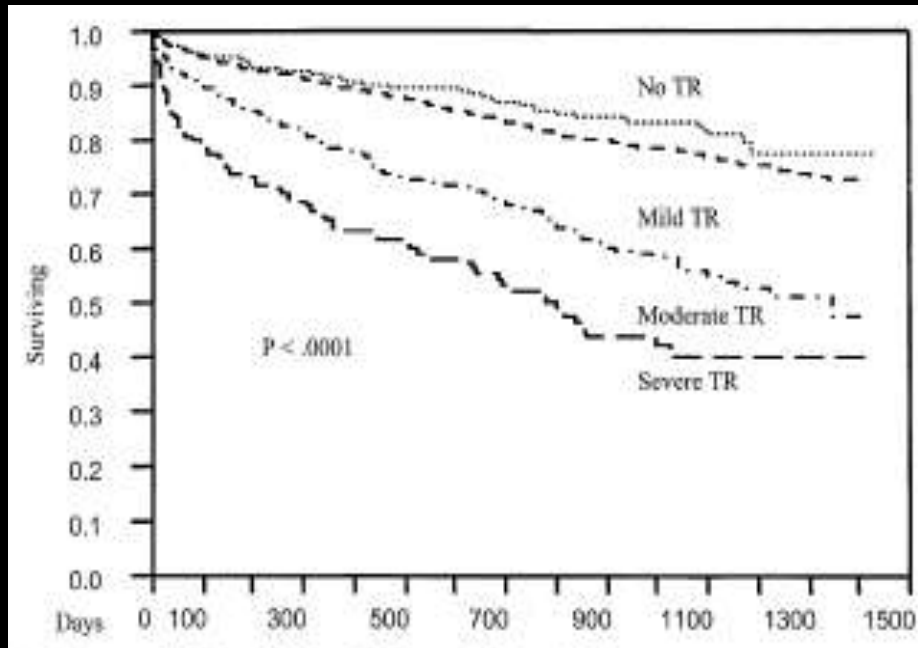
“Tricuspid annuloplasty is reasonable for mild TR in patients undergoing MV repair when there is tricuspid **annular dilatation** or pulmonary hypertension “ (???)

“TR associated with dilatation of the tricuspid annulus should be repaired because tricuspid dilatation is an ongoing process that may progress to severe TR if left untreated.”

“Annuloplasty of the tricuspid valve based on tricuspid dilatation improves functional status **independent of the degree of TR.**”

¹Bonow RO, Carabello BA, Catterjee K, et al. ACC/AHA 2006 Guidelines for the Management of Patients with Valvular Heart Disease. *J Am Coll Cardiol.* 2006 Aug 1;48(3):e1-148.

The development of functional TR is directly associated with increased morbidity and mortality



Nath et al J Am Coll Cardiol 2004; 43 405

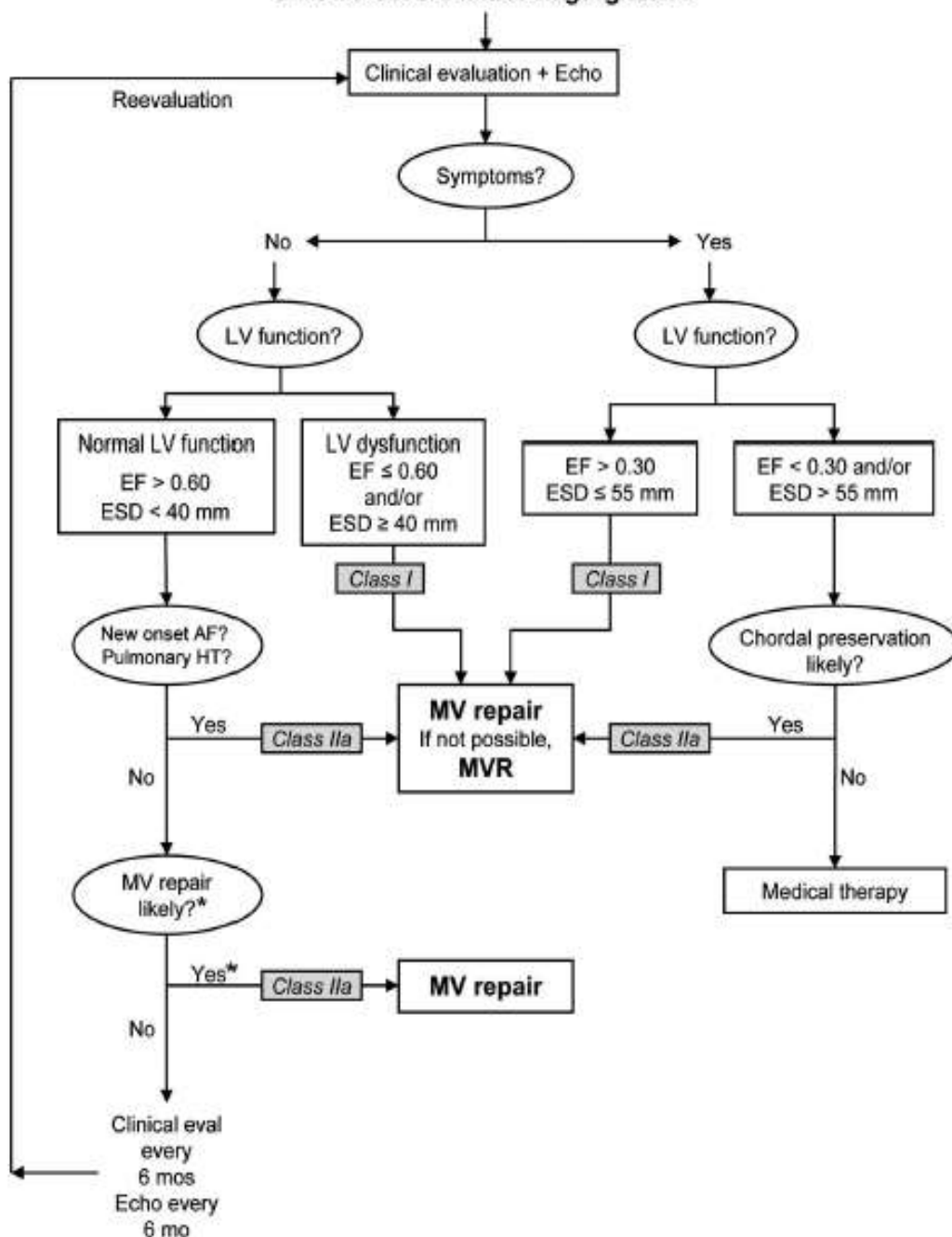
ITR FUNZIONALE

- Non regredisce
- Può peggiorare
- Peggiora la funzione del ventricolo destro
- Un reintervento è ad alto rischio
- La terapia medica è poco efficace

IM degenerativa: quando operare

- Asintomatici con rigurgito severo
- Deterioramento funzione VS (FE < 60%, DTSSVS > 40-45 mm)
- Pazienti asintomatici con normale funzione del VS in presenza di FA o ipertensione polmonare (> 50 mmHg basale o >60 mHg durante sforzo), quando la riparazione si presenta ottimale e duratura

Chronic Severe Mitral Regurgitation



MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and new onset of atrial fibrillation. (Level of Evidence: C)

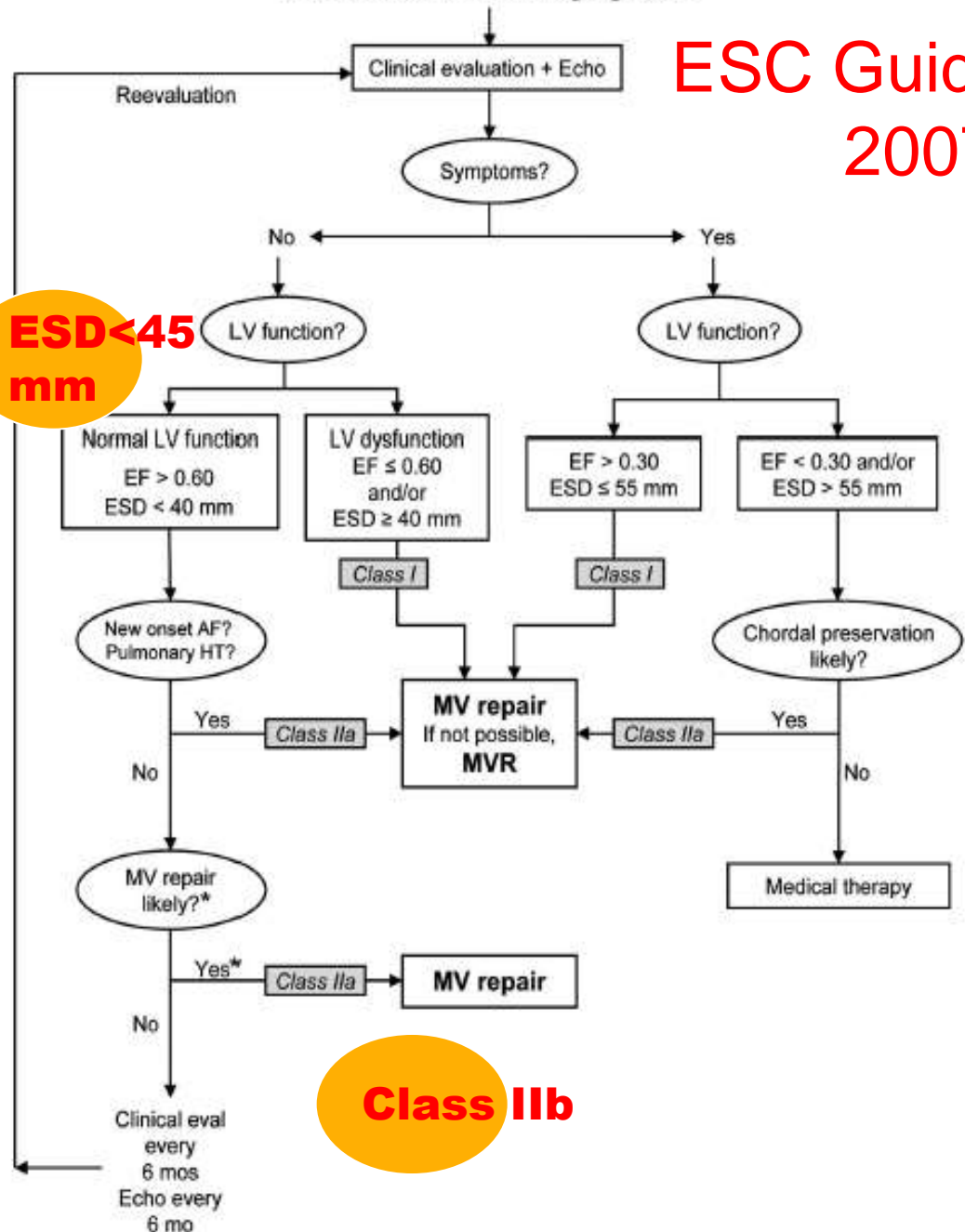
MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). (Level of Evidence: C)

ACC/AHA 2006 Guidelines for the Management of patients with Valvular Heart Disease

Chronic Severe Mitral Regurgitation

ESC Guidelines 2007

ESD < 45 mm



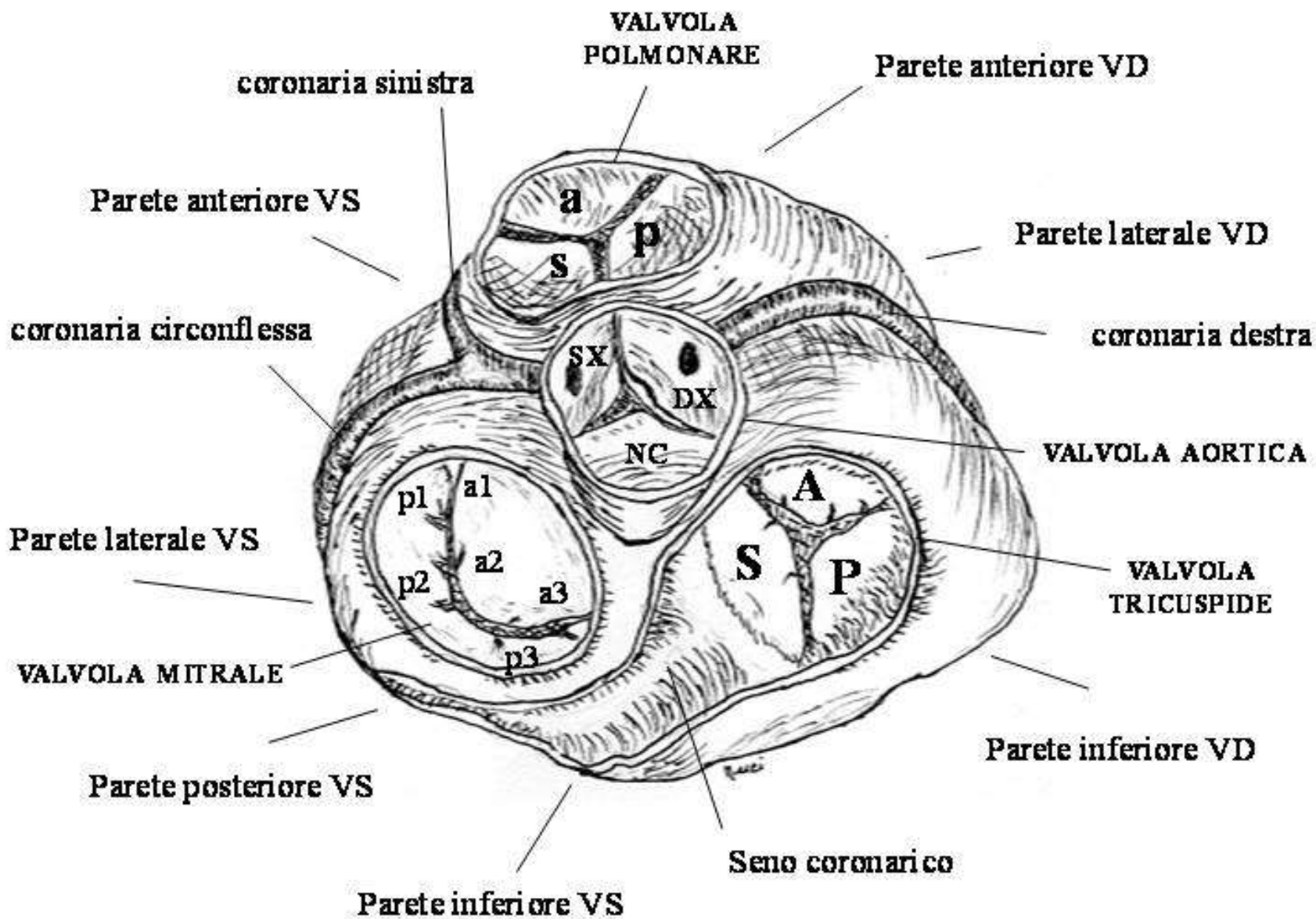
Class IIb

MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and new onset of atrial fibrillation. (Level of Evidence: C)
 MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). (Level of Evidence: C)

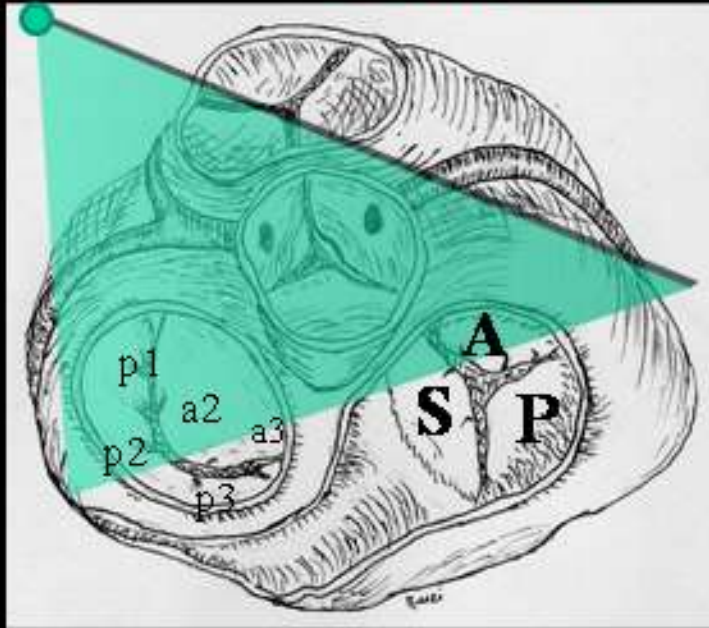
ACC/AHA 2006 Guidelines for the Management of patients with Valvular Heart Disease

Apparati valvolari

- Morfologia della valvola
- Entità della insufficienza o della stenosi
- Funzione ventricolare sx e dx
- Dimensioni delle camere cardiache (anche atri)
- Individuazione di valvulopatie associate
- Stima della pressione in arteria polmonare

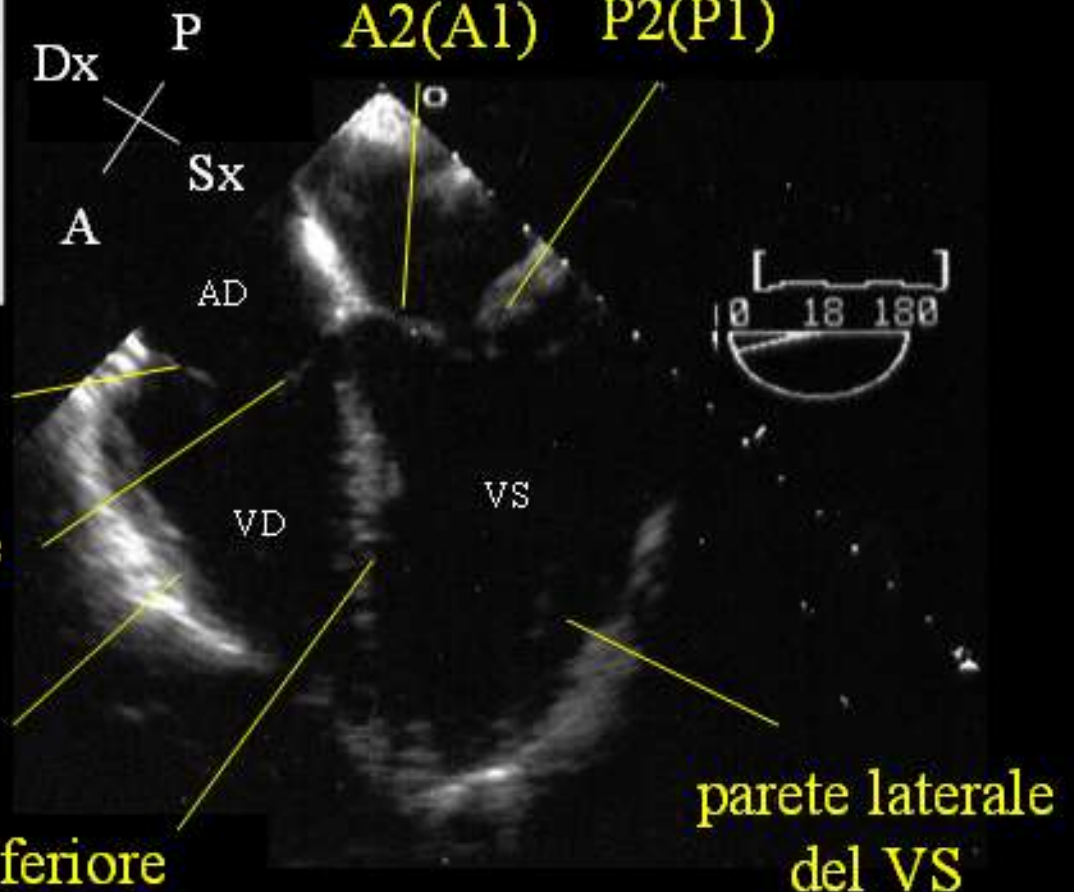


0 GRADI



4 CAMERE

**Valvola mitrale:
A2(A1) P2(P1)**



tricuspide: lembo anteriore

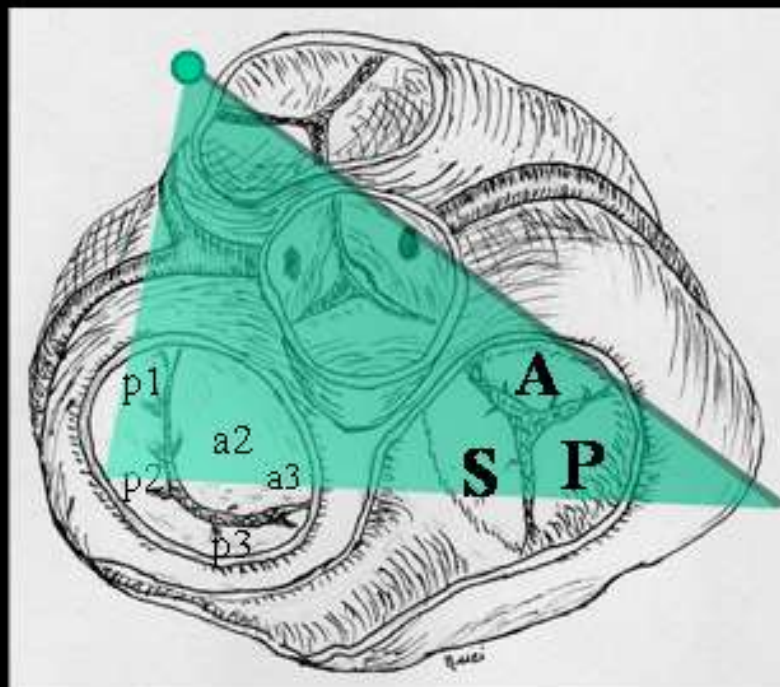
tricuspide: lembo settale

parete laterale del VD

setto interv. inferiore

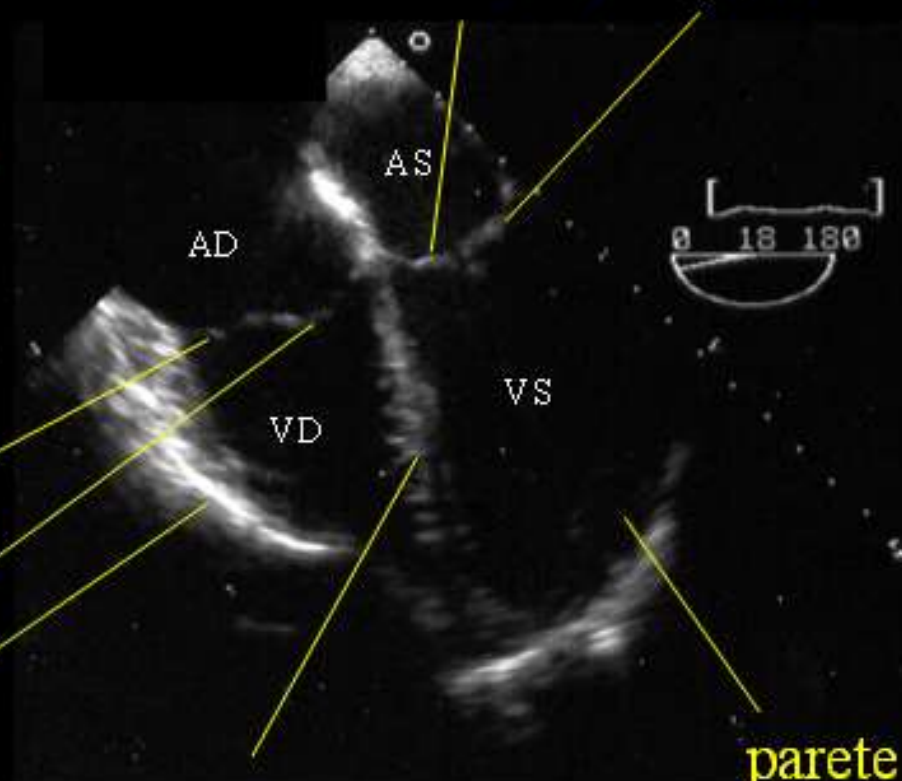
**parete laterale
del VS**

0 -15 GRADI sonda retroflessa



4 CAMERE

valvola mitrale:
A2 (A3) P2(P3)



tricuspide: lembo posteriore

tricuspide: lembo settale

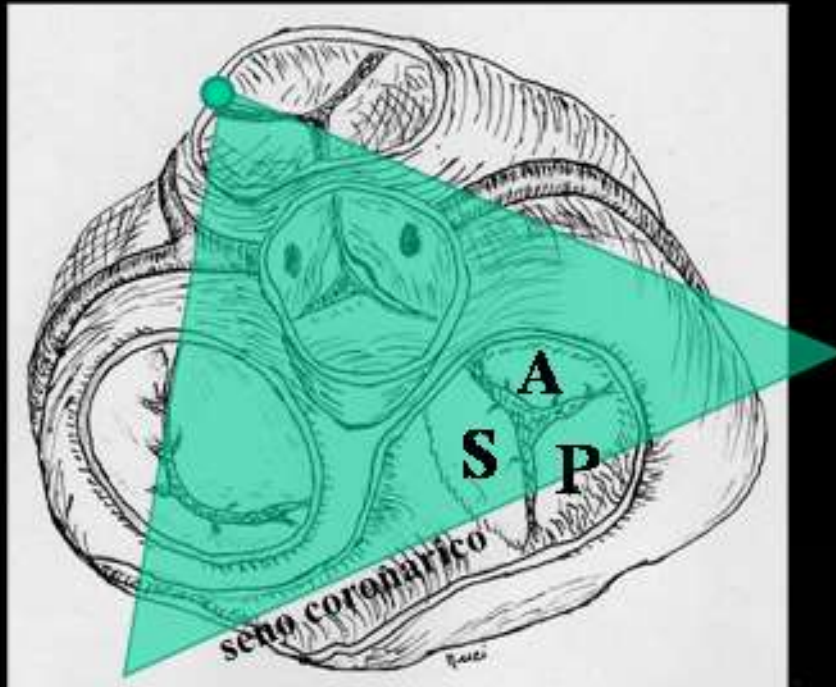
parete infero-laterale
del VD

setto interv. inferiore

parete
laterale del VS

0-20 GRADI

SENO CORONARICO



seno coronarico

AD

VD

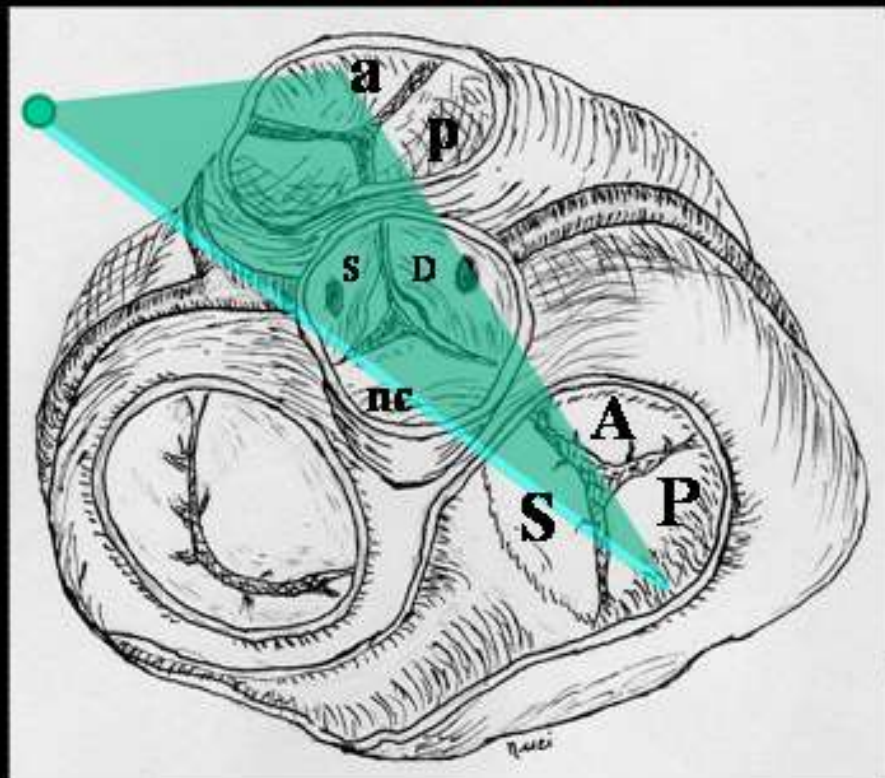
0 22 180

tricuspide: lembo settale

tricuspide: lembo posteriore

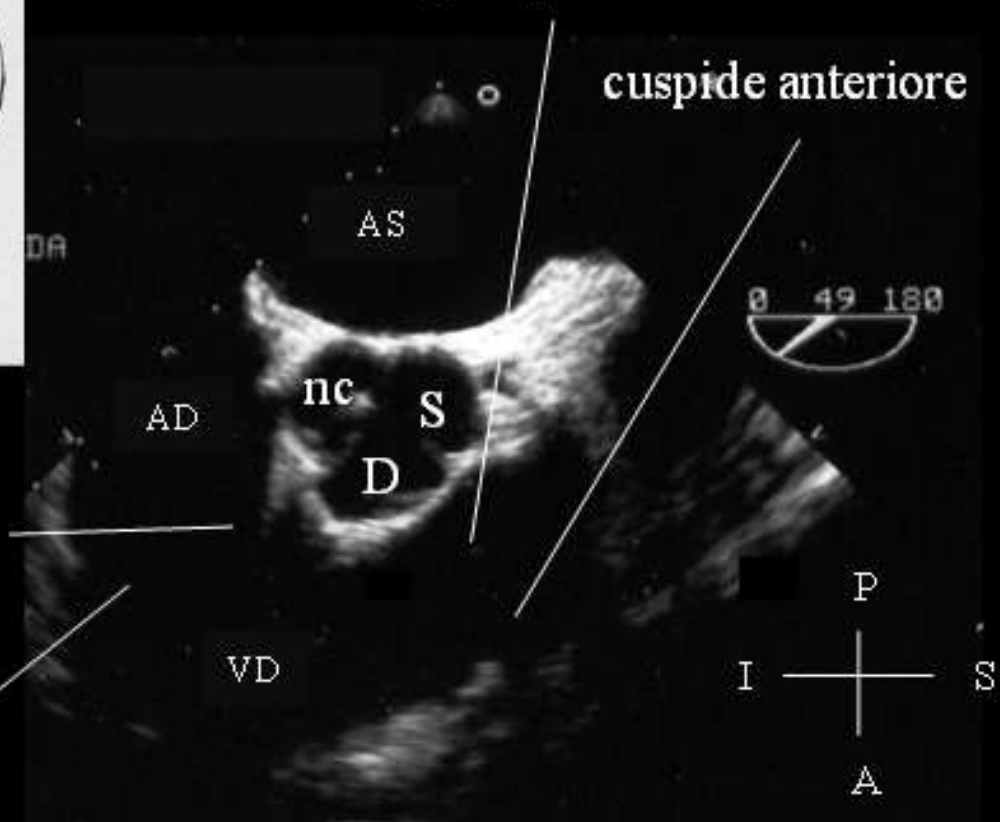
parete inferiore del VD

30-50 GRADI



ASSE CORTO VALVOLA AORTICA

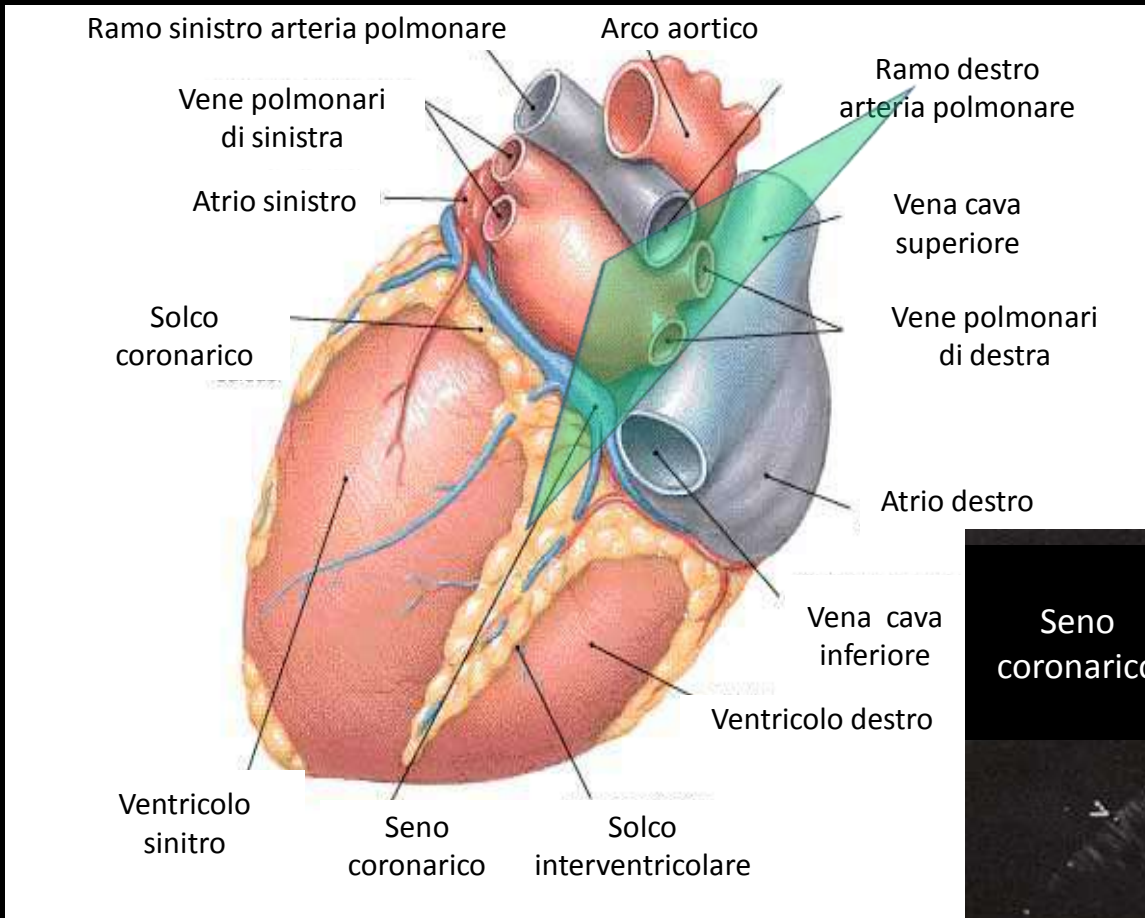
valvola polmonare:
cuspidi posteriore



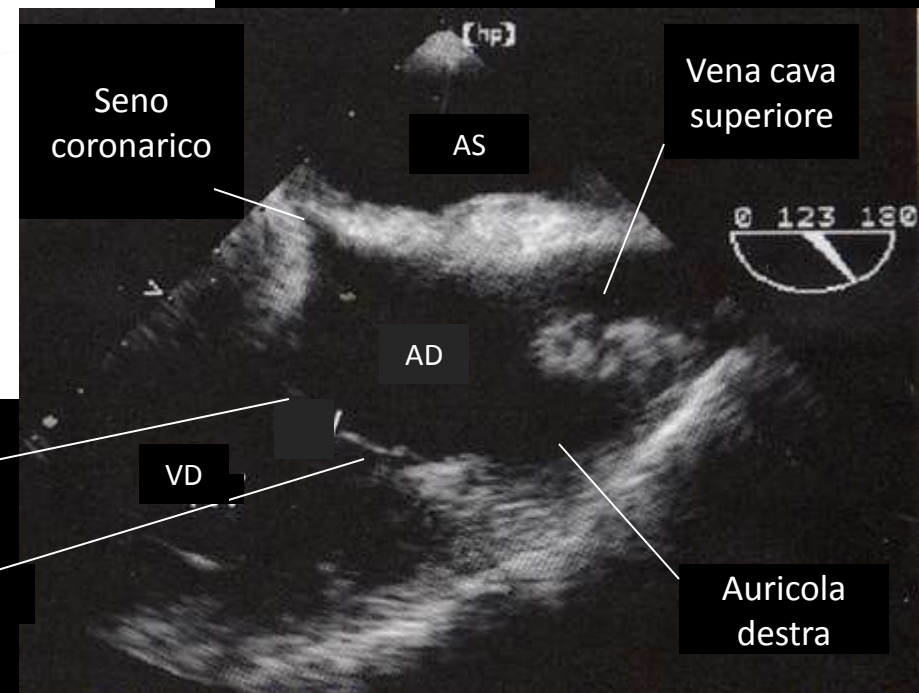
tricuspide: lembo anteriore
o settale

tricuspide: lembo posteriore

BICAVALE modificata per la tricuspide



100-120 GRADI con lieve rotazione in senso antiorario

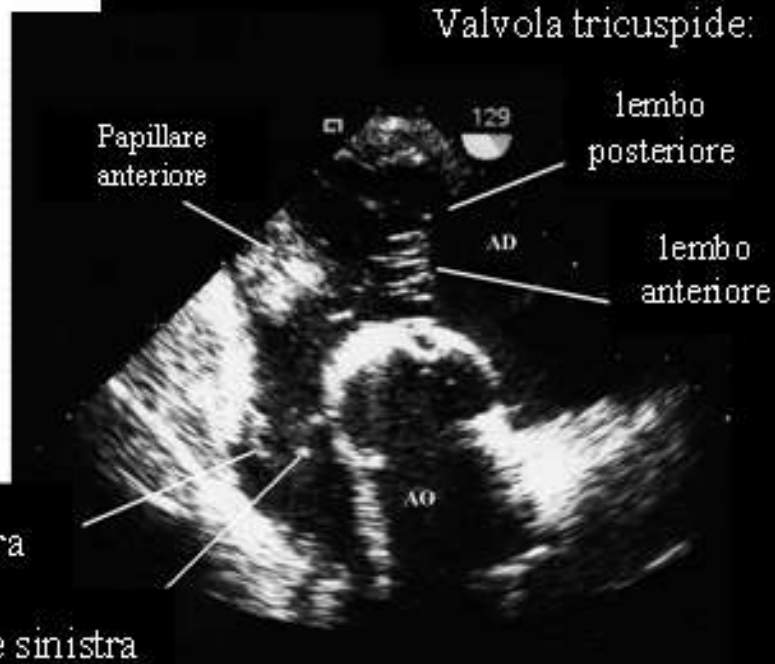
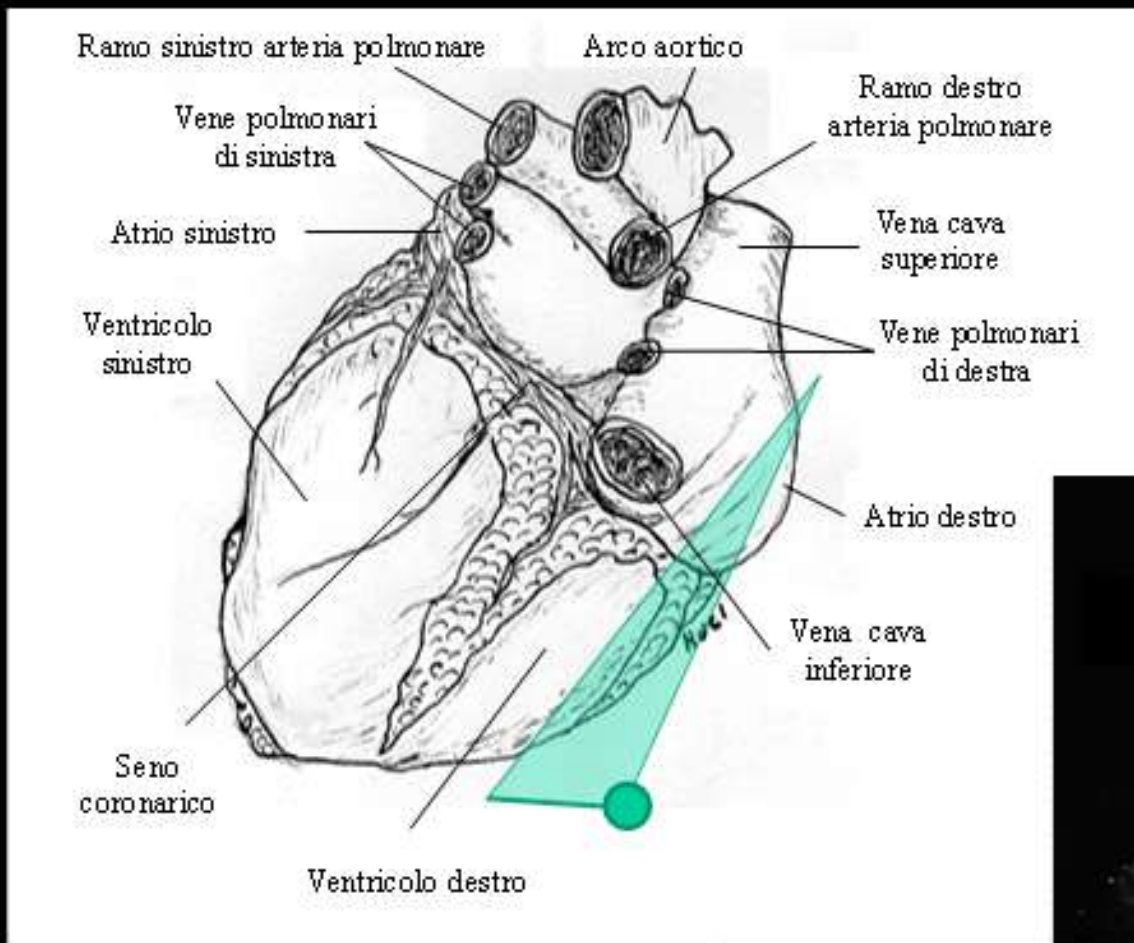


lembo posteriore

lembo anteriore

Transgastrica profonda per il ventricolo destro

120-130 gradi



Valvola polmonare: cuspide destra
cuspide sinistra