Vall d'Hebron
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ECHO ASSESSMENT OF AR AND ITS MECHANISMS

Arturo Evangelista

Investigations in AR

ESC/EACTS Guidelines (Vahanian A et al 2012)
EAE recommendations (Lancellotti 2010)

Echocardiography (TTE) is indicated:

- **To confirm the diagnosis and severity of AR**
- **To assess the mechanism of AR and the feasibility for valve repair. TOE may be necessary when valve repair or valve spare surgery is considered.**
- **To assess LV dimensions (indexing in small bsa pts), and systolic function (EF, tissue Doppler imaging and strain rate)**
- **To assess aortic root size (annulus, sinus of V, sino-tubular junction ams ascending aorta)**
- **For periodic reevaluation of LV size and function**

Echocardiographic criteria for the definition of severe valve regurgitation: *an integrative approach*

	Aortic regurgitation	Mitral regurgitation		Tricuspid regurgitation
Semiquantitative				
Vena contracta width (mm)	> 6	≥ 7 (> 8 for biplane)		≥ 7
Upstream vein flow	–	Systolic pulmonary vein flow reversal		Systolic hepatic vein flow reversal
Inflow	–	E-wave dominant ≥ 1.5 m/s		E-wave dominant ≥ 1 m/s
Other	Pressure half-time < 200 ms	TVI mitral/TVI aortic > 1.4		PISA radius > 9 mm
Quantitative		*Primary*	*Secondary*	
EROA (mm^2)	≥ 30	≥ 40	≥ 20	≥ 40
R Vol (ml/beat)	≥ 60	≥ 60	≥ 30	≥ 45
+ enlargement of cardiac chambers/ vessels	LV	LV, LA		RV, RA, inferior vena cava

Adapted from Lancellotti, EAE recommendations. *Eur J Echocardiogr.* 2010;11:223-244 and 307-332

European Heart Journal 2012 - doi:10.1093/eurheartj/ehs109 & European Journal of Cardio-Thoracic Surgery 2012 - doi:10.1093/ejcts/ezs455).

www.escardio.org/guidelines

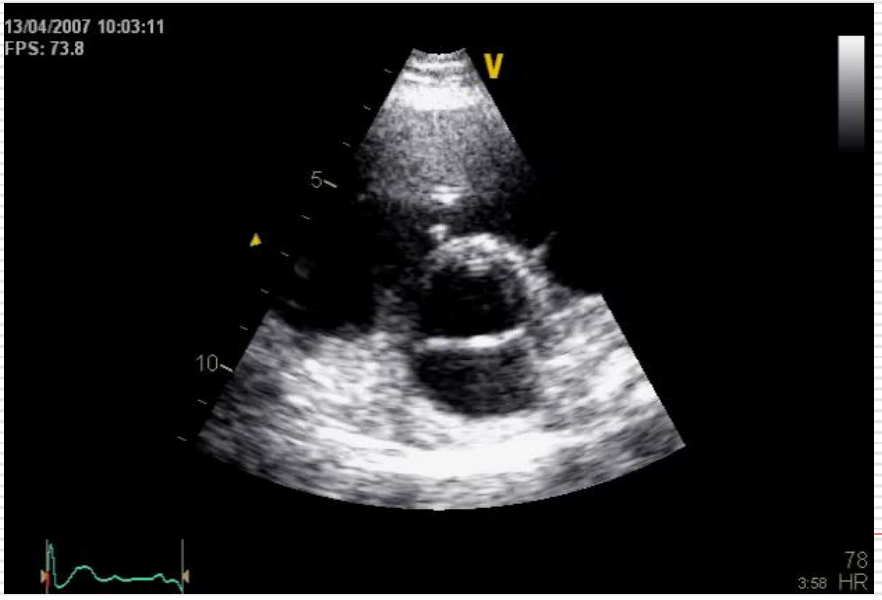
EACTS

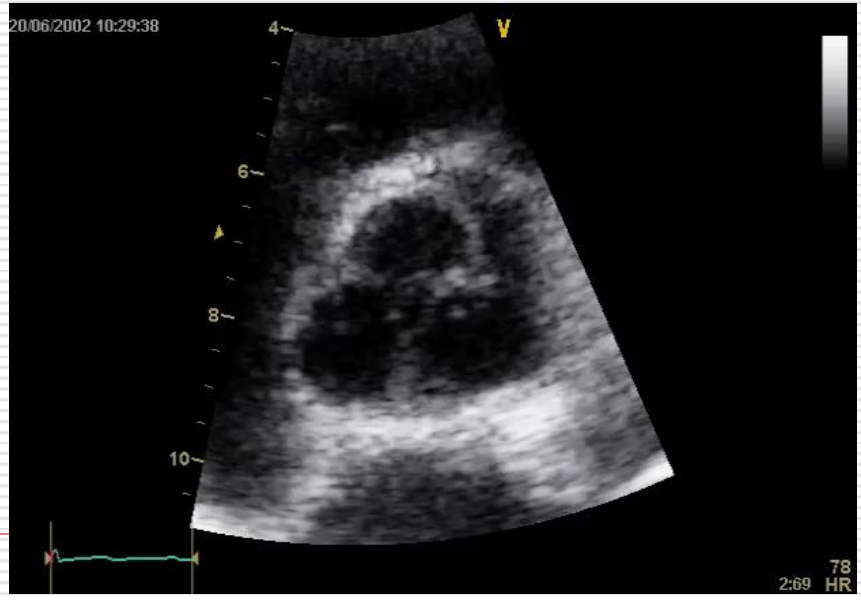
EUROPEAN SOCIETY OF CARDIOLOGY®

Mechanism of Aortic Regurgitation

Valvular disease	**Aortic root dilatation**
Bicuspid valve	Aneurysm of AA or aortic root
Sclerosis	Annuloaortic ectasia
Rheumatic	Dissection
Degenerative	Hypertension
Endocarditis	

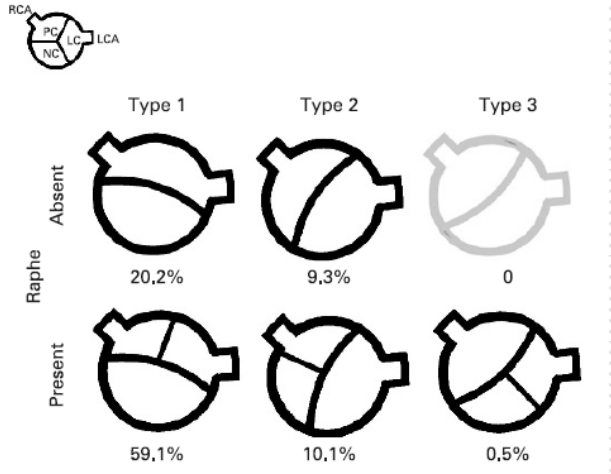
Bicuspid aortic valve





Aortic Valve Degeneration

BAV phenotypes



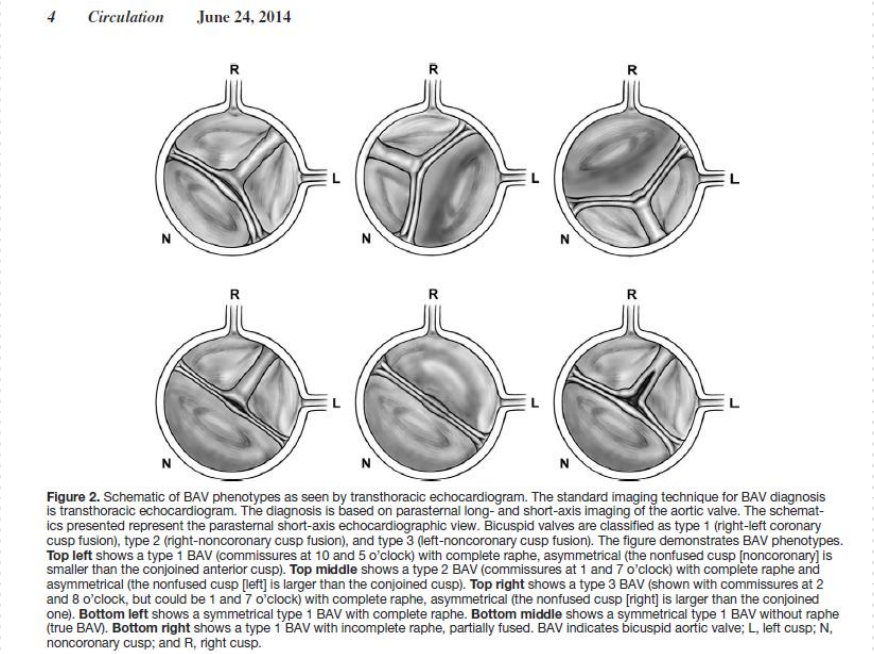
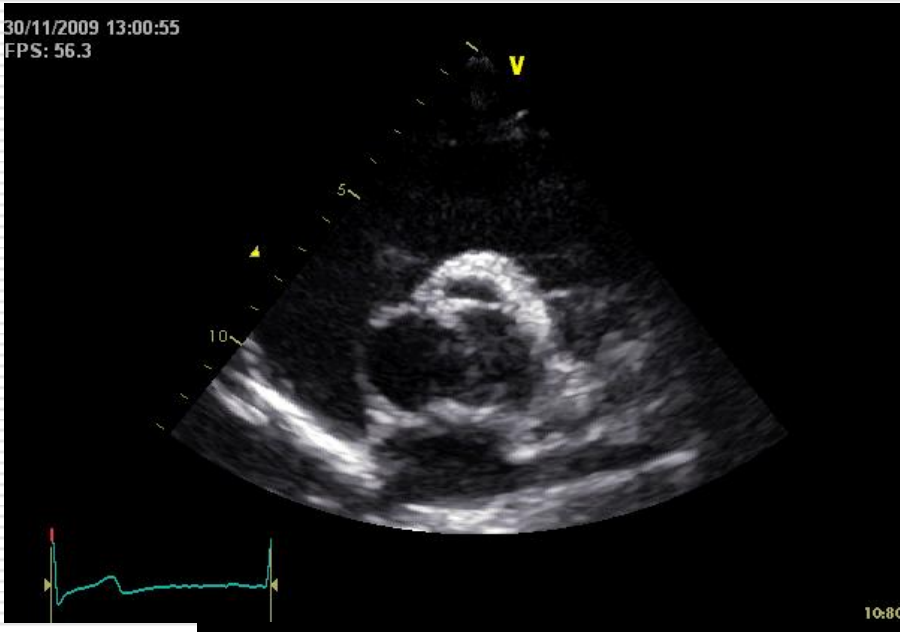


Figure 2. Schematic of BAV phenotypes as seen by transthoracic echocardiogram. The standard imaging technique for BAV diagnosis is transthoracic echocardiogram. The diagnosis is based on parasternal long- and short-axis imaging of the aortic valve. The schematics presented represent the parasternal short-axis echocardiographic view. Bicuspid valves are classified as type 1 (right-left coronary cusp fusion), type 2 (right-noncoronary cusp fusion), and type 3 (left-noncoronary cusp fusion). The figure demonstrates BAV phenotypes. **Top left** shows a type 1 BAV (commissures at 10 and 5 o'clock) with complete raphe, asymmetrical (the nonfused cusp [noncoronary] is smaller than the conjoined anterior cusp). **Top middle** shows a type 2 BAV (commissures at 1 and 7 o'clock) with complete raphe and asymmetrical (the nonfused cusp [left] is larger than the conjoined cusp). **Top right** shows a type 3 BAV (shown with commissures at 2 and 8 o'clock, but could be 1 and 7 o'clock) with complete raphe, asymmetrical (the nonfused cusp [right] is larger than the conjoined one). **Bottom left** shows a symmetrical type 1 BAV with complete raphe. **Bottom middle** shows a symmetrical type 1 BAV without raphe (true BAV). **Bottom right** shows a type 1 BAV with incomplete raphe, partially fused. BAV indicates bicuspid aortic valve; L, left cusp; N, noncoronary cusp; and R, right cusp.

Schaefer BM, Heart 2008:1634-8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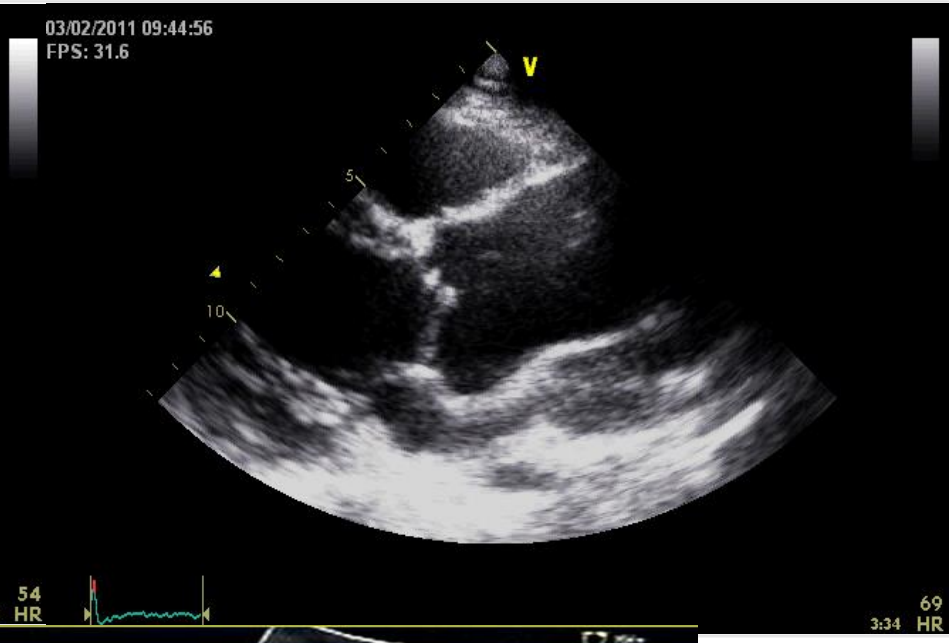
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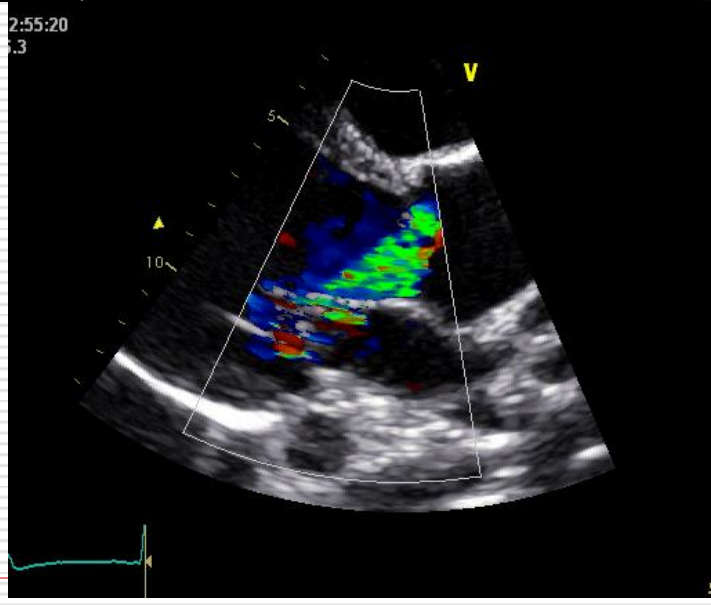
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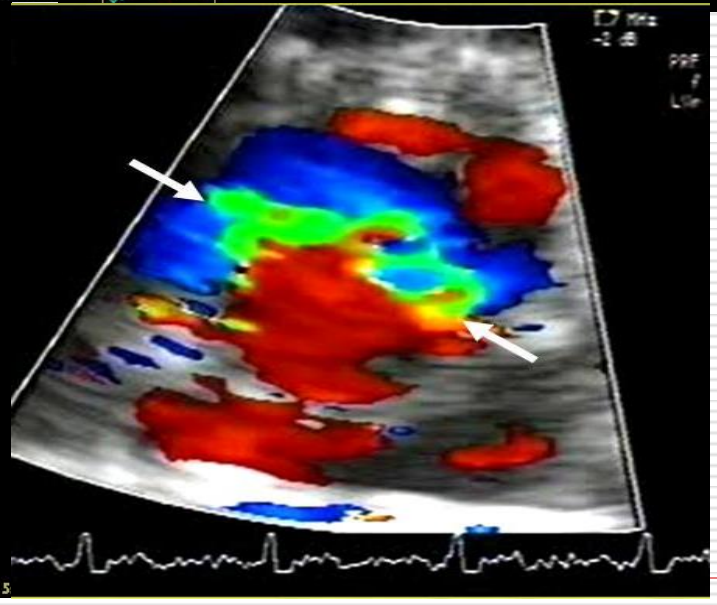
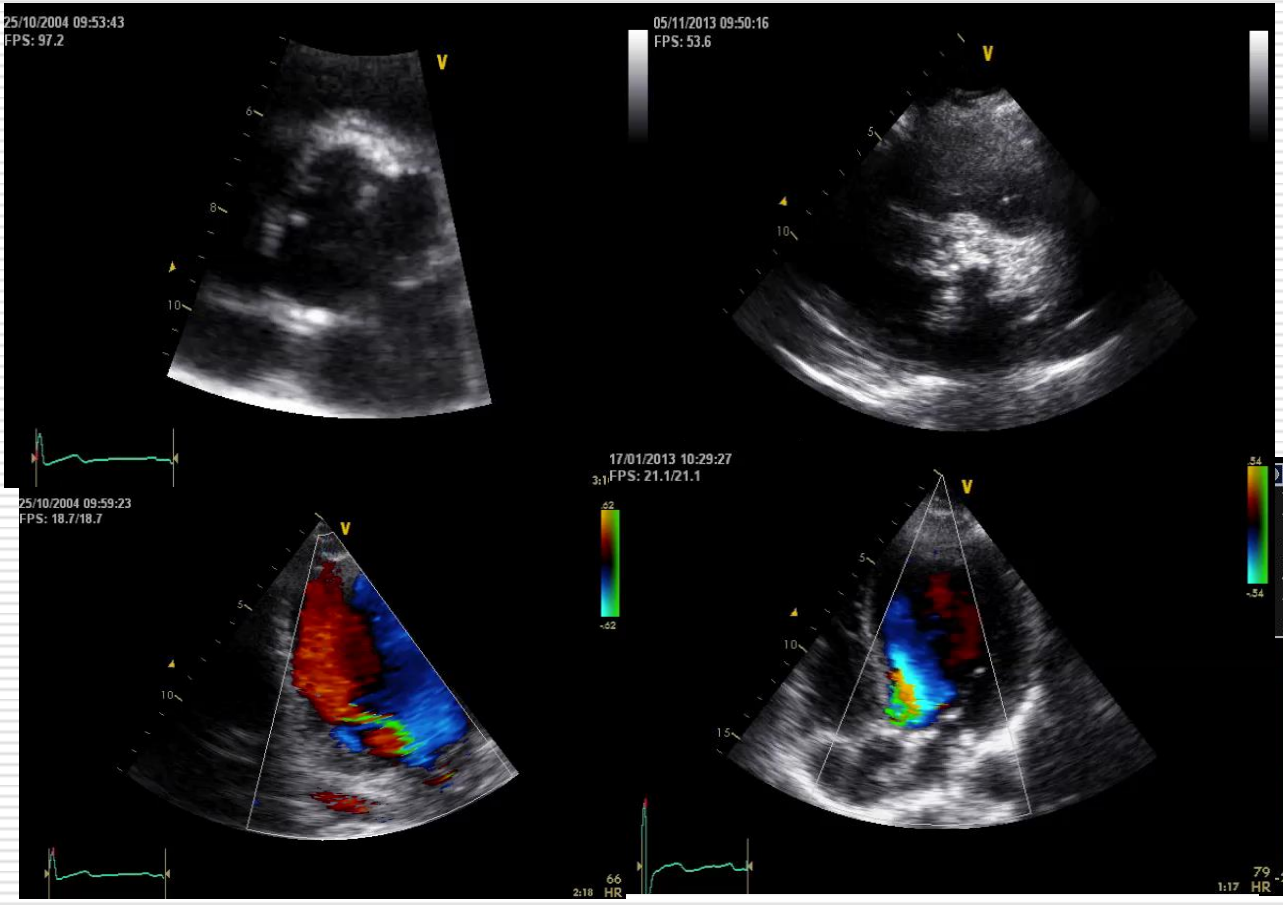
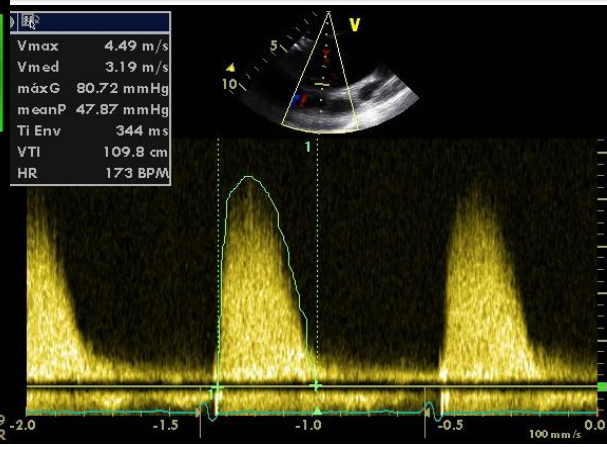


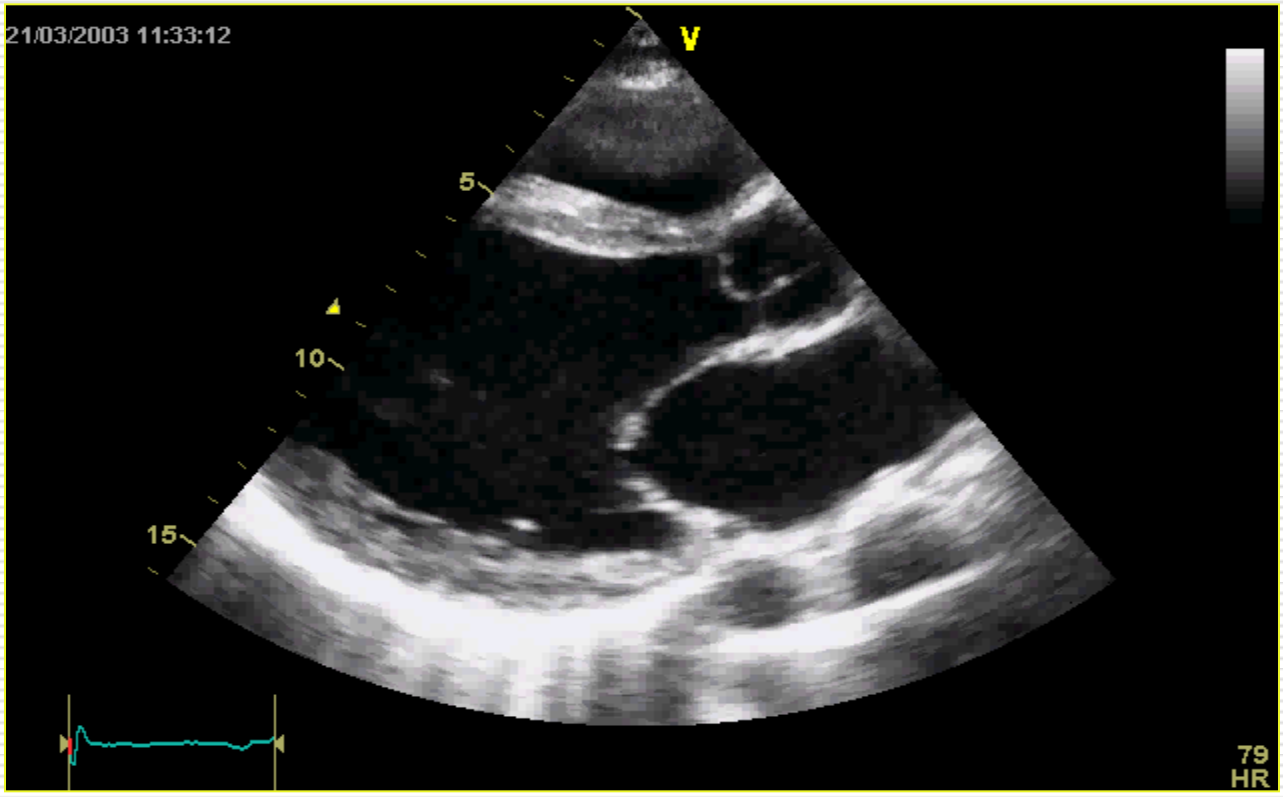
Evolution of aortic valve dysfunction 24y-old man

2004 2014



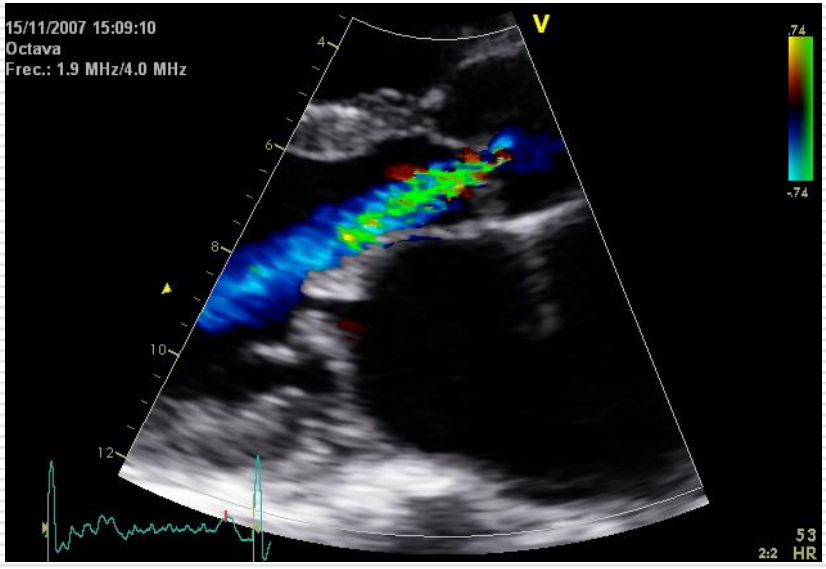


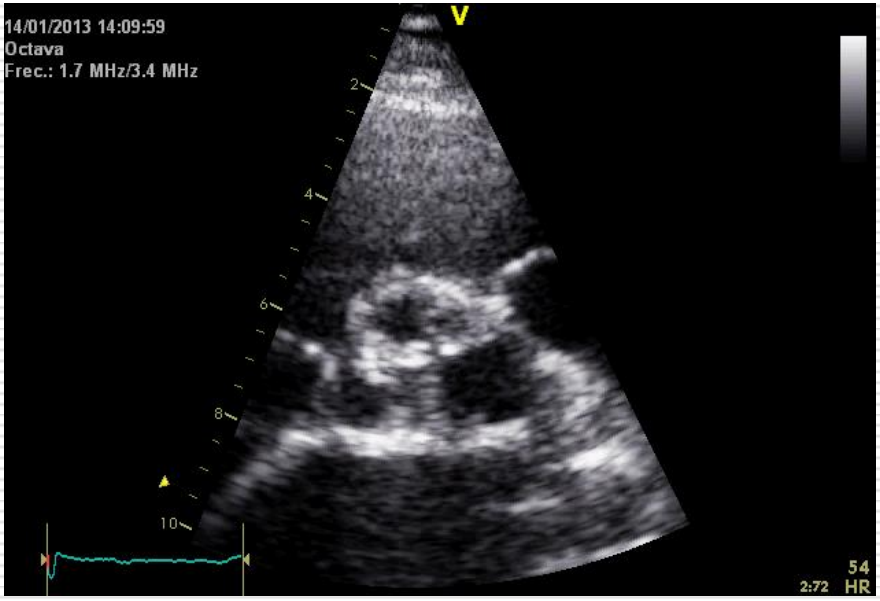
Aortic Valve Prolapse



Linked videos

Rheumatic disease



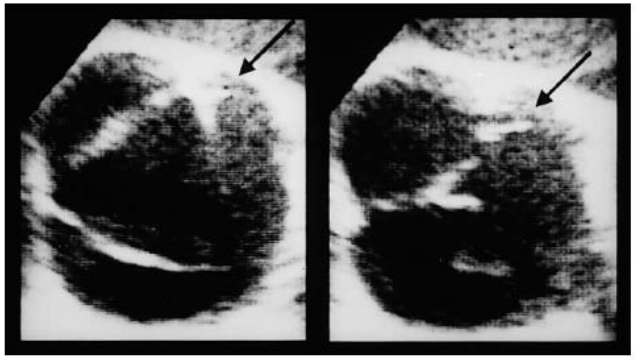


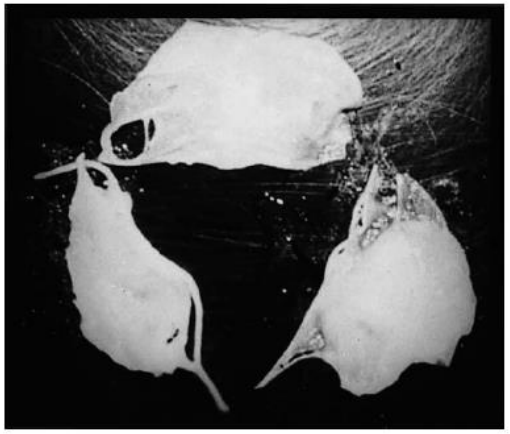
Circ J 2004; **68:** 439–443

Pathogenetic Significance of Myxomatous Degeneration in Fenestration-Related Massive Aortic Regurgitation

Kazuya Akiyama, MD; Jun Hirota, MD; Naohito Taniyasu, MD; Kazuma Maisawa, MD;
Yutaka Kobayashi, MD; Masatoshi Tsuda, MD

a





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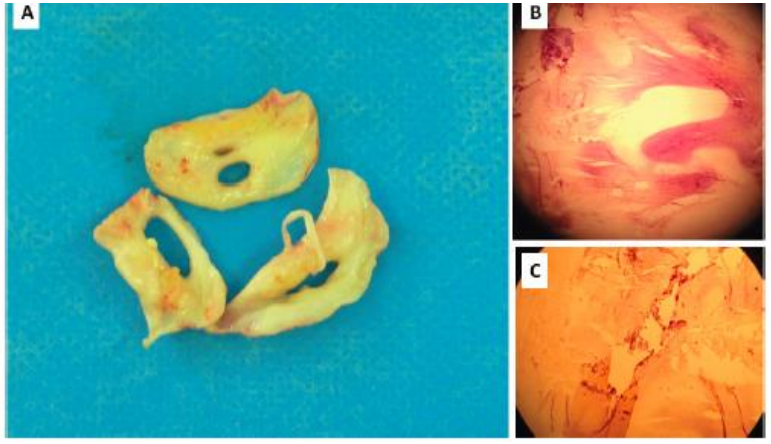


Aortic valve reconstruction in myxomatous degeneration of aortic valves: Are fenestrations a risk factor for repair failure?

Hans-Joachim Schäfers, MD,[a] Frank Langer, MD,[a] Petra Glombitza, MD,[a] Takashi Kunihara, MD,[a] Roland Fries, MD,[b] and Diana Aicher, MD[a]

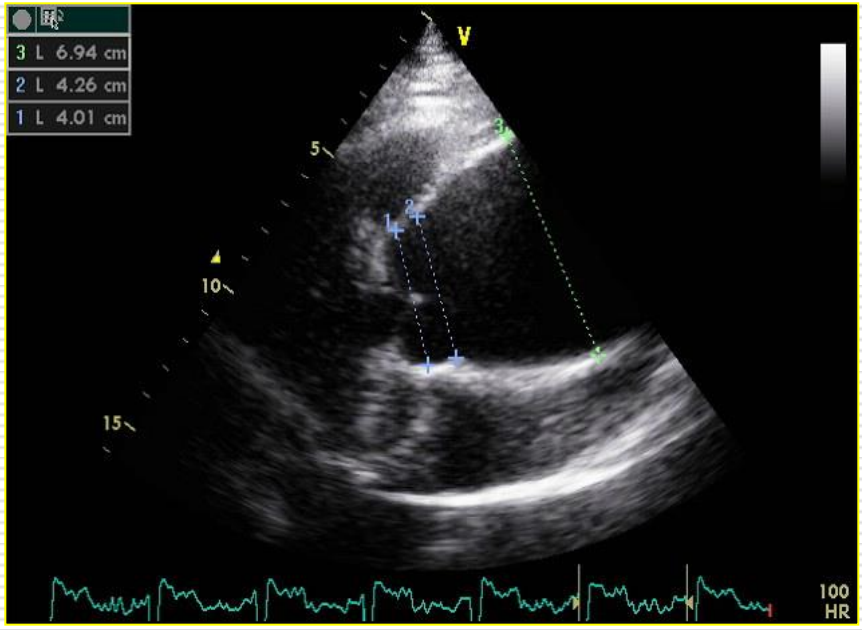
Objective: Aortic valve repair is a more recent approach for the treatment of aortic regurgitation. Limited data exist for reconstruction in specific pathologies with isolated cusp pathology. We analyzed the results of aortic valve repair in patients with aortic regurgitation caused by myxomatous cusp prolapse in the presence of tricuspid valve anatomy and normal root size.

Methods: Over a 12-year period, 111 patients underwent aortic valve reconstruction for regurgitant tricuspid aortic valves without concomitant root dilatation. Cusp prolapse was caused by myxomatous degeneration in 72 subjects (group I) and associated with fenestrations in 39 subjects (group II). Prolapse was corrected by means of plication of the free margin in the presence of normal cusp tissue only ($n = 62$) or combined with triangular resection of cusp tissue ($n = 10$). It was treated with additional closure of the fenestration with autologous pericardium in 39 instances (group II). Follow-up was complete in 98.5% (cumulative 385 years).

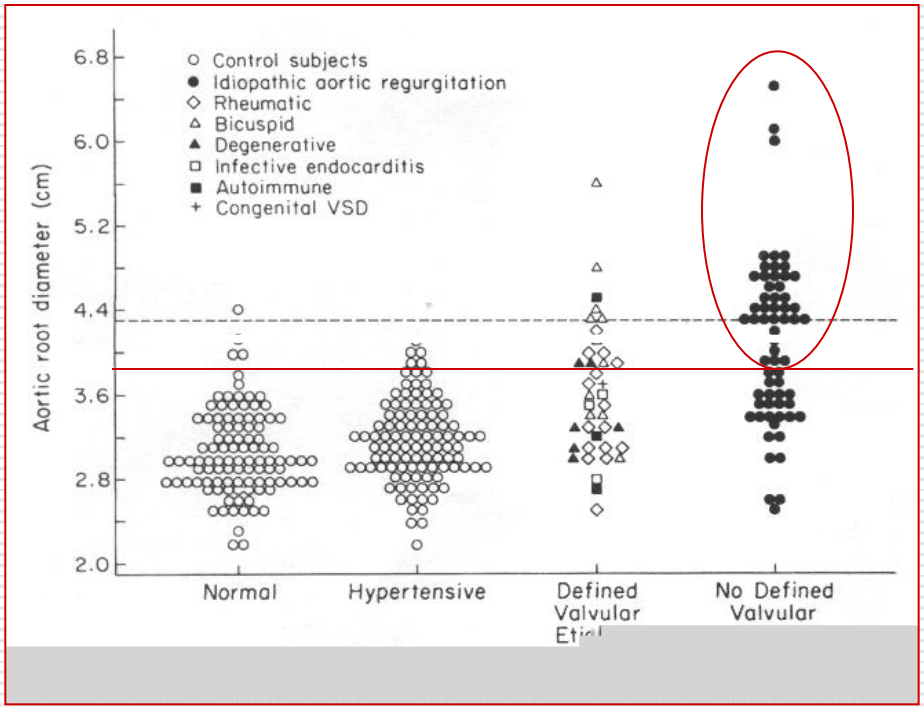
Results: Hospital mortality was 1.8%, and during follow-up, there was 1 thromboembolic event and no endocarditis. Freedom from reoperation at 5 and 8 years was 96%.

Conclusions: Isolated cusp prolapse is a relevant cause of aortic regurgitation in tricuspid aortic valves without concomitant root dilatation. In myxomatous stretching of cusp tissue, plication of the free margin suffices to restore cusp geometry and aortic valve function. In the presence of fenestrations, reconstruction of normal cusp configuration can be achieved by means of closure of the fenestration with a pericardial patch. The midterm stability of both approaches is good. (J Thorac Cardiovasc Surg 2010;139:660-4)

Aortic Valvular Disease
II - Aortic Dilation



Aortic Root Dilatation in Aortic Regurgitation



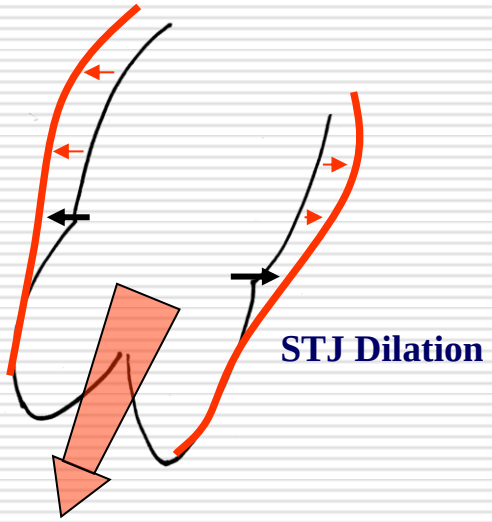
Roman MJ. Ann Intern Med 1987

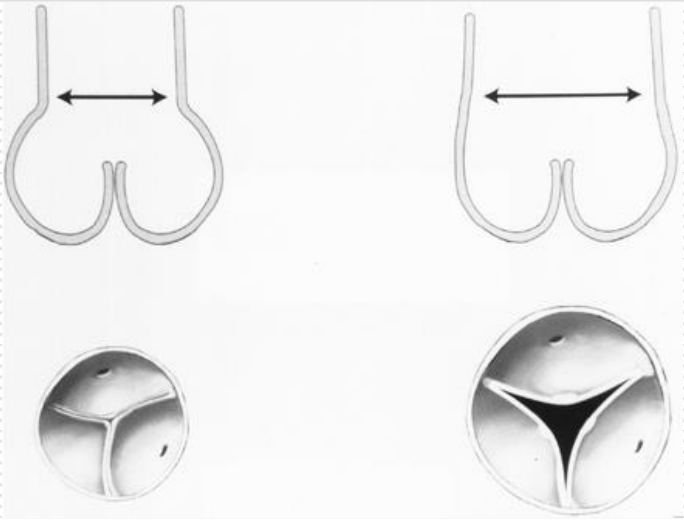
Functional Anatomy of Aortic Regurgitation

- Type I: Enlargement of the aortic root with normal cusp:
  - Ia: AA and STJ dilation
  - Ib: Valsalva sinuses and STJ dilation
  - Ic: Isolated aortic annulus/root dilation
- Type II: Cusp prolapse or fenestration
- Type III: Cusp retraction and thickening

Circulation 2007; 116:I-264-9

Type I:
Enlargement of the Aortic Root with Normal Cusp



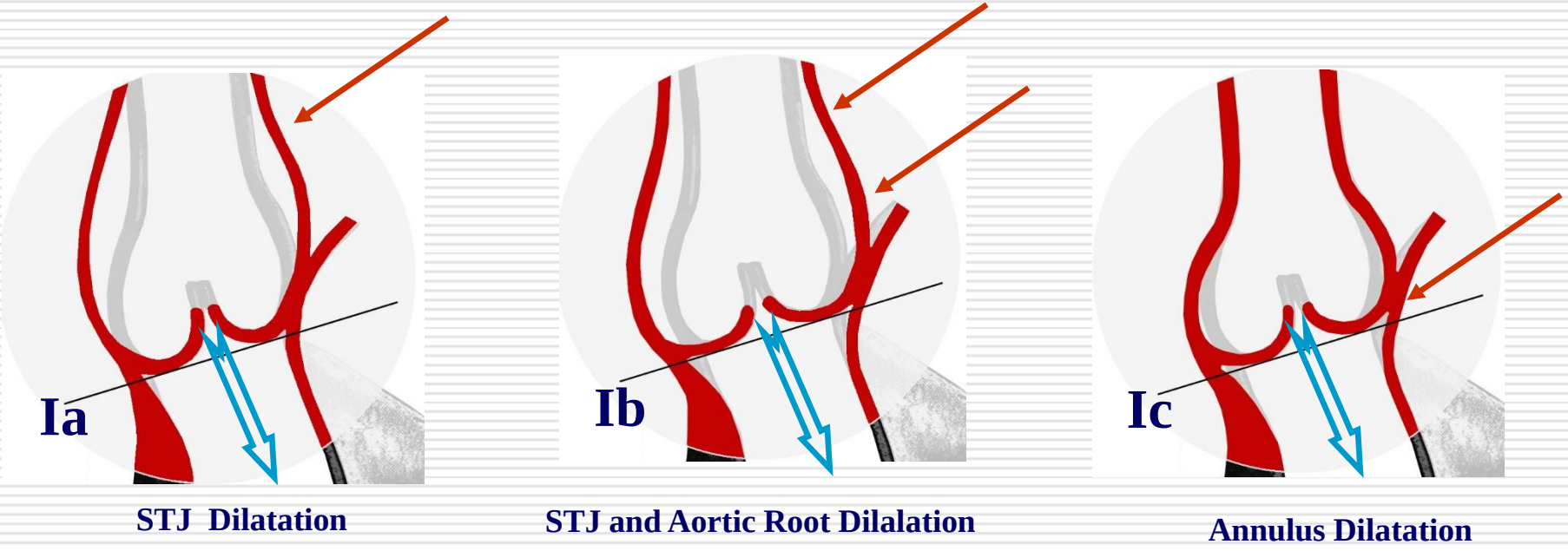


Mechanism of AR with STJ dilation:

Displacement of commissures outwards that restricts the free movement of the sigmoids and avoids correct closure of the valve. This leads to an increase in AR and further AA dilation

Furukawa et al. Ann Thorac Sur 1999; 68: 949

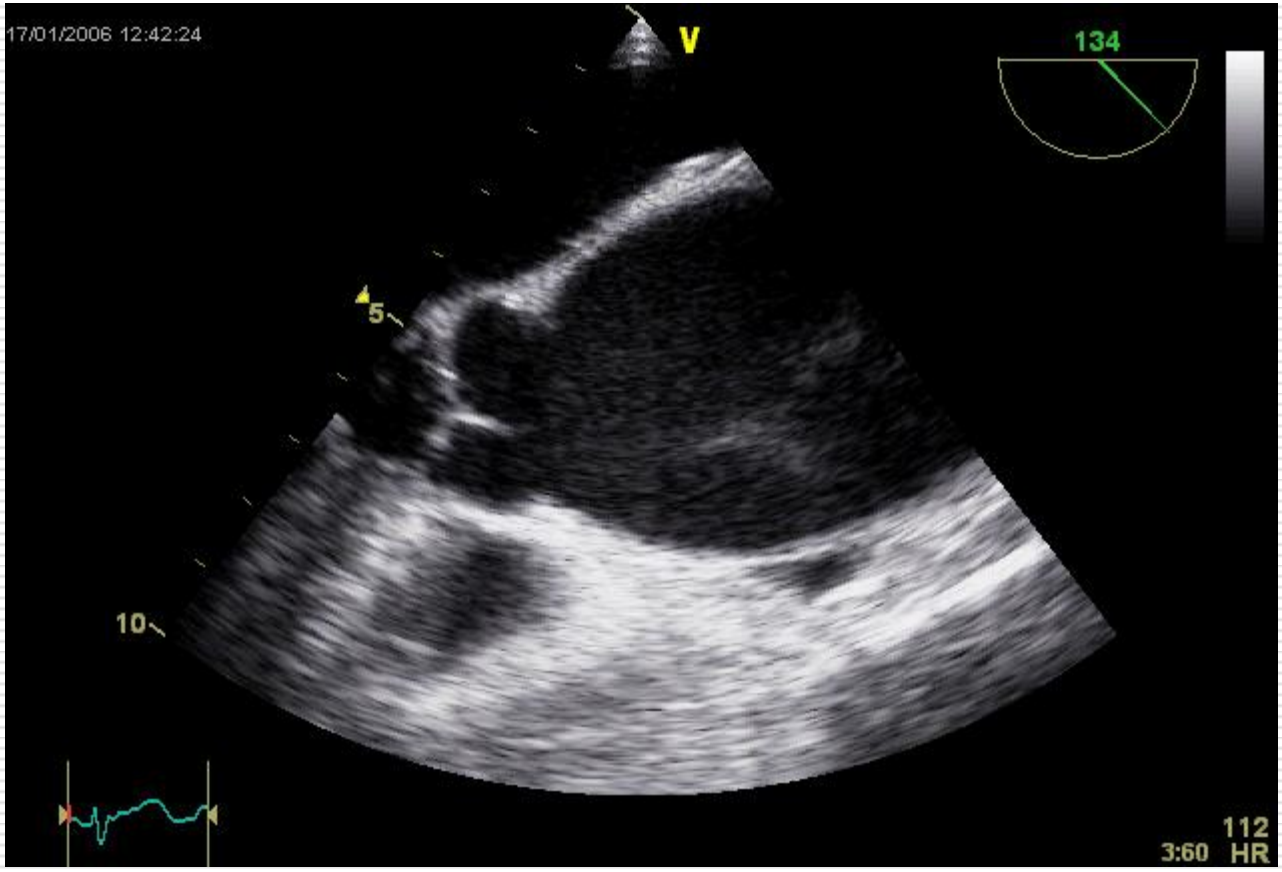
Type I:
Enlargement of the Aortic Root with Normal Cusp



STJ Dilatation | **STJ and Aortic Root Dilalation** | **Annulus Dilatation**

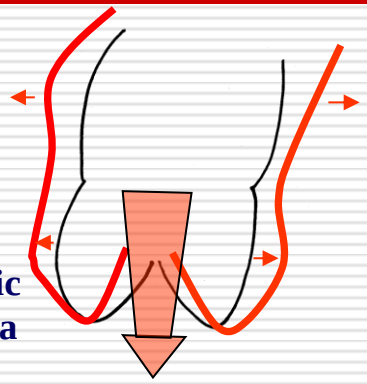
Central jet

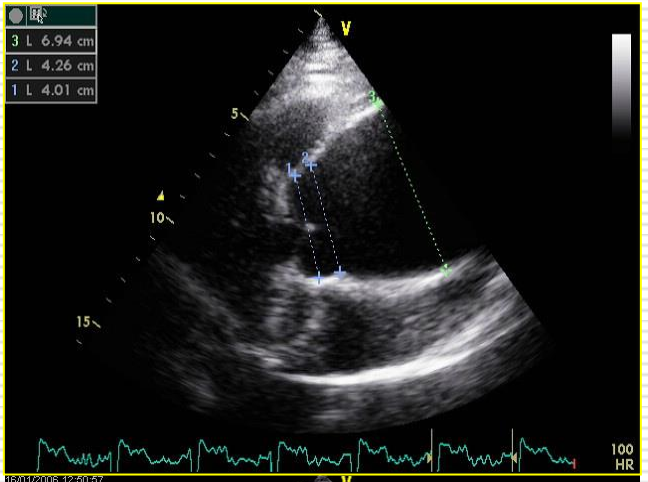
Type Ia

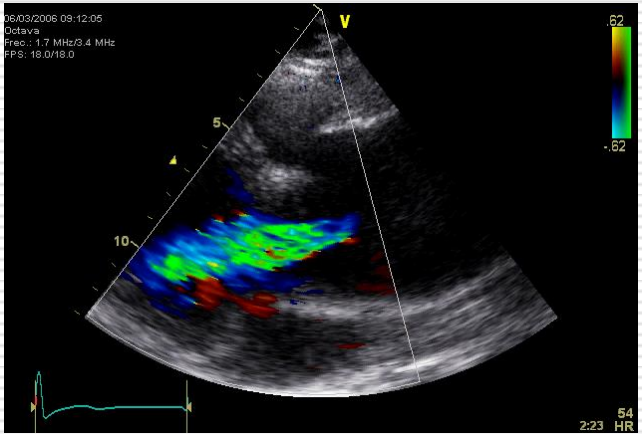


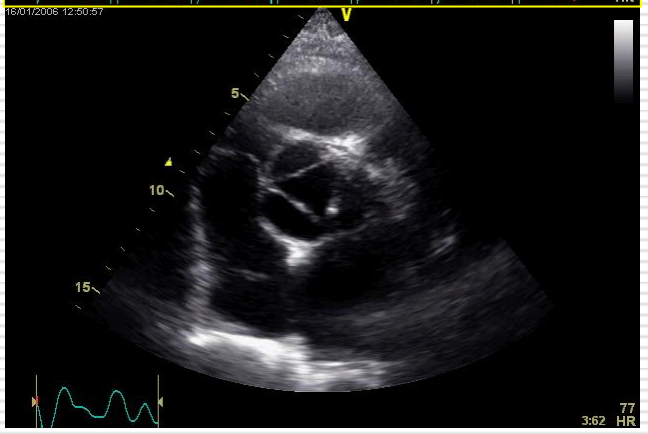
Type Ib

Dilatation of Aotic Root and Valsalva sinuses

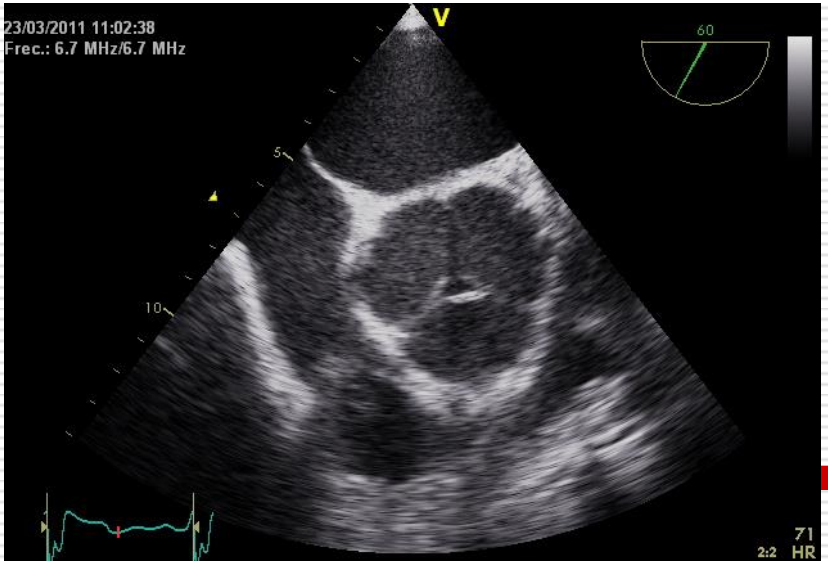






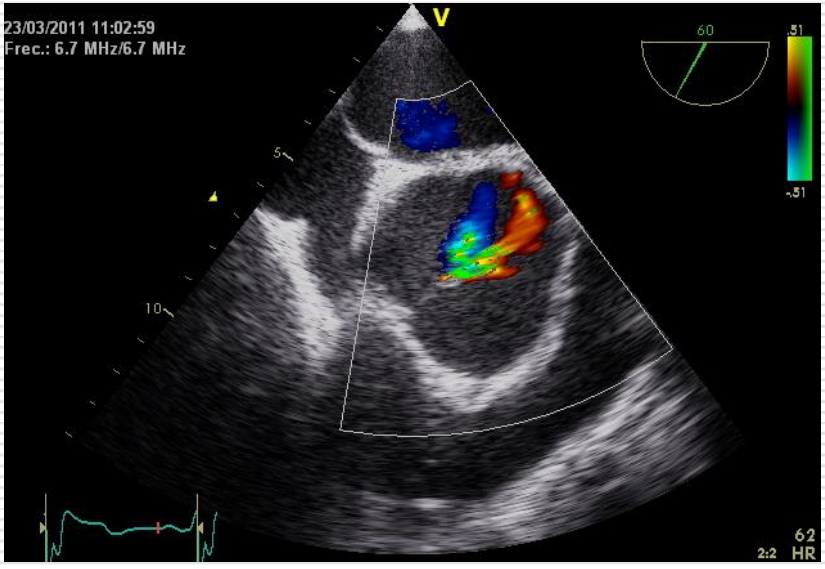


A



A

B



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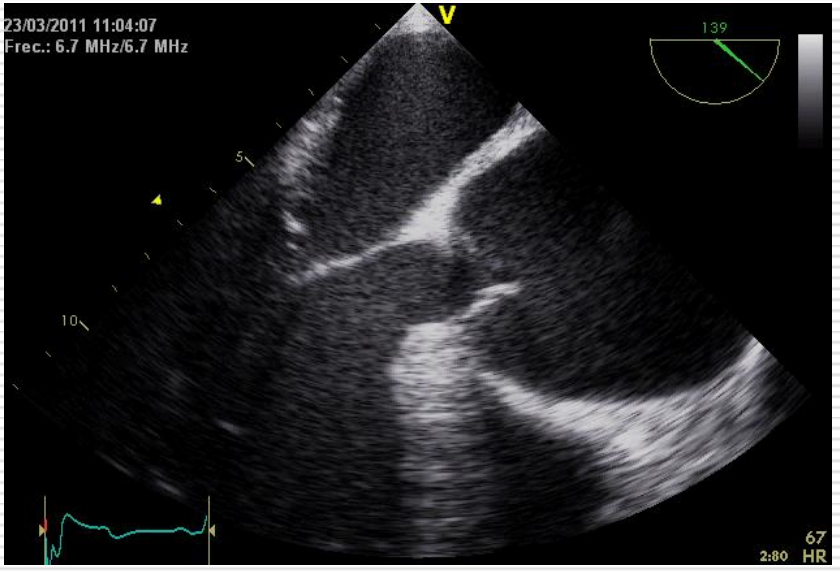
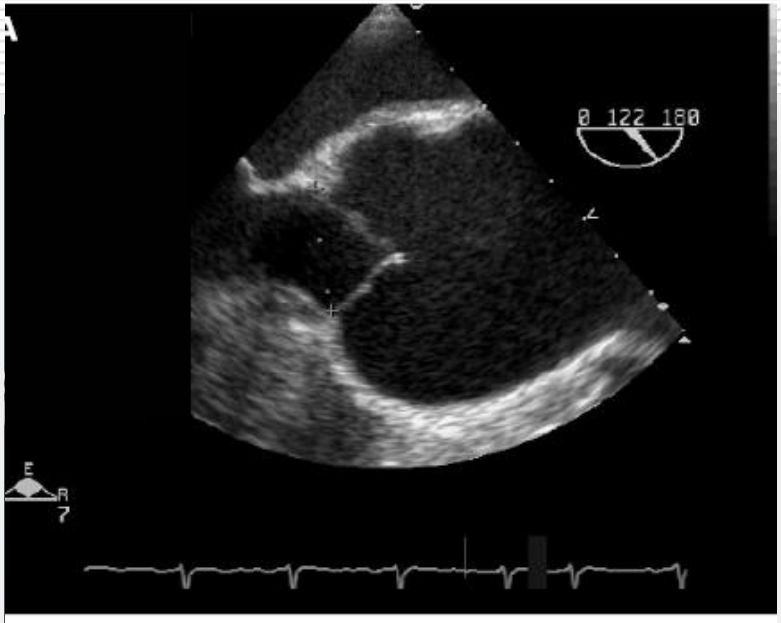
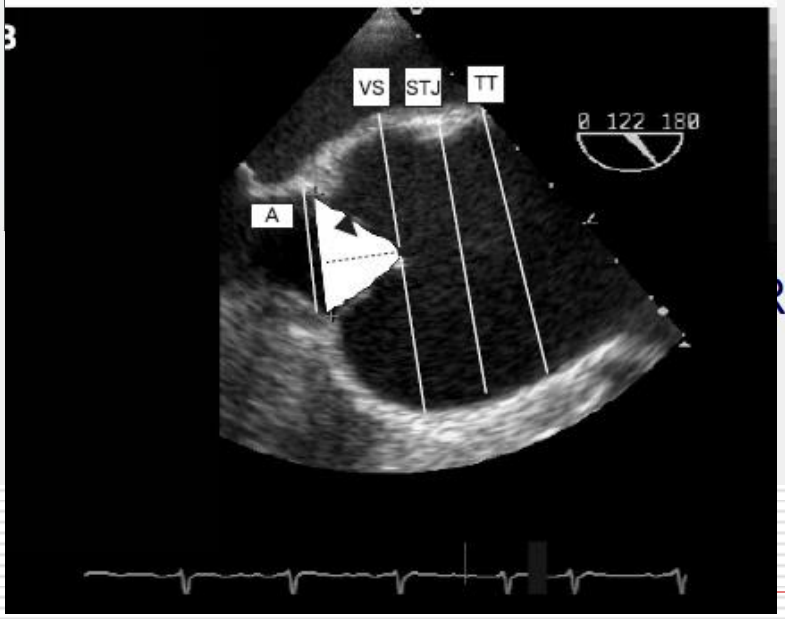
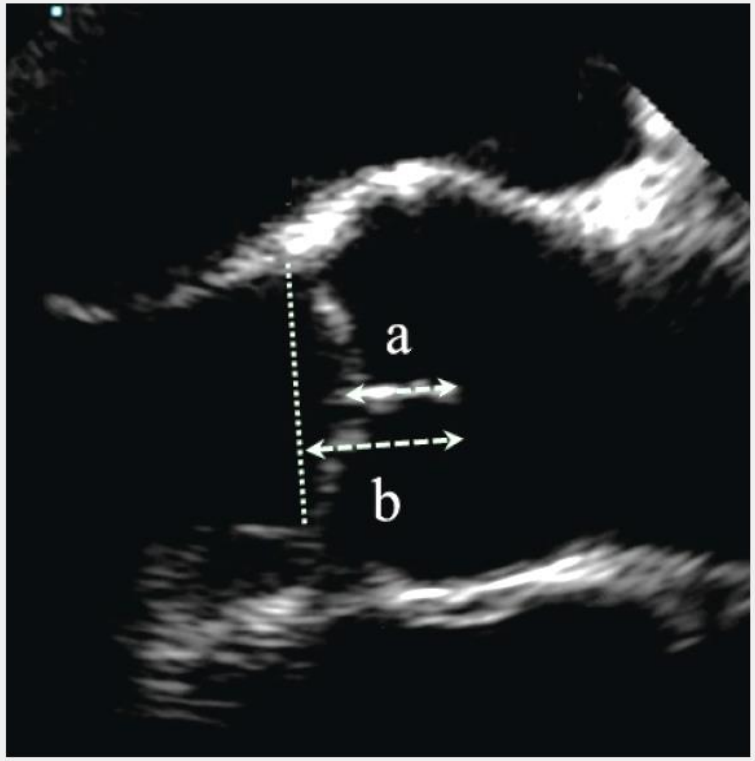


Functional aortic regurgitation secondary to aortic root aneurism. A) Parastenal short-axis view of the aortic valve with central coaptation defect. B) Color Doppler 2D.

Linked videos





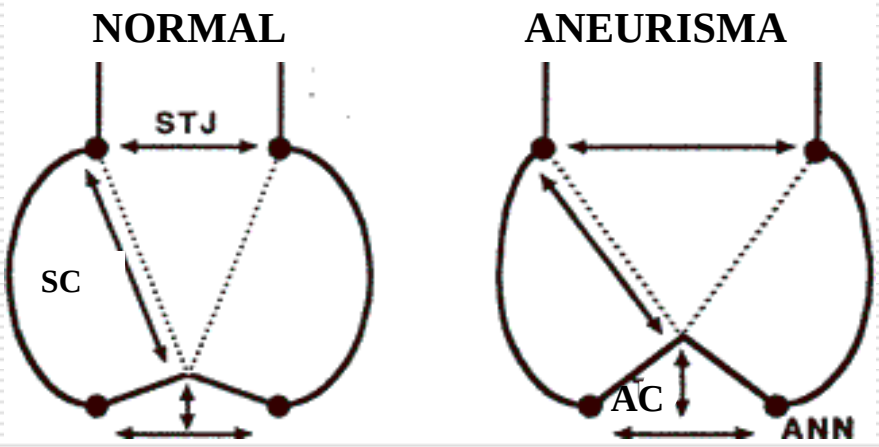


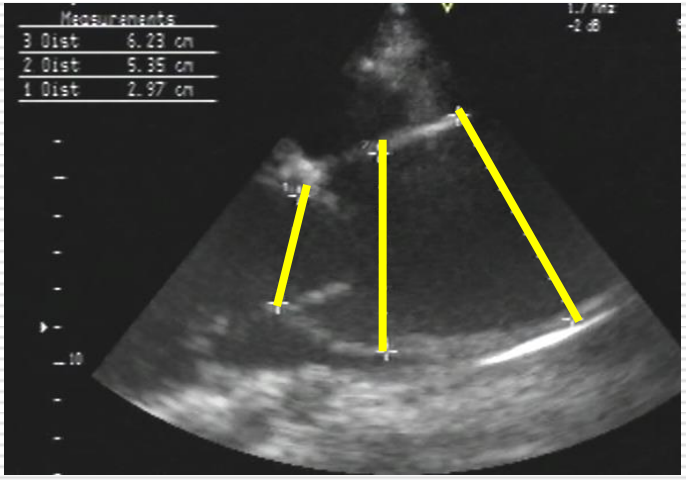
Valve height measurements:

- Normal apposition (a): 4-5mm
- Normal height annulus-tips (b): 4-10mm

Type I:
Enlargement of the Aortic Root with Normal Cusp

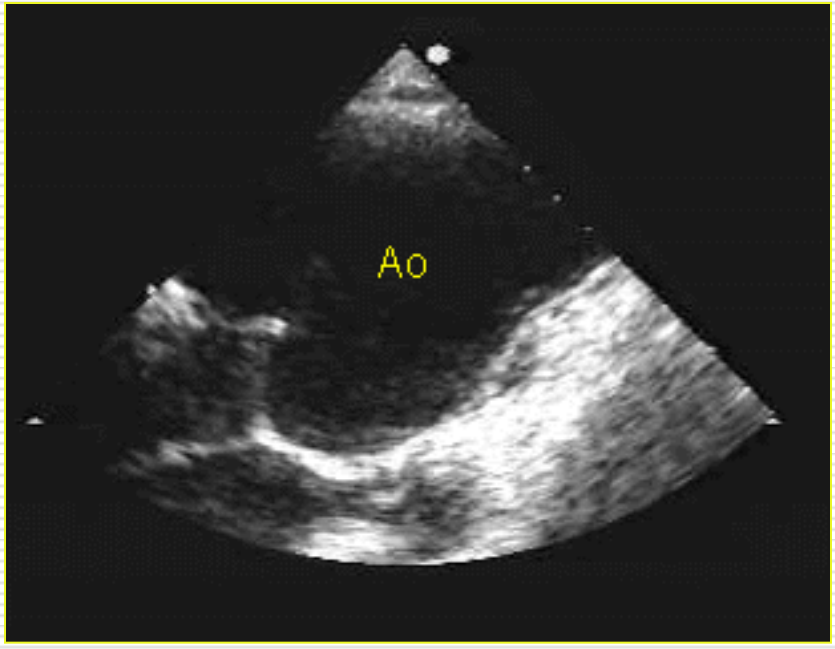
- Supratubular AA aneurysms is tethering of sigmoids
- Severe dilatation of the STJ that implies a STJ/annulus ratio > 1.5
- Coaptation height > 11 mm

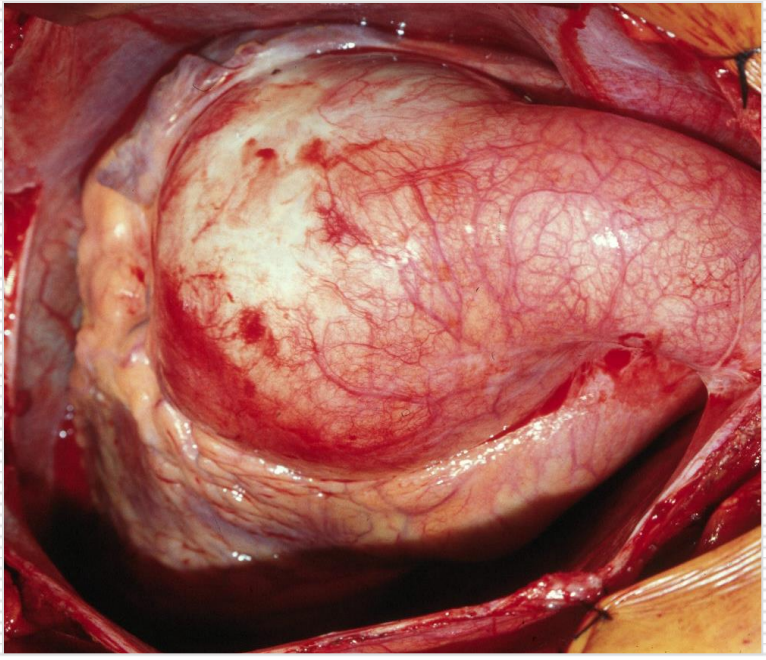




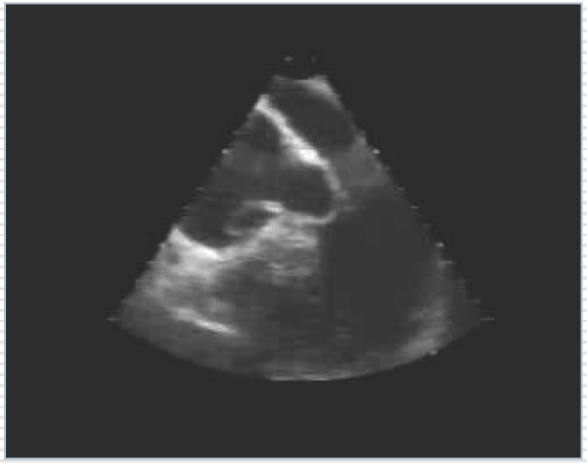
Gallego P et al. Eur Heart J 2003;24(Supp A):701

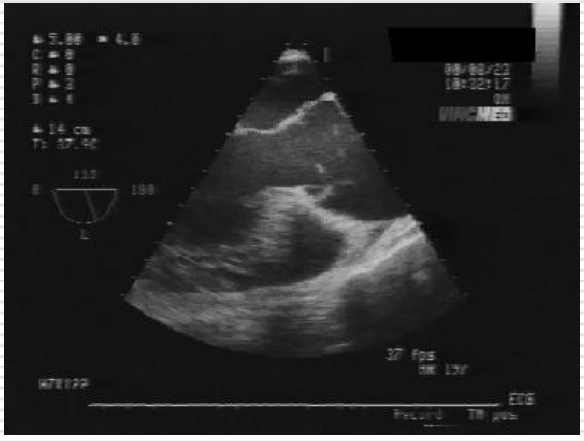
Annuloaortic Ectasia

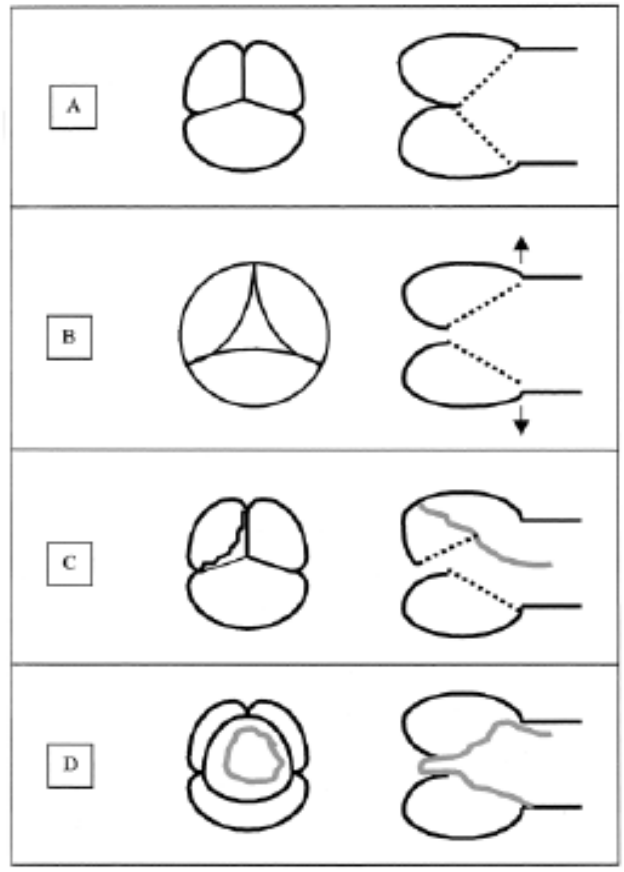




Aortic Regurgitation secondary to Aortic Dissection

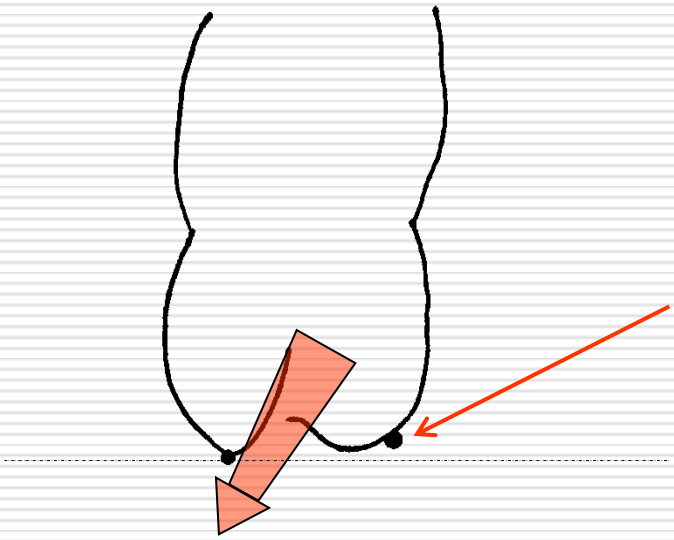




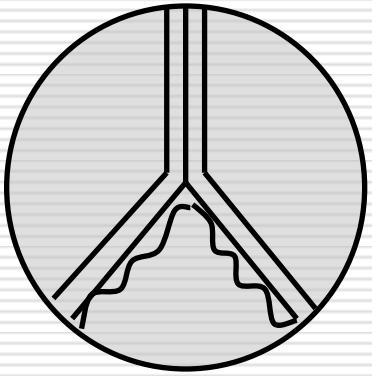


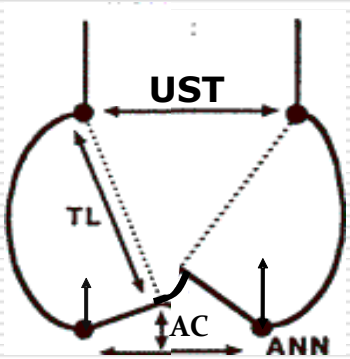
Movsowitz HD, et al. JACC 2000;36:884

Type II: Cusp prolapse or fenestration



Eccentric Jet

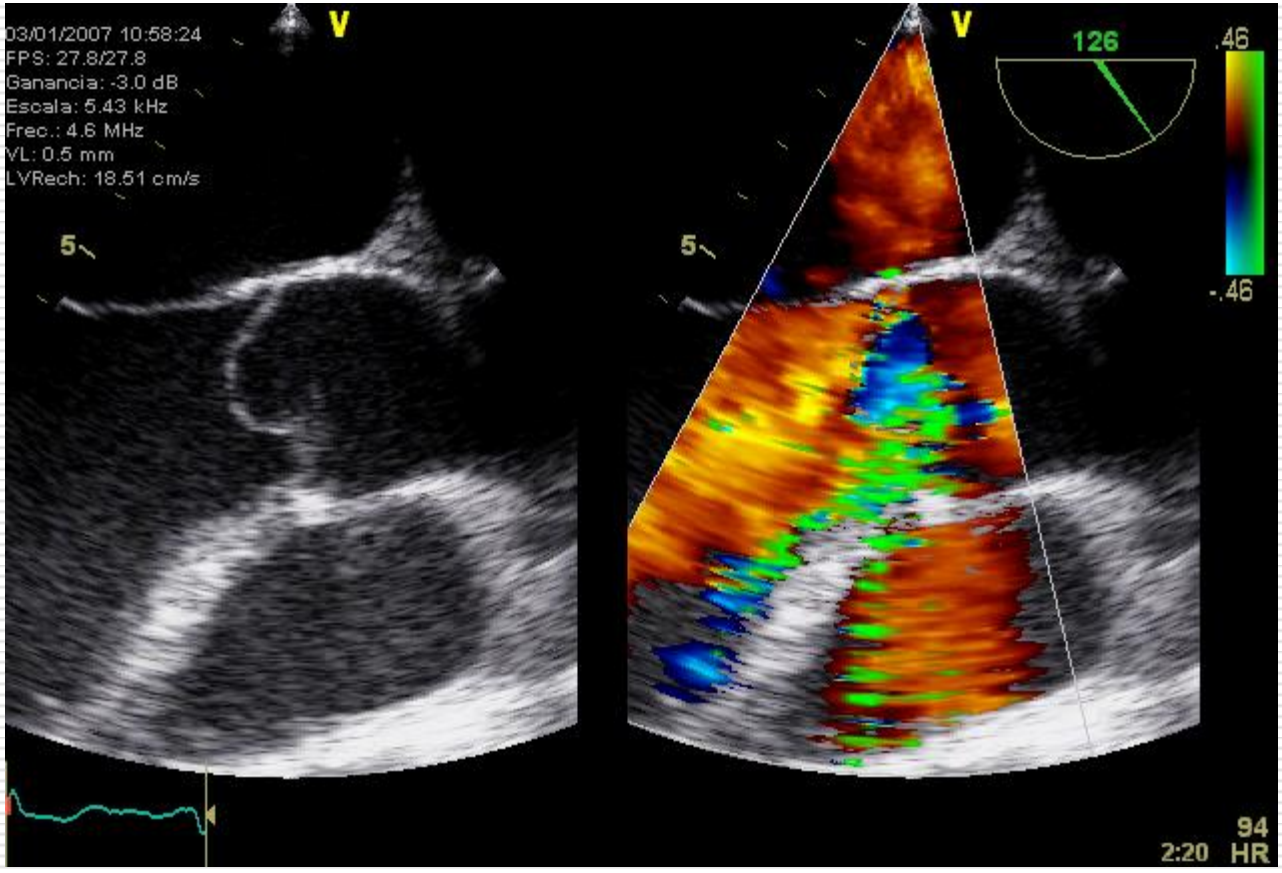




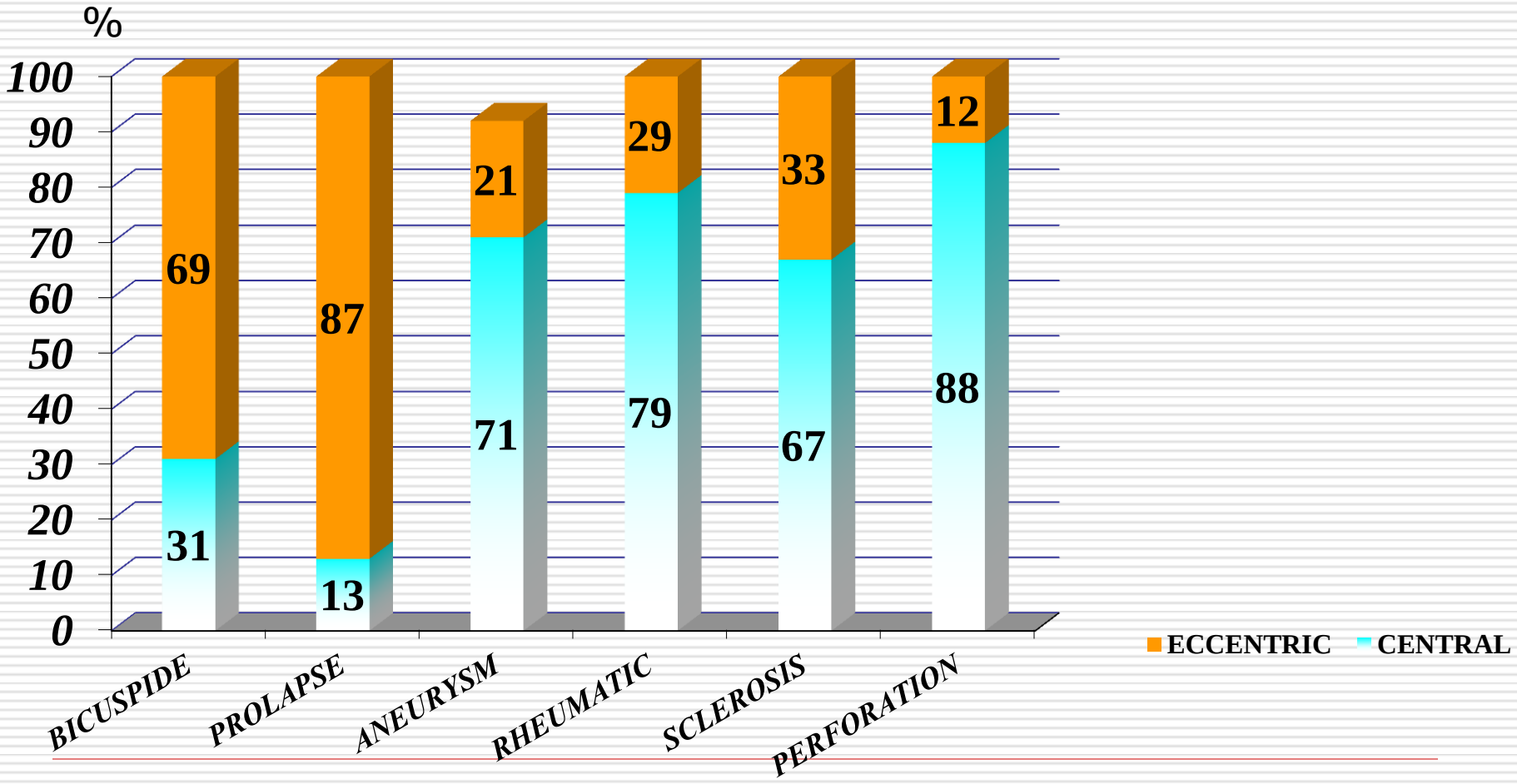
RATIO UST/AN VARIABLE

- **Prolapse of the sigmoids**
- **Geometric alterations of aortic root**
- **Assimetrical distribution**

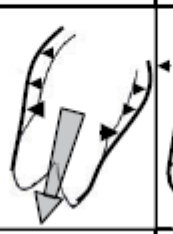
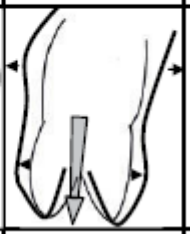
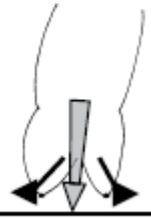
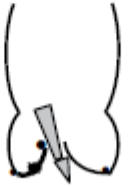
Type II: Cusp prolapse



Regurgitant Jet Direction



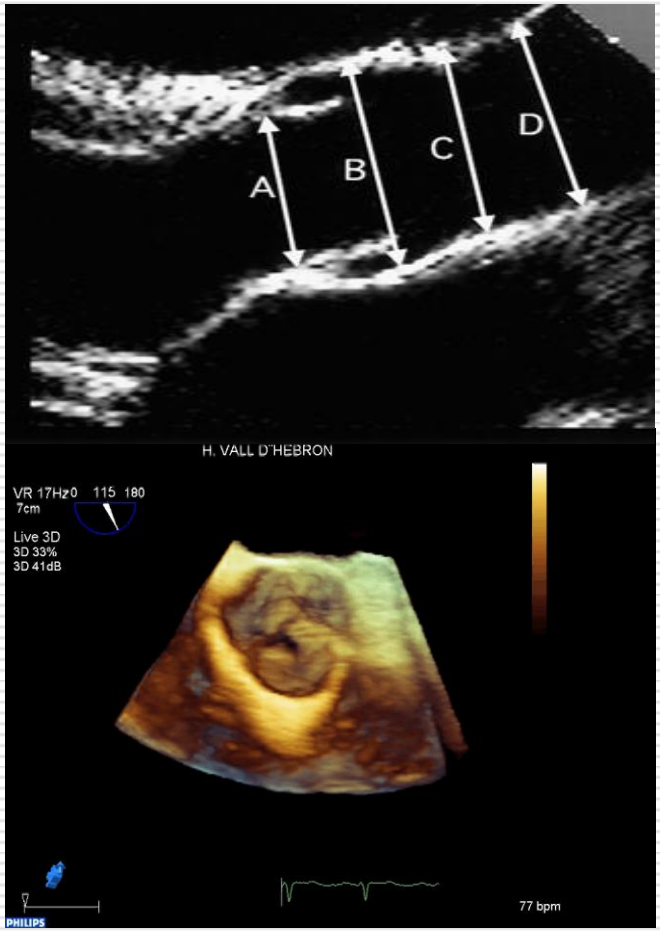
Cohen G. J Am Soc Echocardiogr 1996;9:508 –15

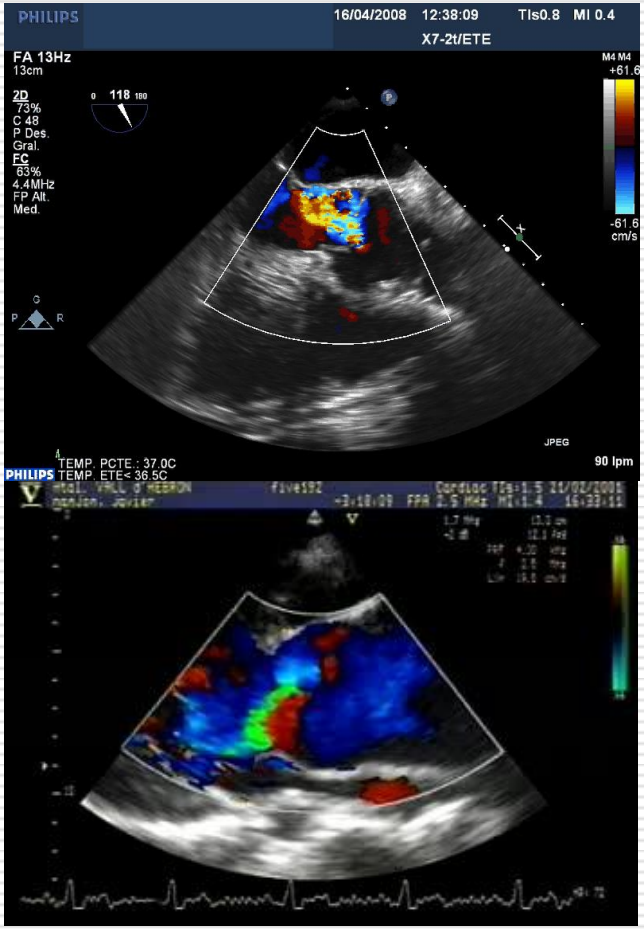
AI Class	Type I Normal cusp motion with FAA dilatation or cusp perforation				Type II Cusp Prolapse	Type III Cusp Restriction
	Ia	Ib	Ic	Id		
Mechanism						
Repair Techniques (Primary)	STJ remodeling *Ascending aortic graft*	Aortic Valve sparing: *Reimplantation or Remodeling with SCA*	SCA	Patch Repair *Autologous or bovine pericardium*	Prolapse Repair *Plication* *Triangular resection* *Free margin Resuspension* *Patch*	Leaflet Repair *Shaving* *Decalcificatio* *Patch*
(Secondary)	SCA		STJ Annuloplasty	SCA	SCA	SCA

Repair-oriented functional classification of aortic insufficiency *(AI)* with description of disease mechanisms and repair techniques used. *FAA,* ortic annulus; *STJ,* sinotubular junction; *SCA,* subcommissural annuloplasty.

Boodhwani et :al. J Thorac Cardiovasc Surg 2009;137;287

Aortic Regurgitation and Ascending Aorta Dilatation Role of Echocardiography





Conclusions I

- Valvular abnormalities are not defined in more than 50 % of AR, and aortic root dilatation is the only apparent cause in more than 30% of cases.

- Ascending aortic dilatation secondary to severe aortic regurgitation is frequent (60%), but only significant (>50mm) in bicuspid aortic valve (30%).

- Aortic root dilatation may be secondary to valvular disease due to increased wall stress (jet effect or volume overload) but in BAV it is associated with intrinsic structural changes in the aorta wall.

Conclusions II

- Aortic root dilatation due to intrinsic disease (collagen alterations or atherosclerosis) leads to AR owing to lack of sigmoid coaptation or changes in aortic root geometry:

  1.- Tethering of the sigmoids due to STJ dilatation

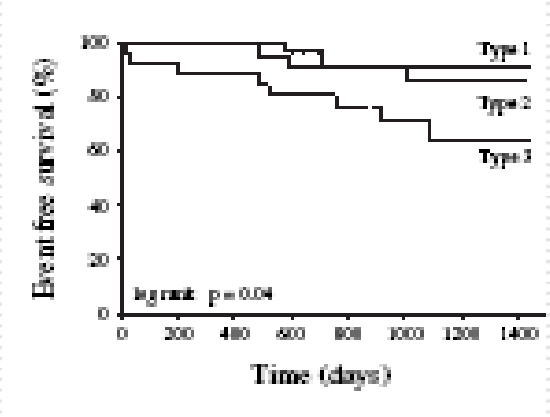
  2.-Stretch lesions secondary to geometric asymmetries of Valsalva sinus and sigmoids, which provoke malcoaptation and degenerative phenomena in the sigmoids.

- Echocardiography is crucial to the understanding of AR mechanisms and in the indication of correct surgical treatment.

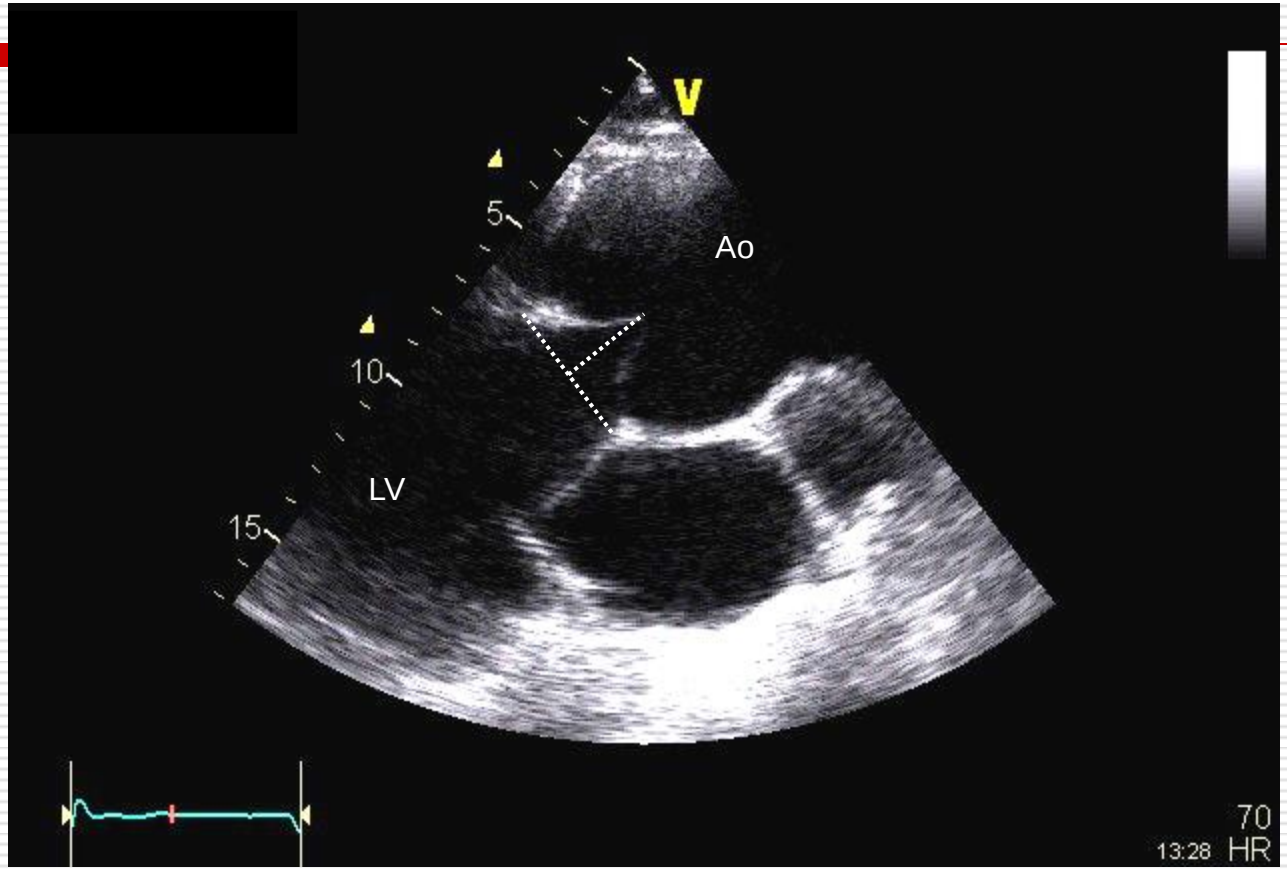
Functional Anatomy of Aortic Regurgitation by TEE

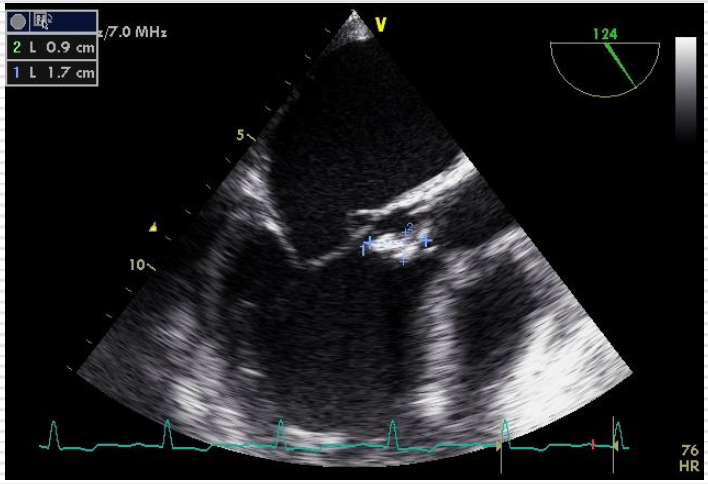
Outcome Implications

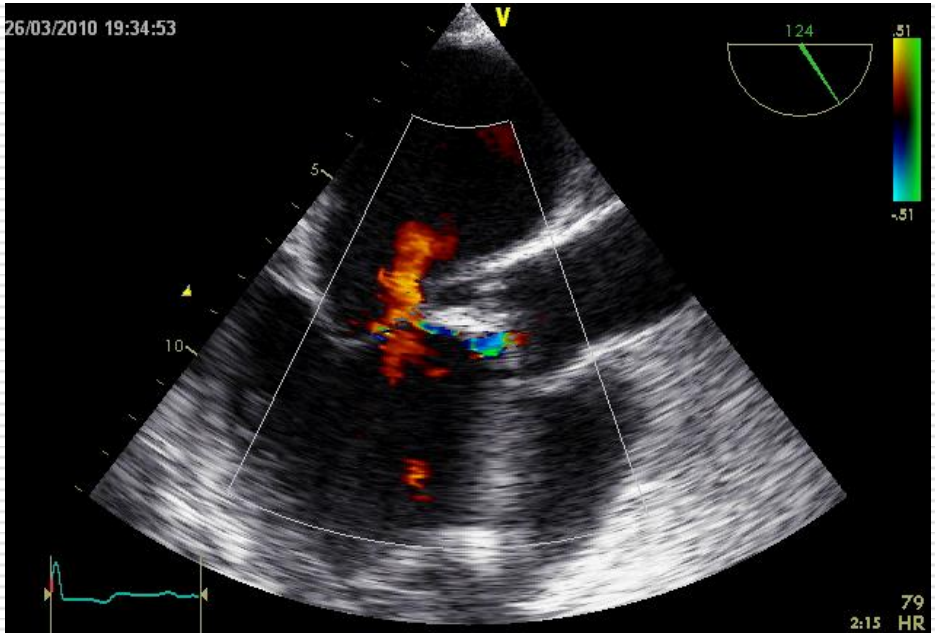
- 163 AR
- TEE correctly predicted
  - 86% valve repair
  - 93% valve replacement
  - 4 years : Survival, Freedom > grade 2 AR, Reoperation

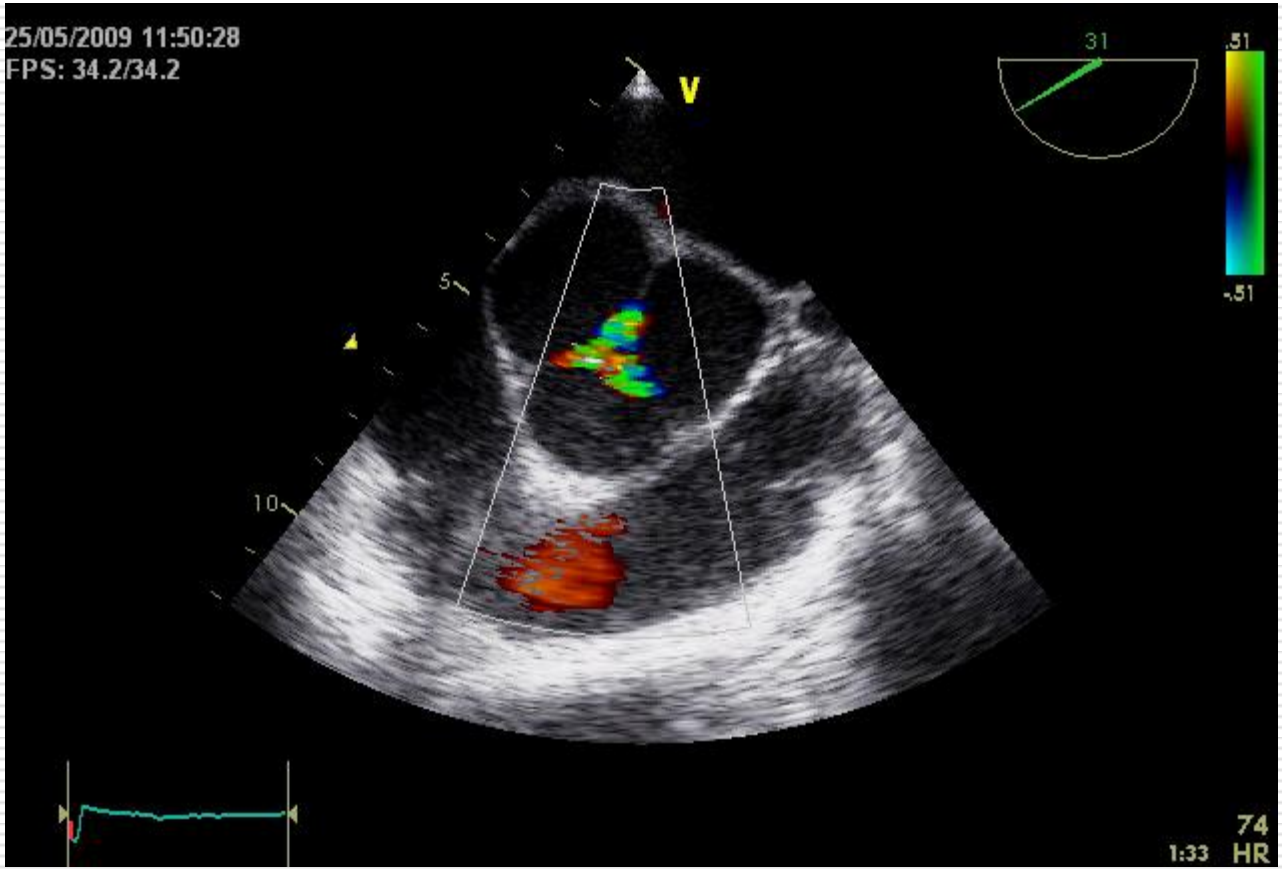


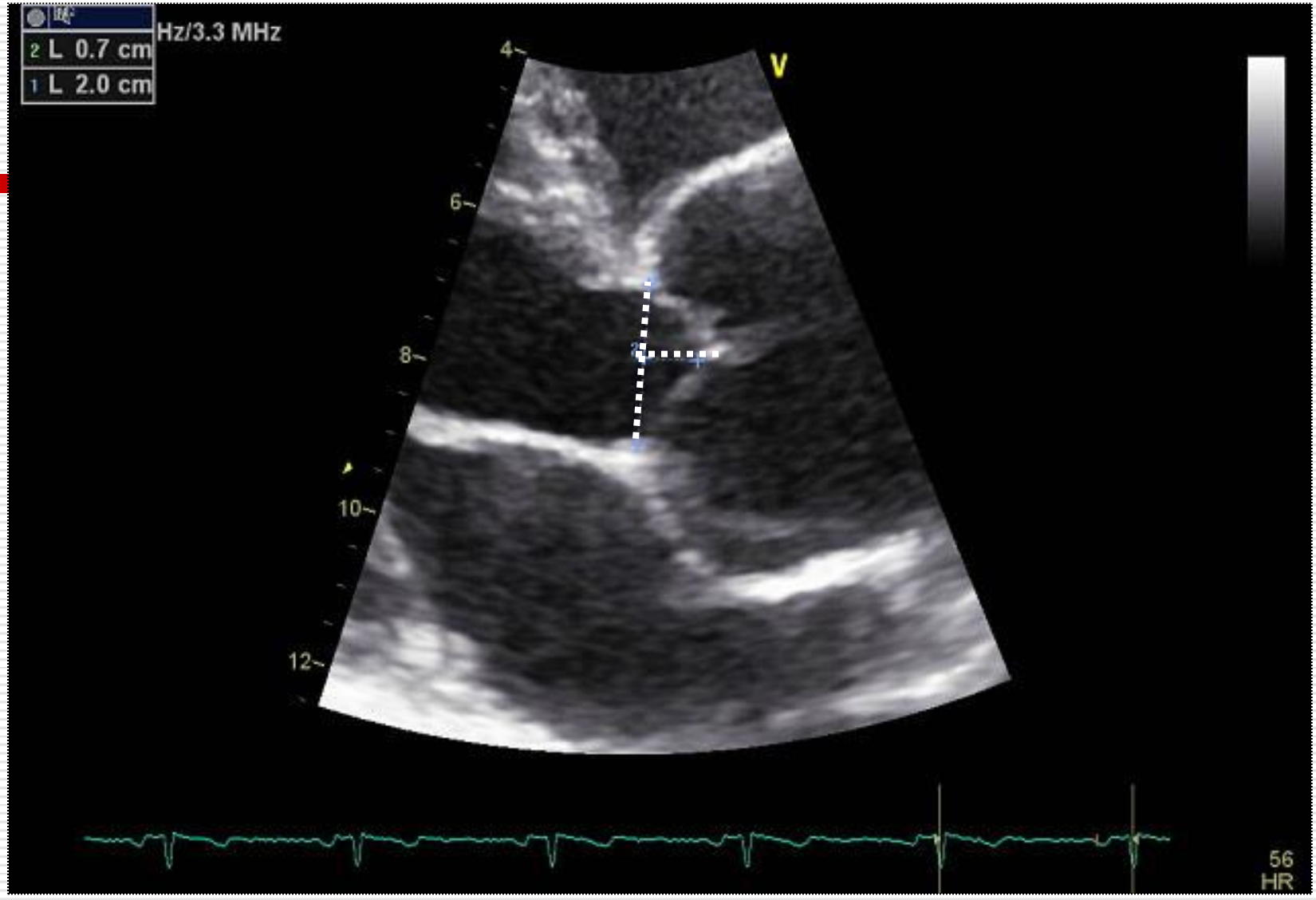
Circulation 2007;116: I-264-9


V
5
10
15
Ao
LV
70
13:28 HR

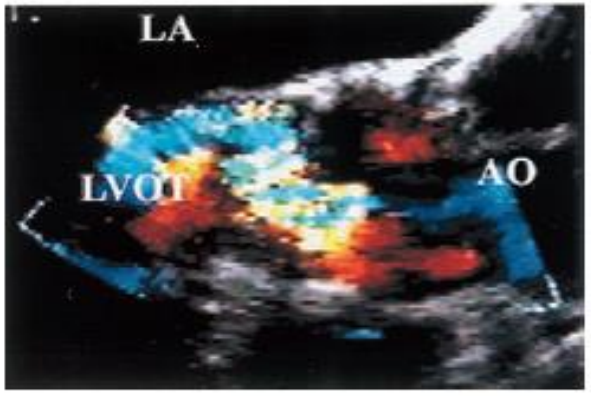

2 L 0.9 cm
1 L 1.7 cm
V
124
5
10
76
HR


26/03/2010 19:34:53
V
124
.51
-.51
5
10
79
2:15
HR


25/05/2009 11:50:28
FPS: 34.2/34.2
V
31
.51
-.51
5
10
74
HR
1:33


Hz/3.3 MHz
2 L 0.7 cm
1 L 2.0 cm
4~
6~
8~
10~
12~
V
56
HR


LA
LVOT


LA
LVOT
AO