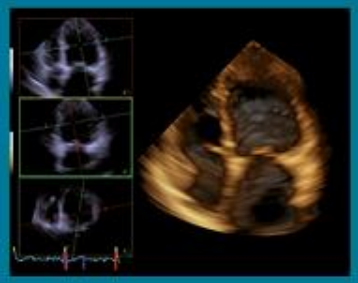


EuroValve

October 24-25, 2014

What are the best diagnostic tools to quantify aortic regurgitation?

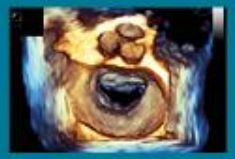
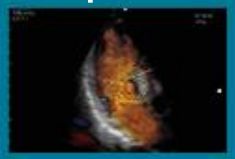
Agnès Pasquet, MD, PhD

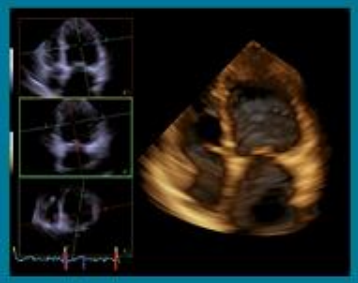
Pôle de Recherche Cardiovasculaire

Institut de Recherche Expérimentale et Clinique

Université catholique de Louvain





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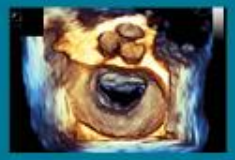
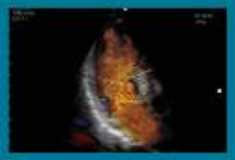
Faculty disclosure

Agnes Pasquet

I have **no financial relationships** to disclose.



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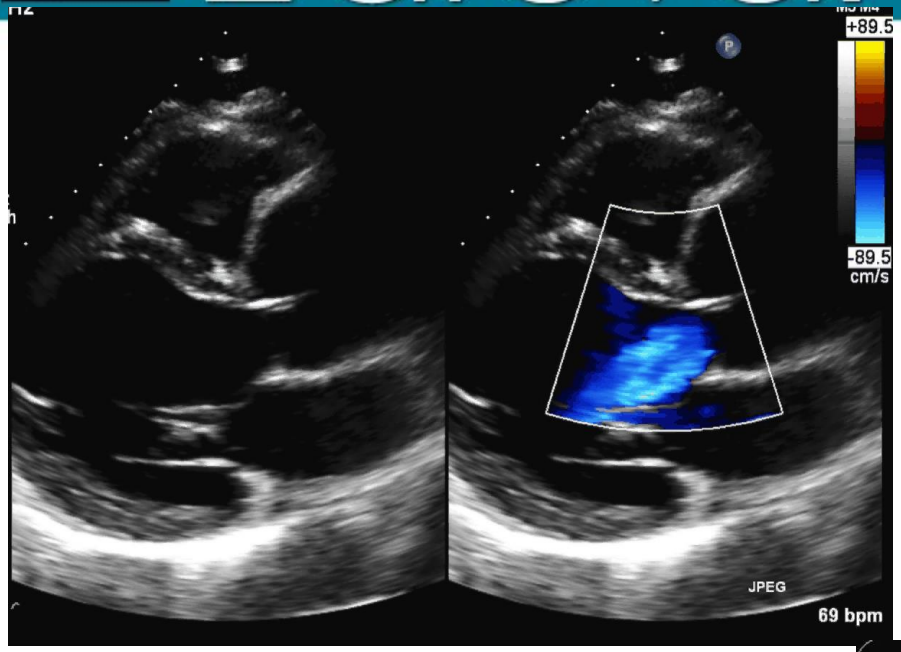
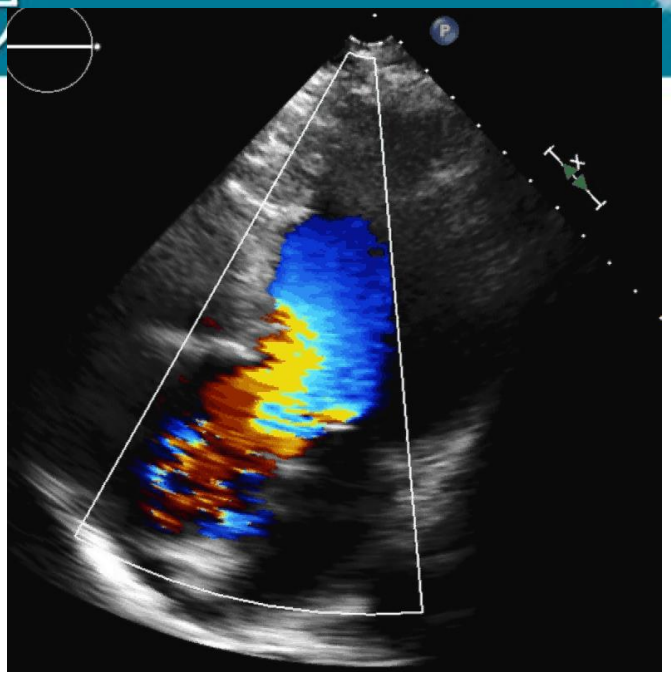
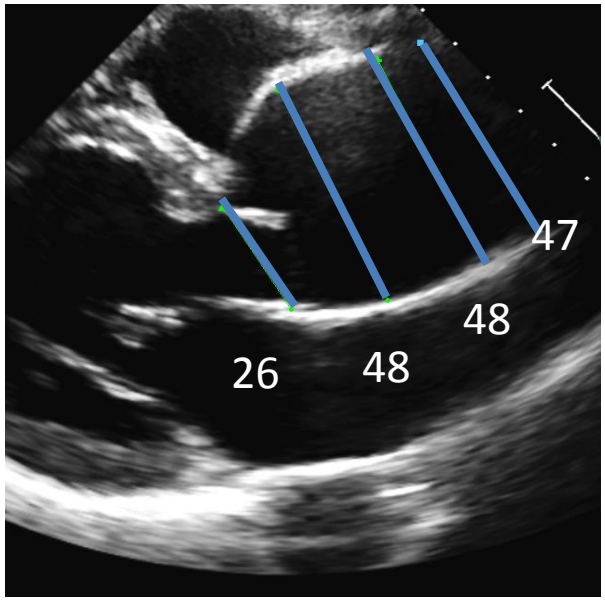
Case :53 Yo man

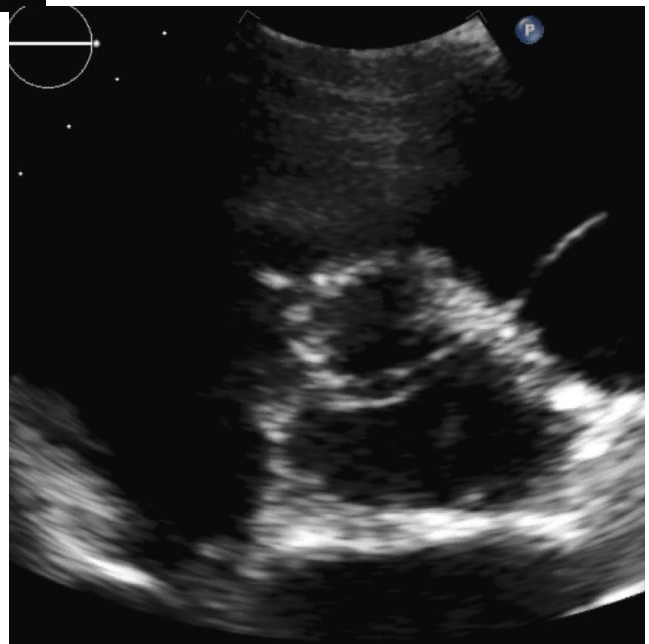
- Know ascending aorta dilatation
- Had the feeling that he is more exhausted at the end of the day
- Clinical examination:

  Diastolic aortic murmur 3/6, BP: 130/80 mmHg


+89.5
-89.5
cm/s
JPEG
69 bpm




47
48
26
48



Questions ?

- Aortic root is not yet an indication for surgery
- Does this patient have severe aortic regurgitation ?
- Assessment of Ao regurgitation severity ?

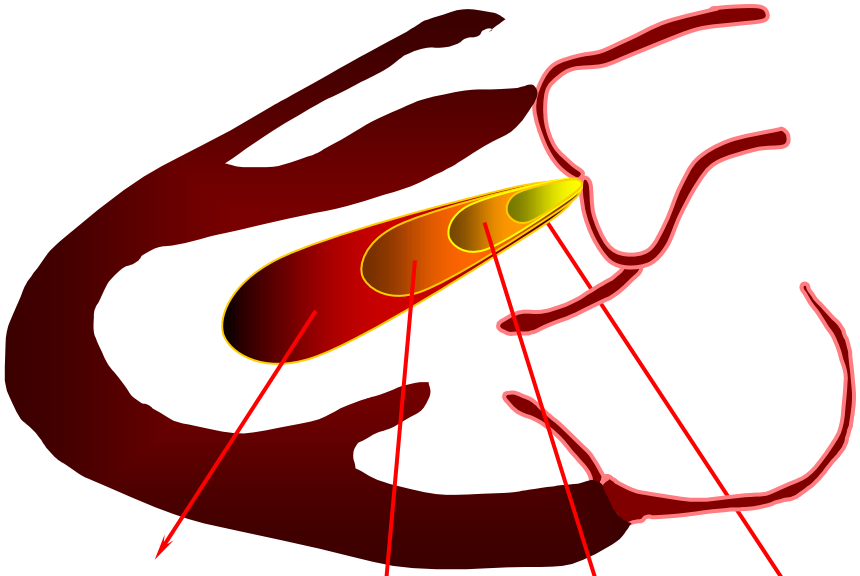
Assessment of aortic regurgitation

Echocardiography remains the corner stone !

Assessment of aortic regurgitation: echo tools ?

- Colour flow area
- Vena contracta
- PISA method
- Continuity equation
- Pressure half time

Assessment of AR: Colour flow mapping



IV
jet extending beyond the papillary muscle

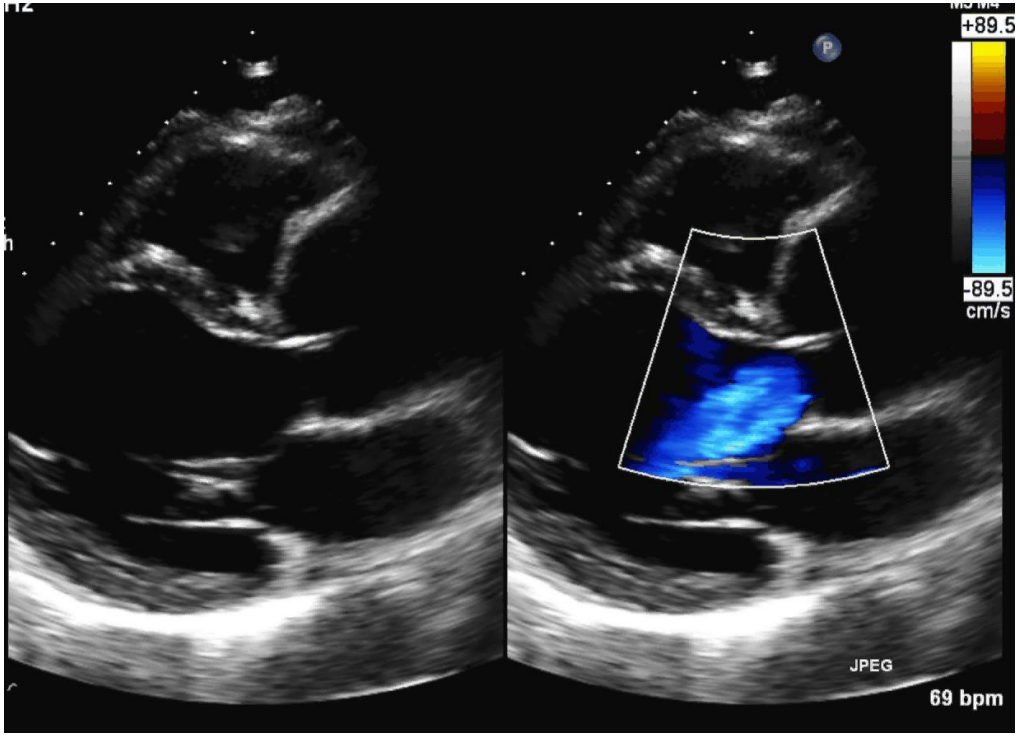
III
jet extending to the papillary muscle

II
jet extending to the tip of the anterior leaflet

I
jet confined to LVOT

- Apical or Parasternal long axis, (better axial resolution)
- Optimize colour /gain scale
- Easy to use
- Spatial orientation of the jet
- Screening for AR

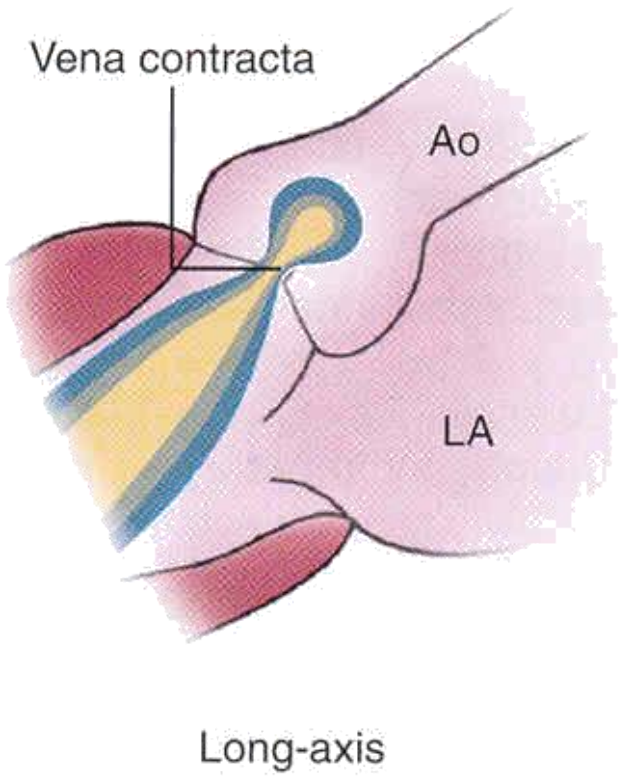
Assessment of AR: Colour flow mapping



- Inaccurate for excentric jets !
- Influenced by technical and haemodynamical factors !

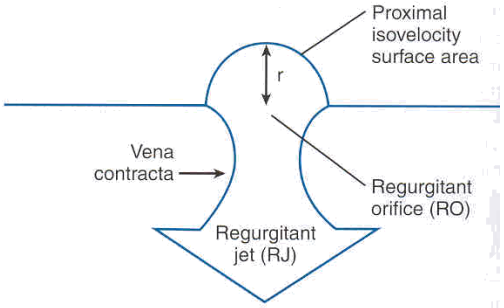
The colour flow area of the regurgitant jet is **not recommended** to quantify the severity of AR.
Should only be used for a visual assessment of AR.
A more quantitative approach is required when more than a small central AR jet is observed.

Assessment of AR: vena contracta



Long-axis

- The veina contracta is the narrowest portion of the jet dowstrean from the regurgitant orifice”
  - PS long axis (Zoom)
  - Identify the 3 component

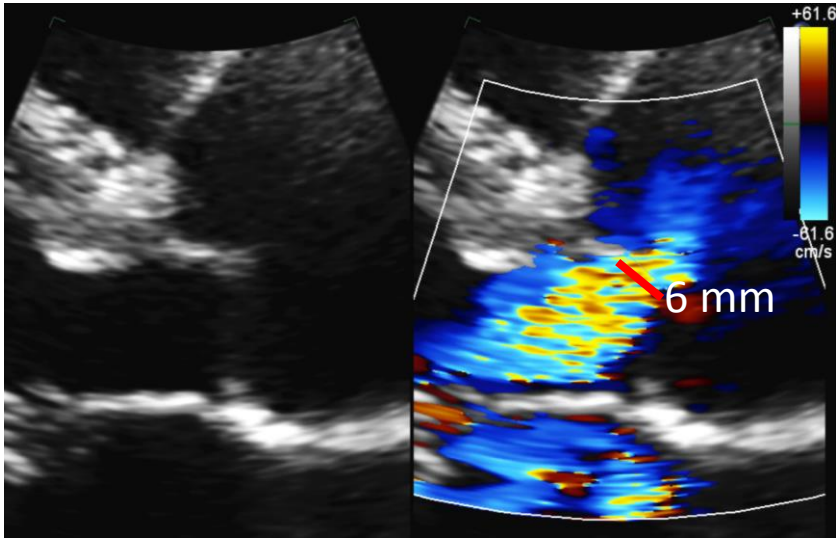


Regurg. volume = PISA × velocity

RO area = regurg. volume/VTI_{RJ}

  - Easy to perform !

Assessment of AR: vena contracta



- Small value ?

	Mild	Moderate	Severe
VC (mm)	< 3	intermediaire	> 6

- Vena contracta width is **recommended** to quantify AR.
- Intermediate VC values (3–6 mm): confirmation by a quantitative method.
- Could be obtained and used in eccentric jet.
- Multiple jets: the respective values of VC width are not additive.

Assessment of AR: flow convergence PISA

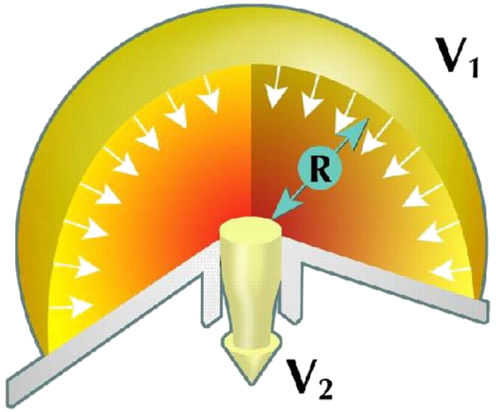
"As a blood flow converges towards a regurgitant orifice, it forms concentric isovelocity shells of decreasing surface and increasing velocity".

$Q = 2\prod R^2 Va$

Va=aliasing velocity

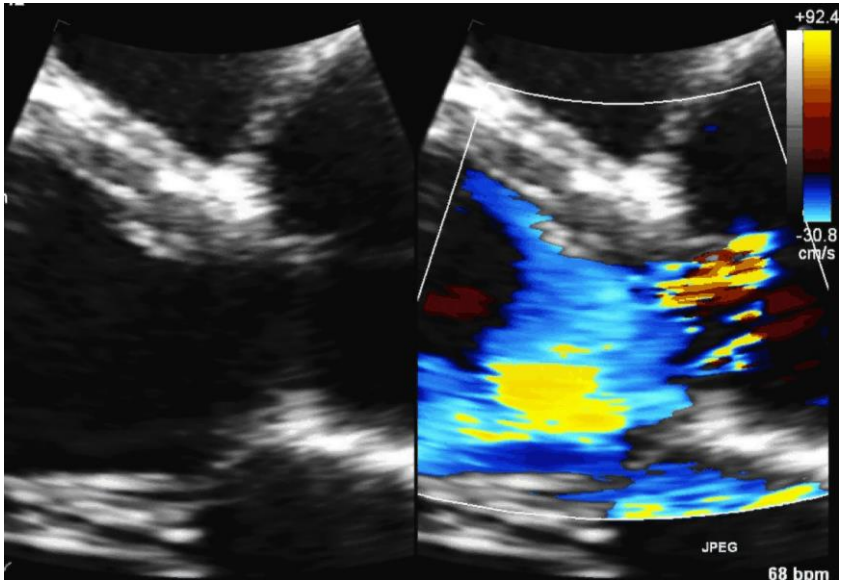
EROA= Q/peak orifice velocity

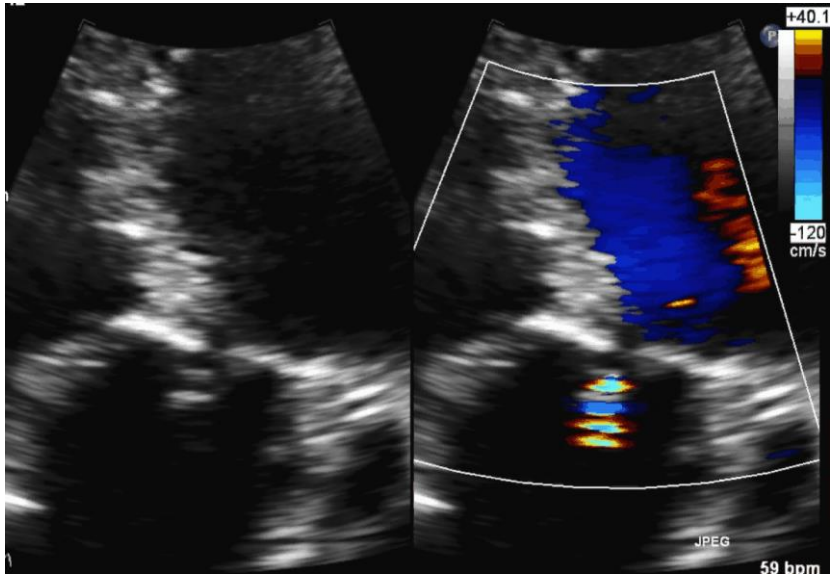
R Vol (ml) = EROA (cm2) /TVI (cm)

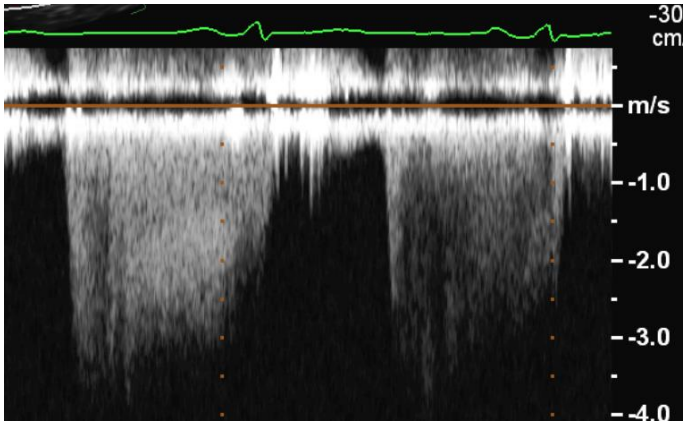


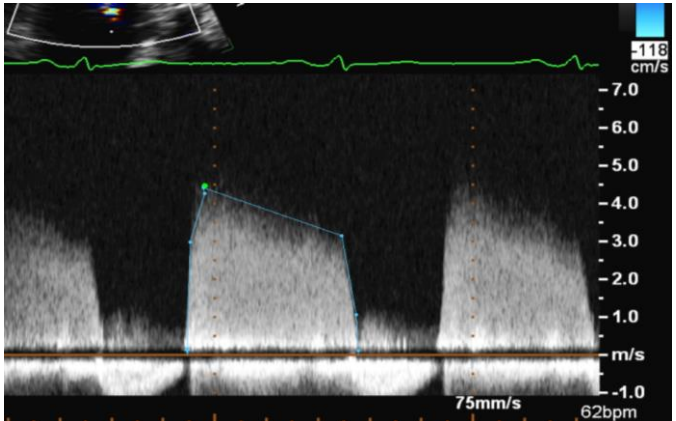
Assessment of AR: flow convergence PISA

- Pisa ao: from apical view or for excentric jet from ps view measurement



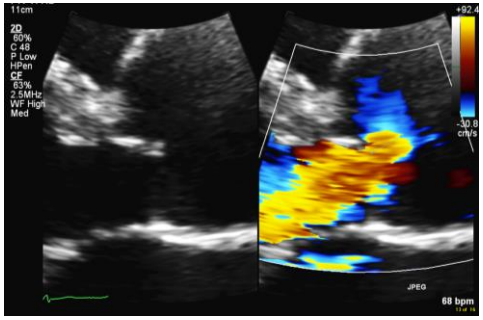


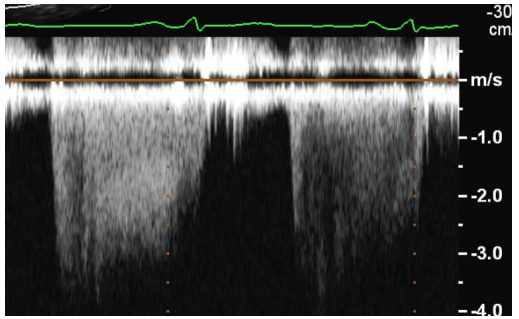




Assessment of AR: flow convergence PISA

- Flow convergence method (PISA)



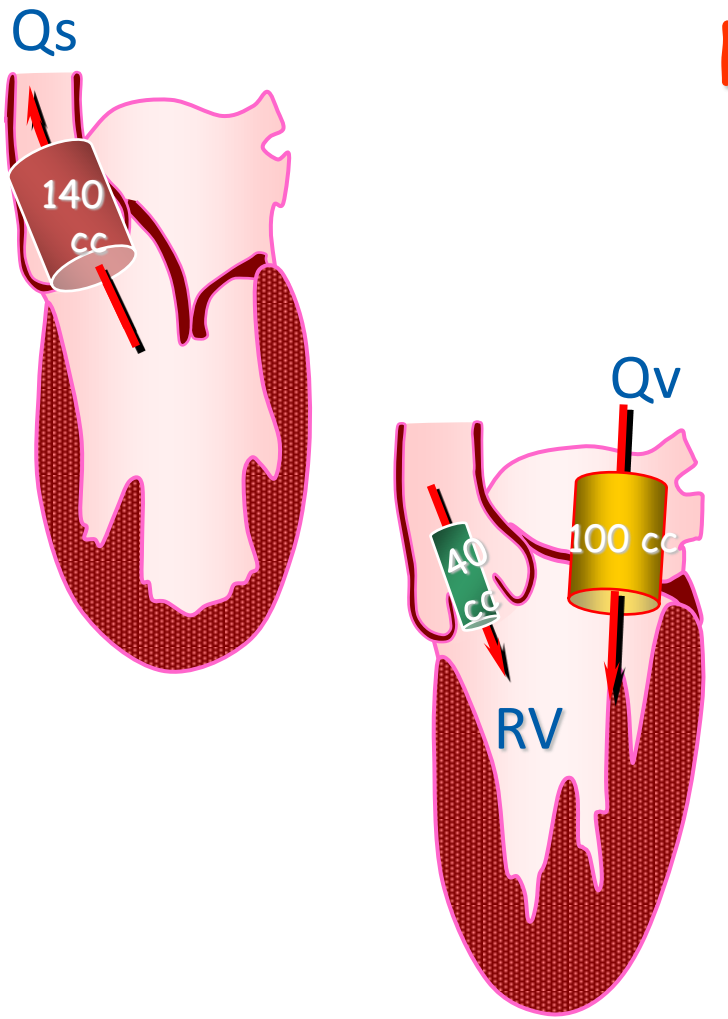


- RV: 65 ml, ERO:32 mm2

	Mild	Moderate	Severe
EROA (mm^2)	< 10	10 -29	>30
RV (ml)	< 30	30 – 60	> 60 ml

- PISA method **is highly recommended** to quantify the severity of AR.
- It can be used in both central and eccentric jets. In eccentric AR jets, use the parasternal long-axis view
- An EROA ≥30 mm2 or an R Vol ≥60 mL indicates severe AR.

Assessment of AR: continuity equation

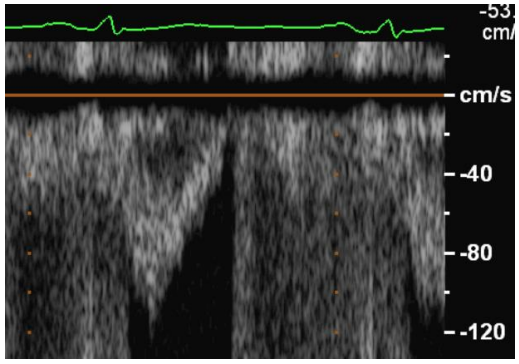


$$RV = Qv - Qs$$

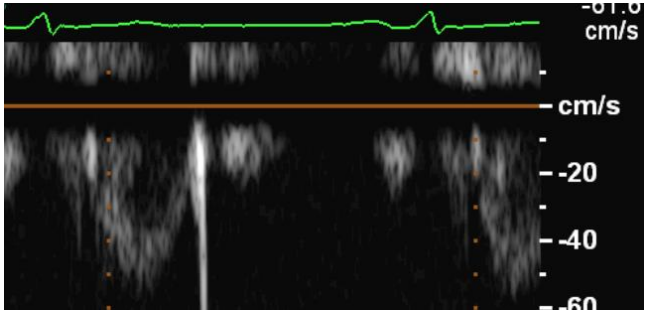
- Time consuming
- Mitral flow/pulmonary Flow
- Several errors !
- No valvular regurgitation

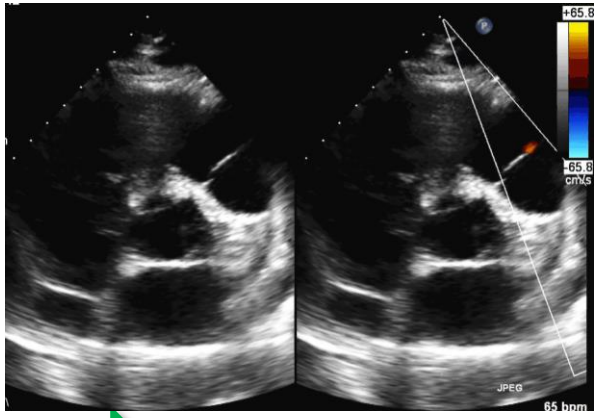
RF > 50%: severe AR

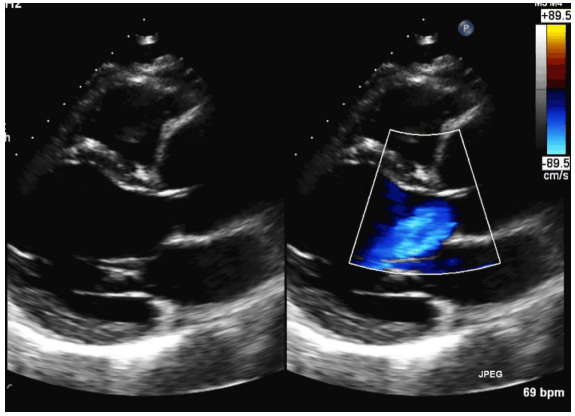
Assessment of AR: continuity equation



Q pulm / Q Ao



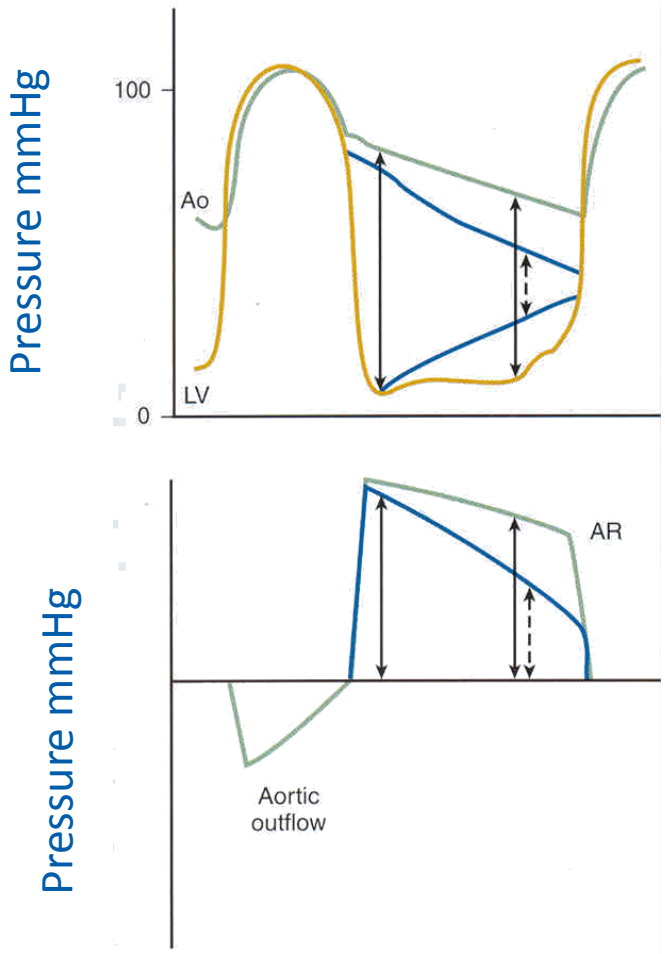


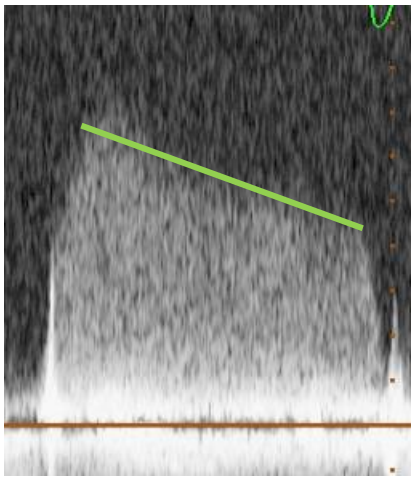


- Quantitative: estimate lesion severity (ERO) and volume overload (R Vol)
- Valid in multiple jets
- Time-consuming
- Requires multiple measurements: source of errors
- Not applicable in the case of significant MR (use the pulmonic site)

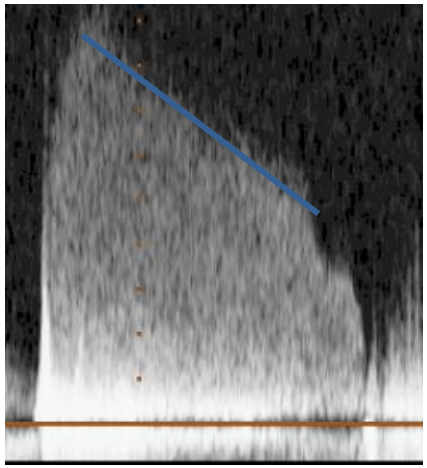
Assessment of AR: CW pressure half time

- CW : Pressure half time



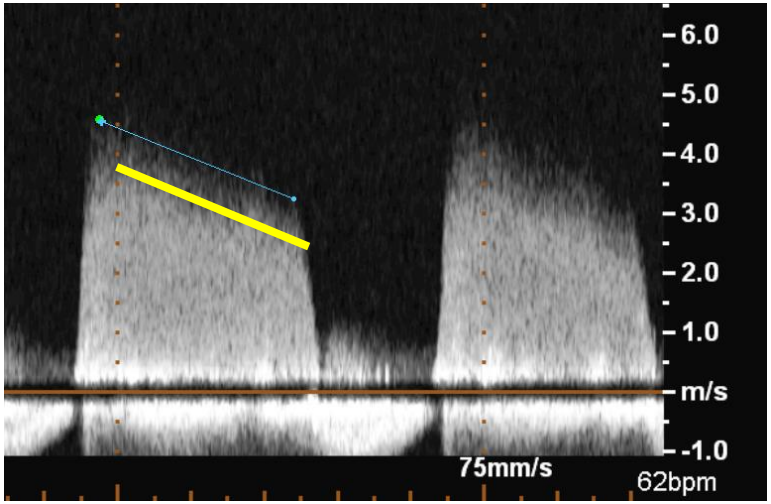


Moderate



Severe

Assessment of AR: CW pressure half time

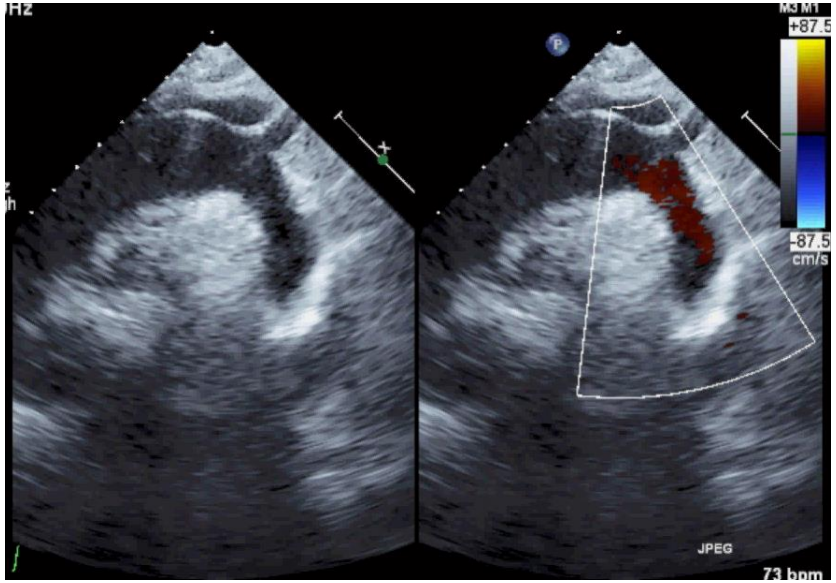


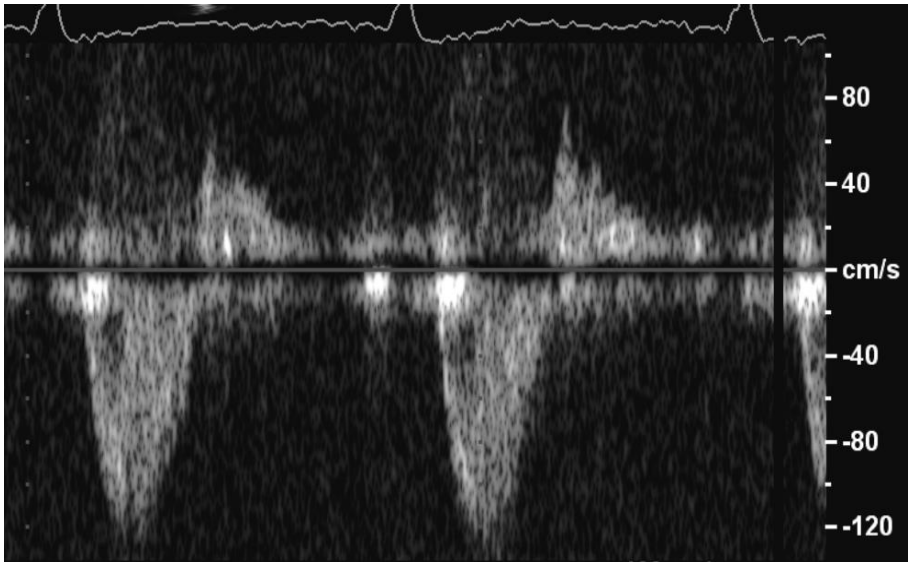
PHT: 188 msec

	Mild	Moderate	Severe
PHT (msec)	>500	intermediate	<200

- The assessment of the pressure half-time requires good Doppler beam alignment. A careful probe angulation is often needed.
- Influenced by chamber compliance and chamber pressures, it serves only as a complementary finding for the assessment of AR severity.

Assessment of AR: Flow reverse descending Ao



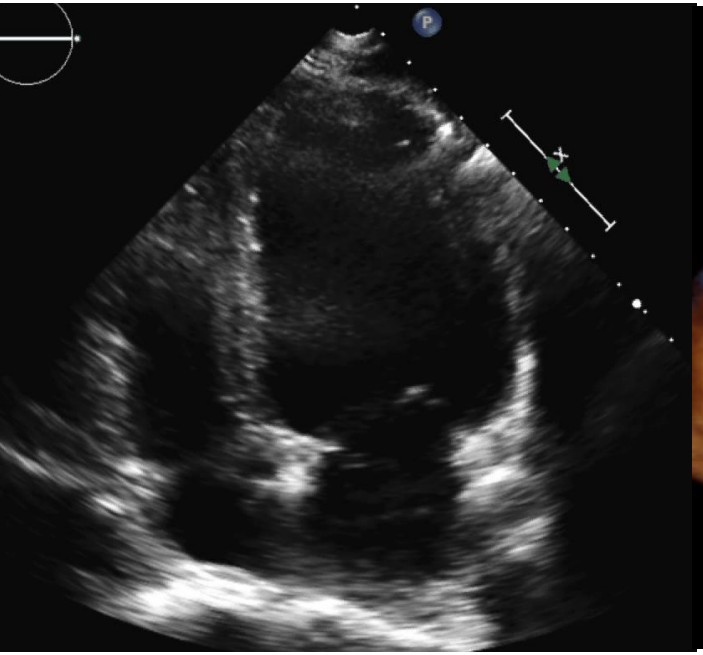


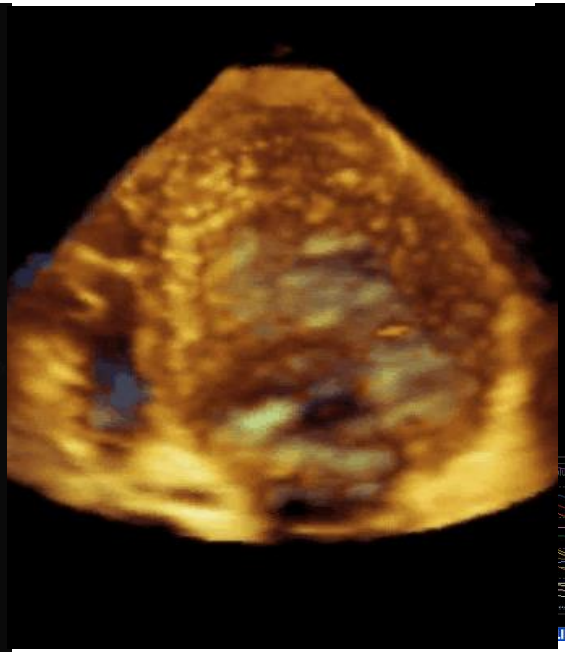
	Mild	Moderate	Severe
Flow reversal	brief protodiastolic	intermediate	holodiastolic (>20 cm/s

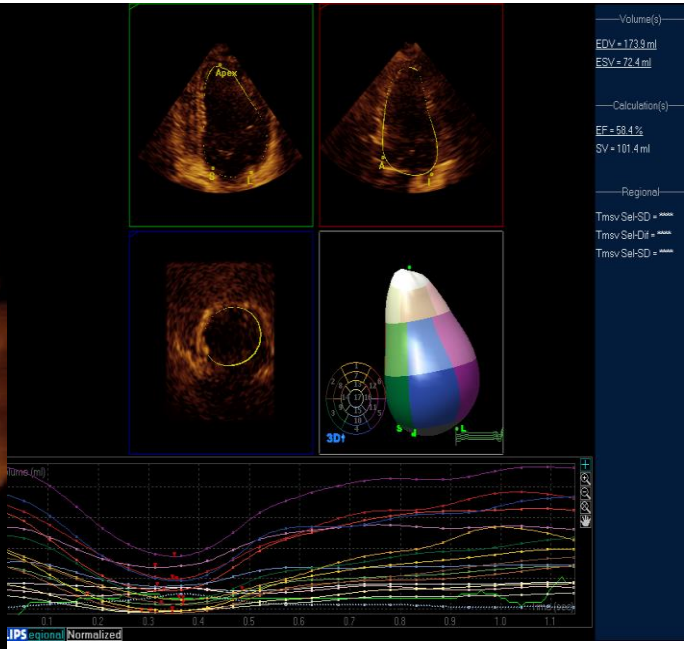
The measurement of the diastolic flow reversal in the descending aorta is recommended, when assessable. It should be considered as the strongest additional parameter for evaluating the severity of AR

Assessment of AR: consequence LV dilatation

- LV volumes 2D , 3D



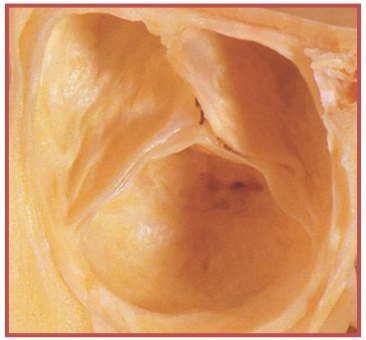


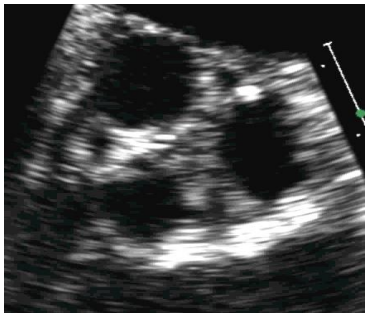


LV diameters, volumes, and ejection fraction should always be evaluated and reported.

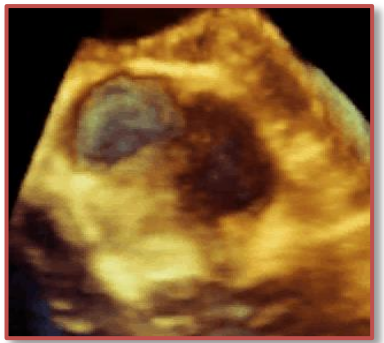
Assessment of AR: valve and root morphology

Tricuspid valve

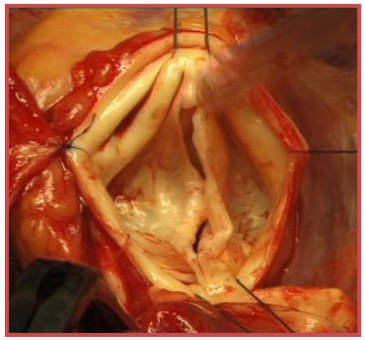


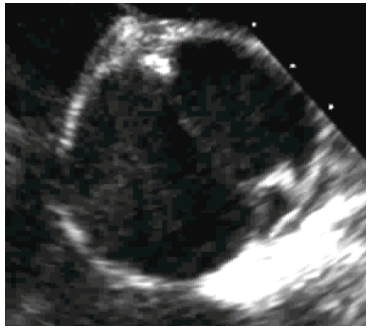


Unicuspid valve

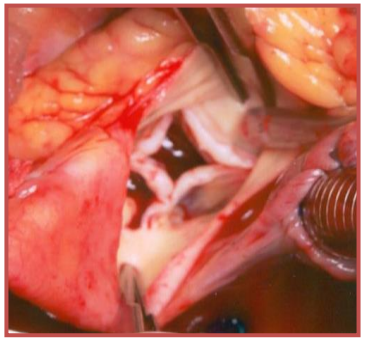


Bicuspid valve



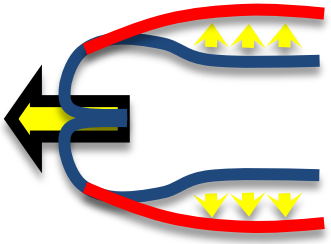


Quadricuspid valve



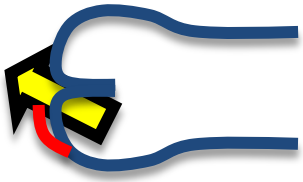
Assessment of AR: valve and root morphology

I

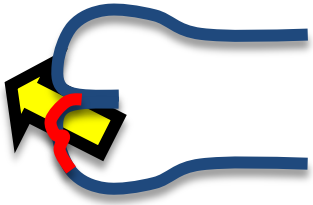


Enlargement of the aortic root (annulus, sinus… with normal cusp

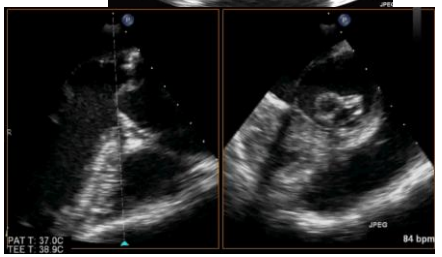
II

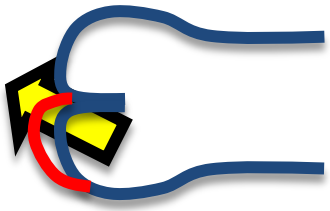


Cusp flail: complete eversion of a cusp

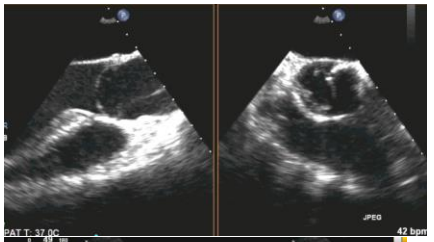


Partial prolapse: distal part of the cusp prolapsing

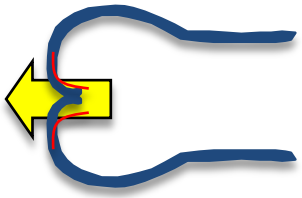




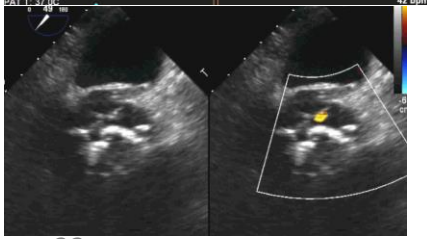
Whole cusp prolapse: free edge ofthe cusp overiding the place of the annulus



III



Poor cusp quality, thickened valve, with reduce motion



Assessment of AR: in summary

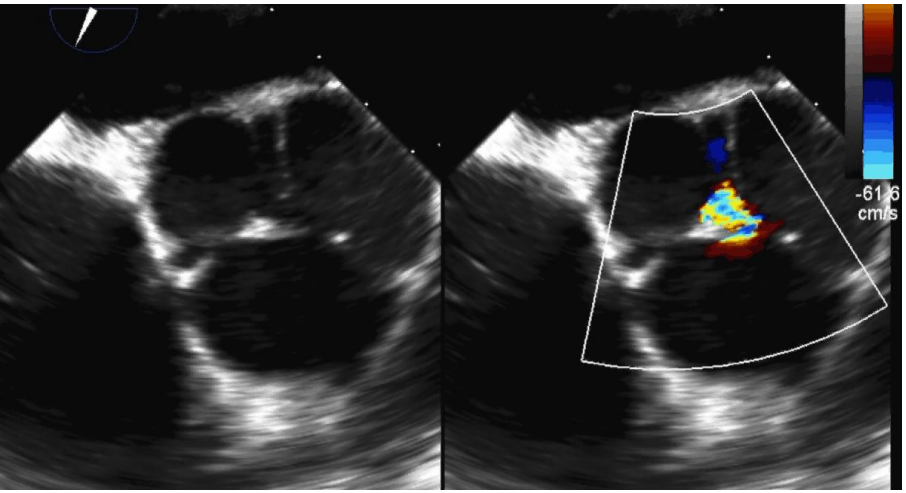
Parameters	Mild	Moderate	Severe
Qualitative			
Aortic valve morphology	Normal/Abnormal	Normal/Abnormal	Abnormal/flail/large coaptation defect
Colour flow AR jet width[a]	Small in central jets	Intermediate	Large in central jet, variable in eccentric jets
CW signal of AR jet	Incomplete/faint	Dense	Dense
Diastolic flow reversal in descending aorta	Brief, protodiastolic flow reversal	Intermediate	Holodiastolic flow reversal (end-diastolic velocity >20 cm/s)
Semi-quantitative			
VC width (mm)	<3	Intermediate	>6
Pressure half-time (ms)[b]	>500	Intermediate	<200
Quantitative			
EROA (mm^2)	<10	10–19; 20–29[c]	≥30
R Vol (mL)	<30	30–44; 45–59[c]	≥60
+LV size[d]			

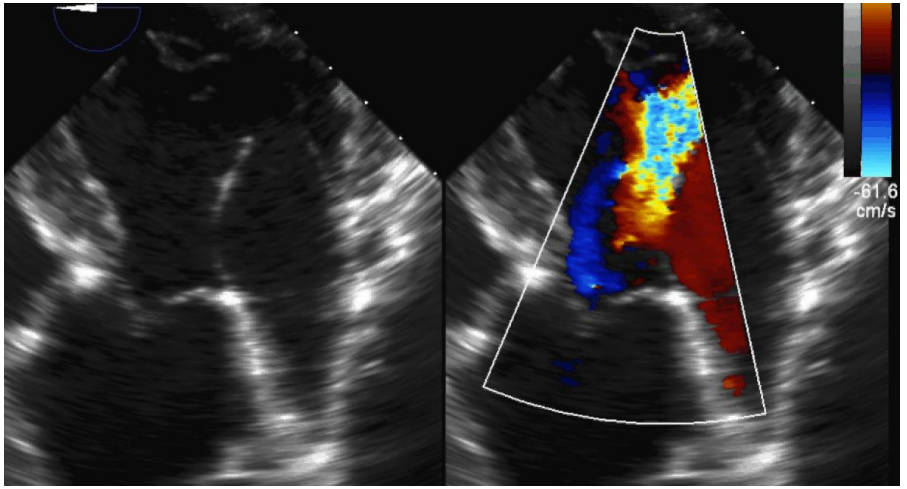
Source:: Lancellotti et al, Eur J echo 2010;:11 233-244

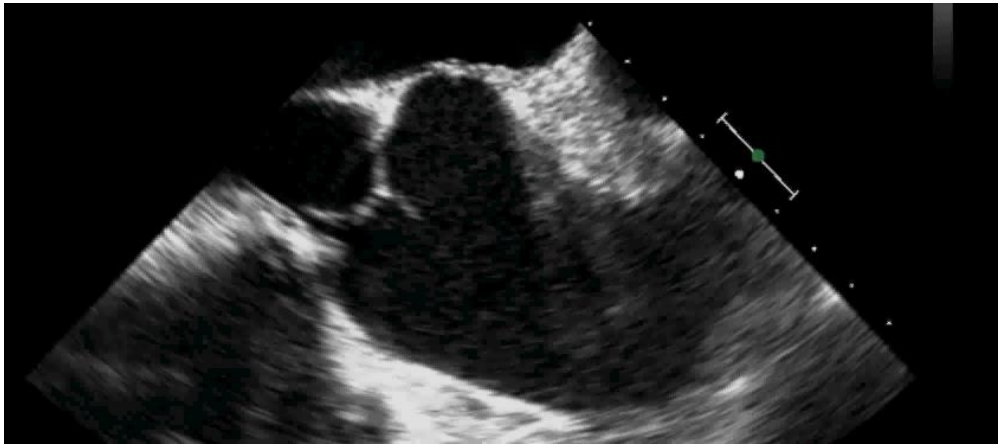
Assessment of AR: Problems ?

- Conflicting value
- Or some measurement are not feasible
- Patient had poor image quality
- You need some confirmation of the severity and repercussion ?

Assessment of AR: in summary: TOE

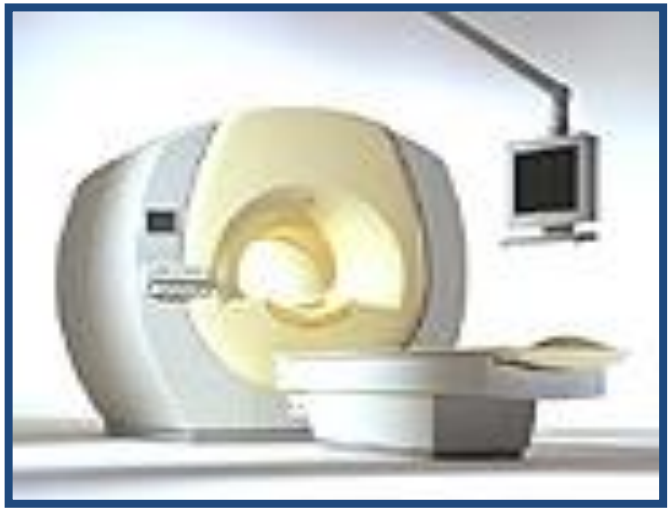






- Same method as for TTE except diastolic flow reverse in the aorta
- Aortic root assessment
- LV function and volumes ? (more difficult)

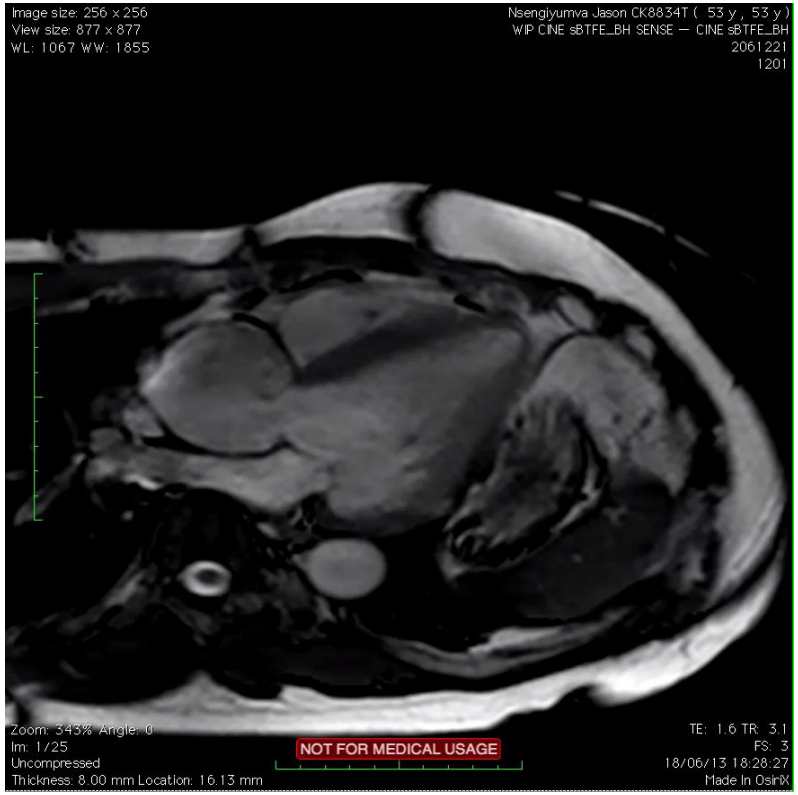
Assessment of aortic regurgitation : MRI

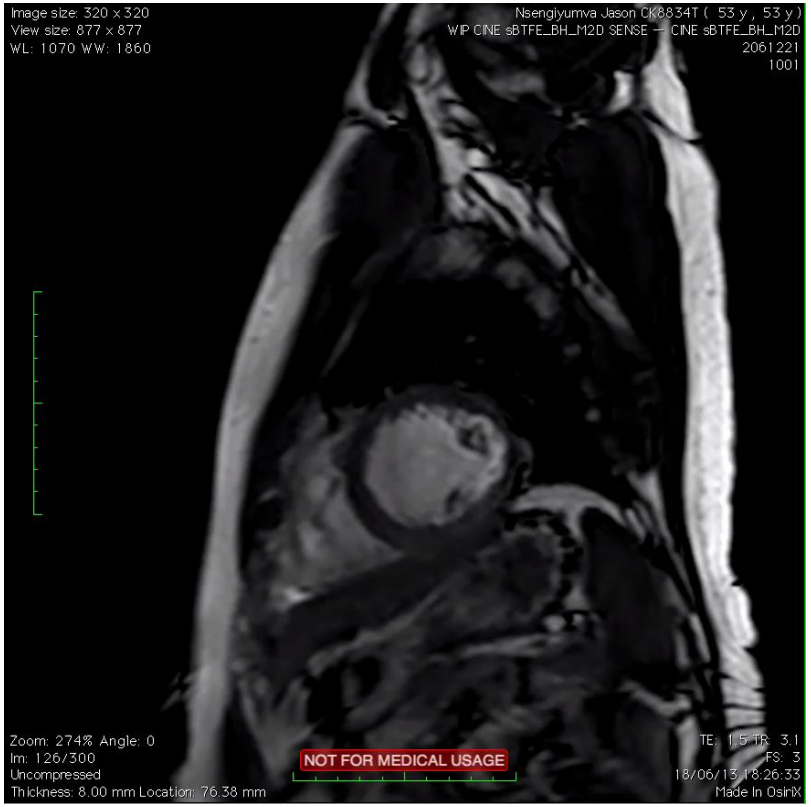


- Allows volumes measurement
- Quantification of AR using phase contrast technique
- Tissue characterization

Assessment of aortic regurgitation : MRI

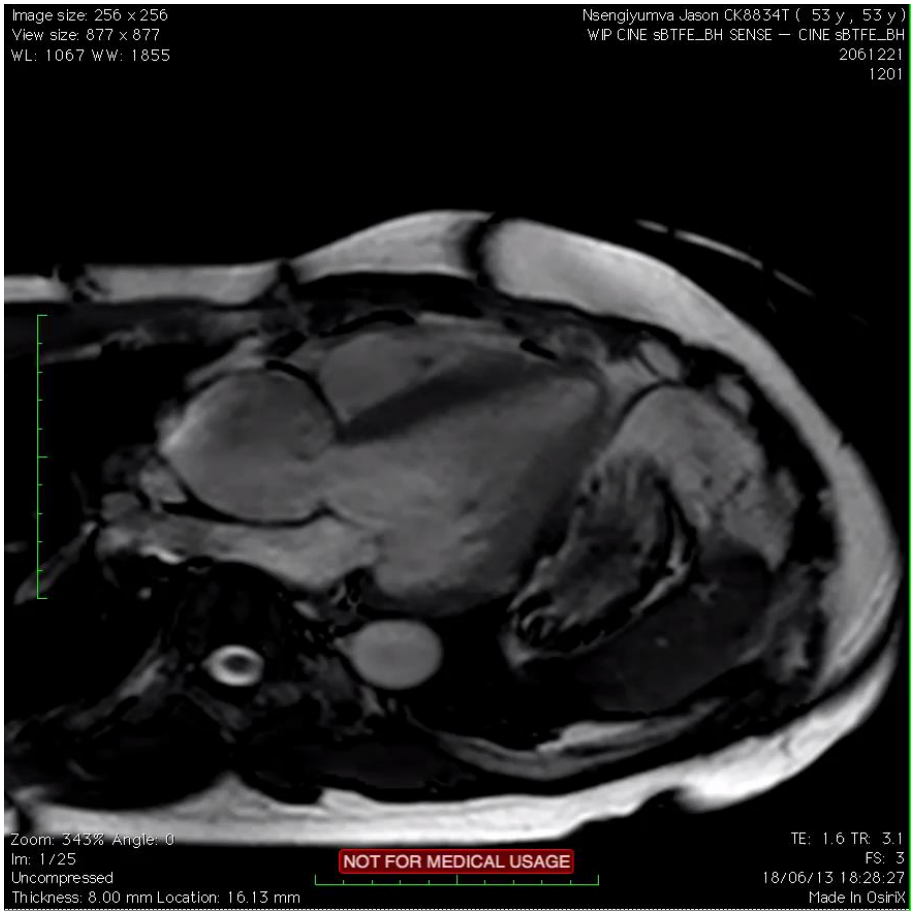
- LV and volumes

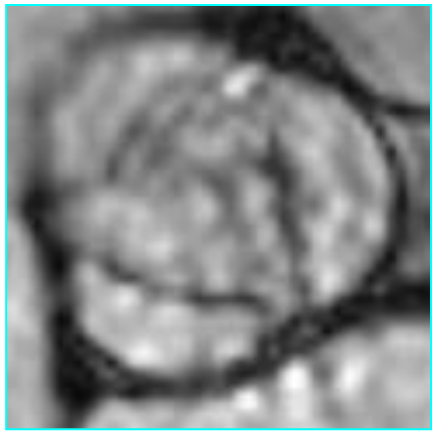


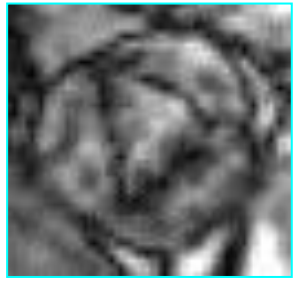


Assessment of aortic regurgitation : MRI

- Aortic valve

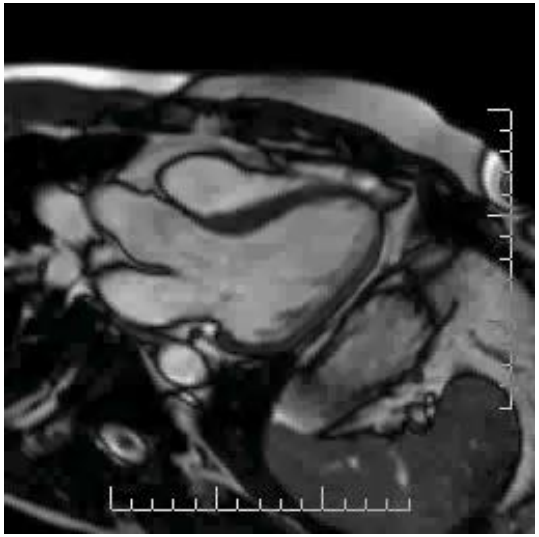




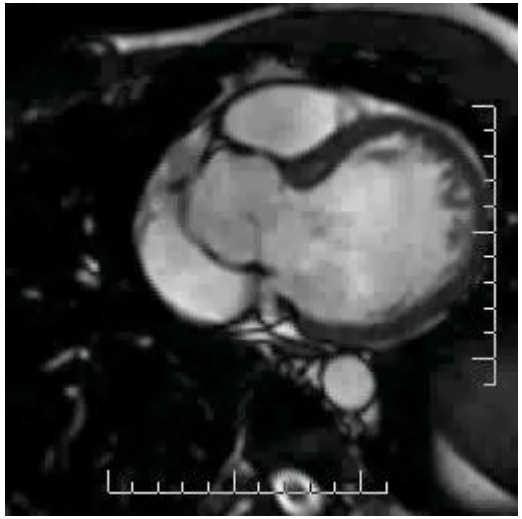


Assessment of aortic regurgitation : MRI

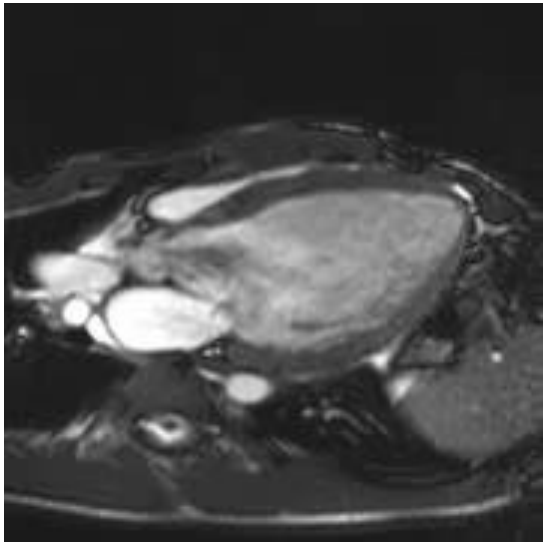
Visual Imaging of jet turbulence



no AR.



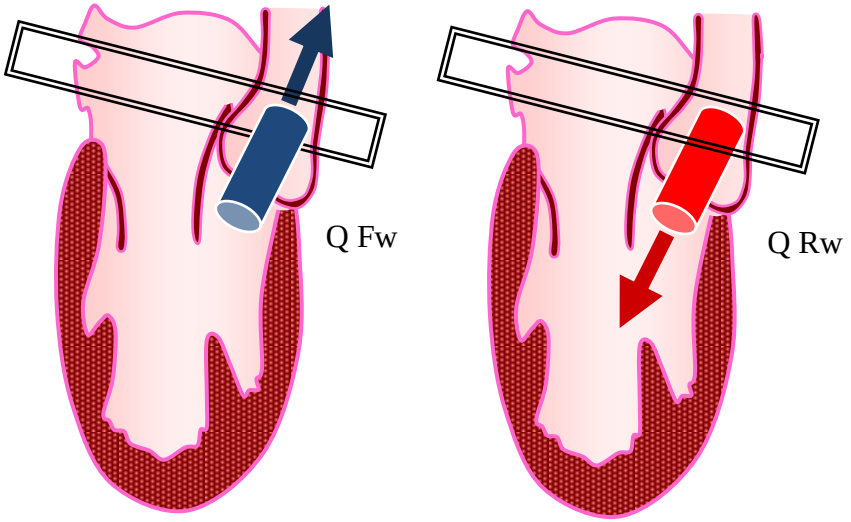
Mild-Moderate AR.



Severe AR.

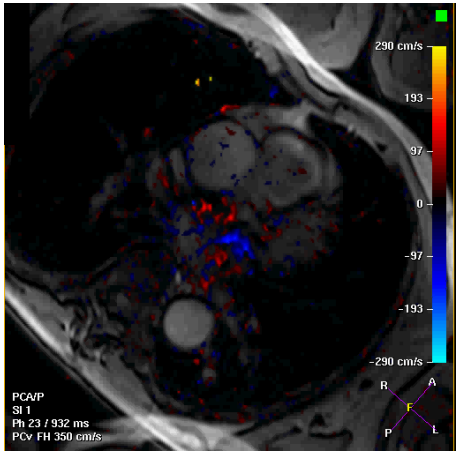
Imprecise for quantification with SSFP pulse sequences
Useful for direction of jet.

Assessment of aortic regurgitation : MRI

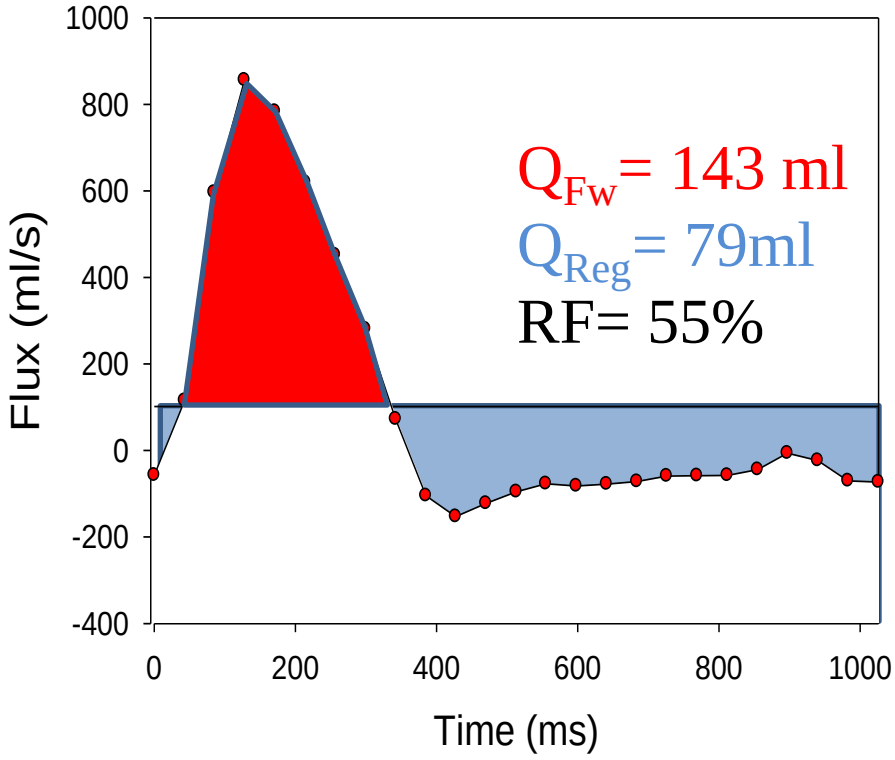


Systole: forward volume

Diastole: backward volume



- Phase contrast technique for flow quantification
- Quantitative measurement of aortic flow



Assessment of aortic regurgitation : MRI

- Flow reversal in descending aorta

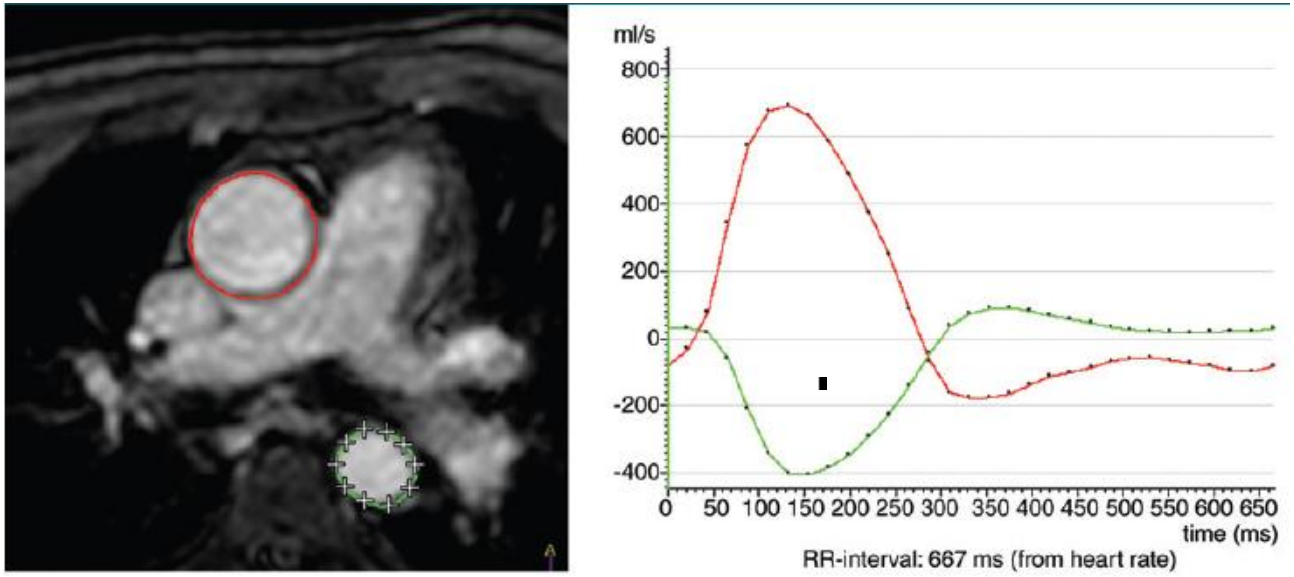


Table 2

HDR Predictive Value for Aortic TTE Regurgitant Grade

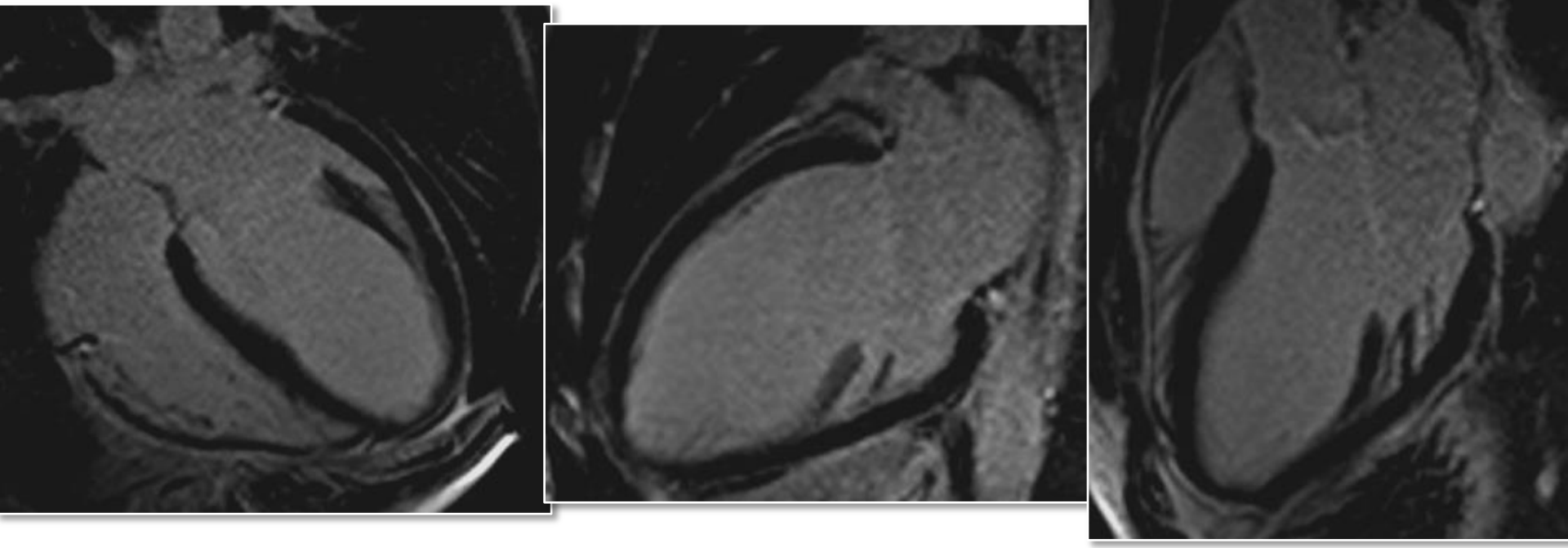
TTE Grade	Sensitivity (%)	Specificity (%)	Odds Ratio	*P* Value
4	100	93	164 (8)	<.001
3 or 4	61	100	192 (10)	<.001

Note.—Data in parentheses are the 95% lower confidence limit.

Bolen, Radiology 2011

Assessment of aortic regurgitation : MRI

- Tissue Characterization : fibrosis ?



Guidelines :

Class I

1. **TTE is indicated in patients with signs or symptoms of AR (stages A to D) for accurate diagnosis of the cause of regurgitation, regurgitant severity, and LV size and systolic function, and for determining clinical outcome and timing of valve intervention.[34,75–84] *(Level of Evidence: B)***
2. **TTE is indicated in patients with dilated aortic sinuses or ascending aorta or with a bicuspid aortic valve (stages A and B) to evaluate the presence and severity of AR.[85] *(Level of Evidence: B)***
3. **CMR is indicated in patients with moderate or severe AR (stages B, C, and D) and suboptimal echocardiographic images for the assessment of LV systolic function, systolic and diastolic volumes, and measurement of AR severity.[86,87] *(Level of Evidence: B)***

Class I

1. **An initial TTE is indicated in patients with a known bicuspid aortic valve to evaluate valve morphology, to measure the severity of AS and AR, and to assess the shape and diameter of the aortic sinuses and ascending aorta for prediction of clinical outcome and to determine timing of intervention.[99–104] *(Level of Evidence: B)***
2. **Aortic magnetic resonance angiography or CT angiography is indicated in patients with a bicuspid aortic valve when morphology of the aortic sinuses, sinotubular junction, or ascending aorta cannot be assessed accurately or fully by echocardiography. *(Level of Evidence: C)***

Bicuspid AV

ACC/AHA guidelines on valve disease 2014

3.1.3.2 Cardiac magnetic resonance

In patients with inadequate echocardiographic quality or discrepant results, cardiac magnetic resonance (CMR) should be used to assess the severity of valvular lesions—particularly regurgitant lesions—and to assess ventricular volumes and systolic function, as CMR assesses these parameters with higher reproducibility than echocardiography.[23]

CMR is the reference method for the evaluation of RV volumes and function and is therefore useful to evaluate the consequences

3.1.3.3 Computed tomography

Multi-slice computed tomography (MSCT) may contribute to the evaluation of the severity of valve disease, particularly in AS, either indirectly by quantifying valvular calcification, or directly through the measurement of valve planimetry.[24,25] It is widely used to assess the severity and location of an aneurysm of the ascending aorta. Due to its high negative predictive value, MSCT may be useful in excluding CAD in patients who are at low risk of atherosclerosis.[25] MSCT plays an important role in the work-up of high-risk patients with AS considered for TAVI.[26,27] The risk of radiation exposure—and of renal failure due to contrast injection—should, however, be taken into consideration.

Both CMR and MSCT require the involvement of radiologists/cardiologists with special expertise in VHD imaging.[28]

ESC guidelines on valves disease

Assessment of aortic regurgitation : MRI

- assessment of the aorta

Conclusion:

- The colour flow area of the regurgitant jet is not recommended to quantify the severity of valvular regurgitation.
- Both the vena contracta measurement and the PISA method are the recommended approaches to evaluate the severity of regurgitation when feasible.
- Adjunctive parameters should be used to confirm the results
- MRI could help for quantification of LV volume and severity of aortic regurgitation

Conclusion:

- Quantified degree of regurgitation and the clinical context must be integrated.
- All the measurements need to be consistent !

Thank you for your attention

European Journal of Echocardiography (2010) 11, 223–244
doi:10.1093/ejechocard/jeq030

RECOMMENDATIONS

European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 1: aortic and pulmonary regurgitation (native valve disease)

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