

## **Overcome the bias in AR assessment**

Simona Sperlongano, MD, PhD, FISC

Division of Cardiology, Department of Traslational Medical Sciences, University of Campania Luigi Vanvitelli, Naples, Italy

Email: simona.sperlongano@unicampania.it



### DISCLOSURE

I have no financial relationships to disclose

# 2021 ESC/EACTS Guidelines for the management of valvular heart disease

Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

The timing of intervention is guided by:

- The severity of aortic regurgitation (AR);
- The presence of clinical symptoms;
- The presence of early signs of LV remodeling (dysfunction or dilation).



### Symptoms: a challenging evaluation



Patients adapt to the chronic volume and pressure overload over time, and they may not be aware of any physical limitations.

### Physical examination: clues about AR severity

- Low diastolic blood pressure;
- Prominent holodiastolic murmur on Erb's point;
- Corrigan sign and dancing carotid arteries;
- Quincke's sign.

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Yang LT et al. J Am Coll Cardiol., 2020

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### TTE: the cornerstone imaging modality

TTE is the initial imaging modality. It provides information on:

- AR severity;
- LV remodeling, due to chronic volume overload.

Strong correlation with outcomes

### TTE assessment of AR severity

European Society European Heart Journal - Cardiovascular Imaging (2022) 23, e171–e232 https://doi.org/10.1093/ehjci/jeab253

**EACVI DOCUMENT** 

### Multi-modality imaging assessment of native valvular regurgitation: an EACVI and ESC council of valvular heart disease position paper

Patrizio Lancellotti () <sup>1,2,3</sup>\*, Philippe Pibarot () <sup>4</sup>, John Chambers<sup>5</sup>, Giovanni La Canna<sup>6</sup>, Mauro Pepi<sup>7</sup>, Raluca Dulgheru<sup>1</sup>, Mark Dweck<sup>8</sup>, Victoria Delgado () <sup>9</sup>, Madalina Garbi<sup>10</sup>, Mani A. Vannan<sup>11</sup>, David Montaigne () <sup>12</sup>, Luigi Badano<sup>13,14</sup>, Pal Maurovich-Horvat<sup>15</sup>, Gianluca Pontone () <sup>16</sup>, Alec Vahanian () <sup>17,18</sup>, Erwan Donal () <sup>19</sup>, and Bernard Cosyns () <sup>20</sup>; On behalf of the Scientific Document Committee of the European Association of Cardiovascular Imaging



#### Color flow Doppler imaging

# Color flow Doppler from multiple echocardiographic views allows the detection and the initial visual assessment of AR.



#### Color-coded M-mode

Color-coded M-mode allows to assess the duration of AR during diastole.



#### Jet width/LVOT diameter

- Semi-quantitative parameter;
- Measured immediately below the aortic valve, in the PLAX view;
- Ratio  $\geq$  65% is specific for severe AR;
- Main limitation: underestimation of AR in the presence of eccentric jets.



#### Vena contracta width

- Semi-quantitative parameter;
- Measured at the level of the aortic valve (the smallest flow diameter) from the PLAX view;
- Width < 3 mm suggests mild AR; > 6 mm (Nyquist limit of 50-60 cm/s) is specific for severe AR;
- Main limitations: problematic in the presence of multiple jets; based on the assumption that the regurgitant orifice is circular.



#### Vena contracta area

- Quantitative parameter;
- Measured by 3D color flow Doppler echocardiography;
- Useful to better delineate the shape of the regurgitant orifice (which is often elliptic or irregular) and report the largest diameter.



#### **Diastolic flow reversal**

- Qualitative parameter;
- Measured in the proximal descending aorta from the suprasternal view by PW Doppler;
- Holodiastolic reverse flow, with tele-diastolic velocity > 20 cm/s is specific for severe AR (more specific if sampled in abdominal aorta).



#### Density of regurgitant jet by CW Doppler

- Qualitative parameter;
- Generally measured in apical 5C view by CW Doppler (but a good Doppler beam alignement is required);
- Faint jet is compatible with mild AR;
- Main limitation: overlap between moderate and severe AR in more dence jets.



#### Pressure half time

- Quantitative parameter;
- Generally measured in apical 5C view by CW
  Doppler (but a good Doppler beam alignement is required);
- PHT < 200 ms is specific for severe AR; > 500 ms is consistent with mild AR;
- Main limitation: it is influenced by aortic and LV compliance and pressure.



PISA method for effective regurgitant orifice area (EROA) and regurgitant volume (RV) assessment

- Quantitative parameter;
- The PISA radius is generally obtained from the apical 5C or 3C views or PLAX view (above all in eccentric jets) in diastole, using the first aliasing;
- AR TVI is traced to obtain EROA and RV;
- EROA ≥ 30 mm<sup>2</sup> and RV ≥ 60 ml indicate severe AR; RF
  (RV/LVOT stroke volume) ≥ 50% indicates severe AR too;
- Main limitation: feasibility limited by AV calcifications and interposition of valve tissue; not valid for multiple jets.





### TTE assessment of LV remodeling

LV end-systolic diameter (LVESD)

Increased LVESD reflects:

- The severity of LV dilation;
- LV systolic dysfunction.





Surgery is recommended in asymptomatic patients with LVESD >50 mm or LVESD >25 mm/m<sup>2</sup> BSA (in patients with small body size) or resting LVEF  $\leq$ 50%.<sup>107,108,112,114,115</sup>



Dujardin et al. Circulation, 1999





Mentias et al. J Am Coll Cardiol., 2016

Yang et al. J Am Coll Cardiol., 2019

#### LV end systolic volume (LVESV)

LVESV may be used in the presence of:

- asymmetrical enlargement of the LV;
- Hypertrophy of the basal septum.

LVESVi  $\geq$  45 ml/m<sup>2</sup> is associated with increased risk of death in AR patients.





LVESV measurement requires apical images of good quality and non-foreshortened. It may be obteined by contrast echocardiography when image quality is sub-optimal.



#### Left ventricular ejection fraction (LVEF)





Surgery is recommended in asymptomatic patients with LVESD >50 mm or LVESD >25 mm/m<sup>2</sup> BSA (in patients with small body size) or resting LVEF  $\leq$ 50%.<sup>107,108,112,114,115</sup>

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#### Left ventricular global longitudinal strain (LV GLS)

GLS is a more sensitive parameter in identifying subclinical LV systolic dysfunction.



A precise GLS cut-off to recommend surgery remains to be defined.



Alashi et al. J Am Coll Cardiol., 2018

Yang et al. J Am Soc Echocardiogr., 2022

### Further imaging modalities: when TTE alone is not enough

Further imaging is necessary when:

- Images' quality on TTE is poor/suboptimal;
- There are discrepancies between clinical and echocardiographic data;
- There are internal discrepancies in the TTE itself (e.g. eccentric jets).

### TEE assessment of aortic valve/root morphology and size

TEE is used to study aortic valve/root morphology, in order to understand the mechanisms and the causes of AR.

<b>Type I</b> Normal Cusp Motion with Aortic Dilation or Cusp Perforation			Type II Cusp Prolapse	Type III Cusp Restriction
a) Sinotubular junction enlargement and dilatation b) Dilatation of the sinuses Valsalva an sinotubular jun	f tion c) Dilatation of the ventriculo- arterial junction (annulus)	d) Aortic cusp perforation		

Lebehn et al. J Cardiovasc Dev Dis., 2023





### CMR assessment of AR severity

<u>Regurgitant volume (RV) and regurgitant fraction (RF)</u>

- Directly quantified by 2D phase contrast CMR;
- Higher reproducibility than echocardiography.



Zoghbi et al. J Am Soc Echocardiogr., 2017



There are no cut-off values to define hemodynamically significant AR. CMR-RF > 33% (32 or 35% in other studies) seems to be associated with symptoms progression, need for aortic valve replacement and cardiovascular outcomes.



### CMR assessment of LV remodeling



#### LV volumes and LV systolic function

CMR is the gold standard (LV volumes are

underestimated by echocardiography).

Ajmone Marsan N et al. Eur Heart J., 2023



#### <u>Fibrosis</u>

Regional replacement fibrosis is detected by LGE , and diffuse interstitial fibrosis by T1 mapping (ECV assessment).

Ajmone Marsan N et al. Eur Heart J., 2023

### CT assessment of AR severity and LV remodeling

Cardiac CT does allow for assessment of:

- AR severity by the measurement of regurgitant orifice area (ROA) (the direct measurement of the flow is not possible);
- LV volumes and function by cardiac CT angiography (CCTA).



Alkadhi et al. Radiology, 2007

### CT assessment of aortic valve/root morphology and size

Cardiac CT is the preferred imaging modality to assess aortic diameters in the presence of aortic dilation.



Alkadhi et al. Radiology, 2007

Aortic root angiography



### Summarising...

#### If symptoms $\rightarrow$ Operate

Surgery is recommended in symptomatic patients regardless of LV function.<sup>105–109</sup>



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#### If symptoms $\rightarrow$ Operate

Surgery is recommended in symptomatic patients regardless of LV function.<sup>105–109</sup>



#### If current guidelines thresholds are reached $\rightarrow$ Operate

Surgery is recommended in asymptomatic patients with LVESD >50 mm or LVESD >25 mm/m<sup>2</sup> BSA (in patients with small body size) or resting LVEF  $\leq$ 50%.<sup>107,108,112,114,115</sup>



If the patients is in the intermediate range  $\rightarrow$  Consider other factors

Surgery may be considered in asymptomatic patients with LVESD >20 mm/m<sup>2</sup> BSA (especially in patients with small body size) or resting LVEF ≤55%, if surgery is at low risk.

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Adjunctive parameters to consider:

- LV volumes (LVESVi > 45 ml/m<sup>2</sup>);
- LV GLS;
- PROGRESSIVE CHANGES IN LV SIZE AND FUNCTION;
- Plasma biomarkers (BNP);
- Presence and extent of myocardial fibrosis;
- Exercise echocardiography.



# Thank you

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