



Recommendations on the Echocardiographic Assessment of Aortic Valve Stenosis: A Focused Update from the European Association of Cardiovascular Imaging and the American Society of Echocardiography

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Echocardiography is the key tool for the diagnosis and evaluation of aortic stenosis. Because clinical decision-making is based on the echocardiographic assessment of its severity, it is essential that standards are adopted to maintain accuracy and consistency across echocardiographic laboratories. Detailed recommendations for the echocardiographic assessment of valve stenosis were published by the European Association of Echocardiography and the American Society of Echocardiography in 2009. In the meantime, numerous new studies on aortic stenosis have been published with particular new insights into the difficult subgroup of low gradient aortic stenosis making an update of recommendations necessary. The document focuses in particular on the optimization of left ventricular outflow tract assessment, low flow, low gradient aortic stenosis with preserved ejection fraction, a new classification of aortic stenosis by gradient, flow and ejection fraction, and a grading algorithm for an integrated and stepwise approach of aortic stenosis assessment in clinical practice. (J Am Soc Echocardiogr 2017;30:372-92.)

Keywords: Aortic stenosis, Echocardiography, Computed tomography, Quantification, Prognostic parameters

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Abbreviations	
AoA = Aortic cross-sectional area	
AR = Aortic regurgitation	
AS = Aortic stenosis	
AV = Aortic valve	
AVA = Aortic valve area	
CMR = Cardiac magnetic resonance imaging	
CSA = Cross-sectional area	
CT = Computed tomography	
CW = Continuous-wave	
CWD = Continuous-wave Doppler	
D = Diameter of the LVOT	
EF = Ejection fraction	
EOA = Effective orifice area	
GLS = Global longitudinal strain	
LV = Left ventricle	
LVOT = Left ventricular outflow tract	
Max = Maximum	
MR = Mitral regurgitation	
MS = Mitral stenosis	
MSCT = Multislice CT	
ΔP = Pressure gradient	
PR = Pressure recovery	
SV = Stroke volume	
SVi = Stroke volume index	
TTE = Transthoracic echocardiography	
TEE = Transesophageal echocardiography	
V = Velocity	
VTI = Velocity time integral	
2D = Two-dimensional	
3D = Three-dimensional	

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INTRODUCTION

Aortic stenosis (AS) has become the most common primary heart valve disease and an important cause of cardiovascular morbidity and mortality. Echocardiography is the key tool for the diagnosis and evaluation of AS, and is the primary non-invasive imaging method for AS assessment. Diagnostic cardiac catheterization is no longer recommended¹⁻³ except in rare cases when echocardiography is

cardiographic evaluation of valve stenosis, including recommendations for specific measures of stenosis severity, details of data acquisition and measurement, and grading of severity. These 2009 recommendations were based on the scientific literature and on the consensus of a panel of experts. Since publication of this 2009 document, numerous new studies on AS have been published, in particular with new insights into the difficult subgroup of low gradient AS. Accordingly, a focused update on the echocardiographic assessment of AS appeared to be a needed document and is now provided with this document.

As with the 2009 document, this document discusses a number of proposed methods for evaluation of stenosis severity. On the basis of an updated comprehensive literature review and expert consensus, these methods were categorized for clinical practice as:

- Level 1 Recommendation: an *appropriate and recommended* method for all patients with aortic stenosis.
- Level 2 Recommendation: a *reasonable* method for clinical use when additional information is needed in selected patients.
- Level 3 Recommendation: a method *not recommended* for routine clinical practice although it may be appropriate for research applications and in rare clinical cases.

It is essential in clinical practice to use an integrative approach when grading the severity of AS, combining all Doppler and 2D data as well as clinical presentation, and not relying on one specific measurement. Loading conditions influence velocity and pressure gradients; therefore, these parameters vary depending on intercurrent illness of patients with low vs. high cardiac output. In addition, irregular rhythms or tachycardia can make assessment of AS severity challenging. Ideally, heart rate, rhythm, and blood pressure should be stated in the echocardiographic report and hemodynamic assessment should be performed at heart rates and blood pressures within the normal range. These guidelines provide recommendations for recording and measurement of AS severity using echocardiography. However, although accurate quantification of disease severity is an essential step in patient management, clinical decision-making depends on several other factors, most importantly, whether or not symptoms are present. This document is meant to provide echocardiographic standards and does not make recommendations for clinical management. The latter are detailed in the current guidelines for management of adults with heart valve disease.^{1,2}

Highlights in this focused update on aortic stenosis document include:

- Optimization of LVOT assessment.
- Low flow, low gradient aortic stenosis with reduced LVEF.
- Low flow, low gradient aortic stenosis with preserved LVEF.
- New classification of AS by gradient, flow and ejection fraction.
- AS grading algorithm- an integrated and stepwise approach.

ETIOLOGIES AND MORPHOLOGIC ASSESSMENT

The most common causes of valvular AS are calcific stenosis of a tricuspid valve, a bicuspid aortic valve with superimposed calcific changes, and rheumatic valve disease (Figure 1). Congenital aortic stenosis owing to a unicuspid aortic valve is rare in adults with usually marked dysmorphic features including severe thickening and calcification and associated with significant concomitant aortic regurgitation (AR). In Europe and North America, calcific AS represents by far the most frequent aetiology with the prevalence of bicuspid vs. tricuspid aortic valves as underlying anatomy being highly age dependent.⁵ While tricuspid valves predominate in the elderly (>75 years)

non-diagnostic or discrepant with clinical data.

Because clinical decision-making is based on the echocardiographic assessment of the severity of AS, it is essential that standards be adopted to maintain accuracy and consistency across echocardiographic laboratories when assessing and reporting AS. Recommendations for the echocardiographic assessment of valve stenosis in clinical practice were published by the European Association of Echocardiography and the American Society of Echocardiography in 2009.⁴ The aim of the 2009 paper was to detail the recommended approach to the echo-

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