GUIDELINES AND STANDARDS

Echocardiographic Assessment of Valve Stenosis: EAE/ASE Recommendations for Clinical Practice

Helmut Baumgartner, MD,† Judy Hung, MD,‡ Javier Bermejo, MD, PhD,†
John B. Chambers, MD,† Arturo Evangelista, MD,† Brian P. Griffin, MD,‡ Bernard Iung, MD,†
Catherine M. Otto, MD,‡ Patricia A. Pellikka, MD,‡ and Miguel Quiñones, MD‡

Abbreviations: AR = aortic regurgitation, AS = aortic stenosis, AVA = aortic valve area, CSA = cross sectional area, CWD = continuous wave Doppler, D = diameter, HOCM = hypertrophic obstructive cardiomyopathy, LV = left ventricle, LVOT = left ventricular outflow tract, MR = mitral regurgitation, MS = mitral stenosis, MVA = mitral valve area, DP = pressure gradient, RV = right ventricle, RVOT = right ventricular outflow tract, SV = stroke volume, TEE = transesophageal echocardiography, $T_{1/2}$ = pressure half-time, TR = tricuspid regurgitation, TS = tricuspid stenosis, V = velocity, VSD = ventricular septal defect, VTI = velocity time integral

Continuing Medical Education Activity for "Echocardiographic Assessment of Valve Stenosis: EAE/ASE Recommendations for Clinical Practice"

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Target Audience:

This activity is designed for all cardiovascular physicians, cardiac sonographers and nurses with a primary interest and knowledge base in the field of echocardiography; in addition, residents, researchers, clinicians, sonographers, and other medical professionals having a specific interest in valvular heart disease may be included.

Objectives:

Upon completing this activity, participants will be able to: 1. Demonstrate an increased knowledge of the applications for echocardiographic assessment of valvular stenosis and their impact on cardiac diagnosis. 2. Differentiate the different methods for echocardiographic assessment of valvular stenosis. 3. Recognize the criteria for echocardiographic grading of valvular stenosis. 4. Identify the advantages and disadvantages of the methodologies employed for assessing valvular stenosis and apply the most appropriate methodology in clinical situations 5. Incorporate the echocardiographic methods of valvular stenosis to form an integrative approach to assessment of valvular stenosis 6. Effectively use echocardiographic assessment of valvular stenosis for the diagnosis and therapy for significant valvular stenosis. 7. Assess the common pitfalls in echocardiographic assessment of valvular stenosis and employ appropriate standards for consistency of valvular stenosis assessment.

Author Disclosures:

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Estimated Time to Complete This Activity: 1 hour

I. INTRODUCTION

Valve stenosis is a common heart disorder and an important cause of cardiovascular morbidity and mortality. Echocardiography has become the key tool for the diagnosis and evaluation of valve disease, and is the primary non-invasive imaging method for valve stenosis assessment. Clinical decision-making is based on echocardiographic assessment of the severity of valve stenosis, so it is essential that standards be adopted to maintain accuracy and consistency across echocardiographic laboratories when assessing and reporting valve stenosis. The aim of this paper was to detail the recommended approach to the echocardiographic evaluation of valve stenosis, including recommendations for specific measures of stenosis severity, details of data acquisition and measurement, and grading of severity. These recommendations are based on the scientific literature and on the consensus of a panel of experts.

This document discusses a number of proposed methods for evaluation of stenosis severity. On the basis of a 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 stenosis of that valve.
- 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

From the University of Muenster, Muenster, Germany (H.B.); Massachusetts General Hospital, Boston, MA, USA (J.H.); Hospital General Universitario Gregorio Marañón, Barcelona, Spain (J.B.); Huy's and St. Thomas' Hospital, London, United Kingdom (J.B.C.); Hospital Vall D'Hebron, Barcelona, Spain (A.E.); Cleveland Clinic, Cleveland, OH, USA (B.P.G.); Paris VII Denis Diderot University, Paris, France (B.I.); University of Washington, Seattle, WA, USA (C.M.O.); Mayo Clinic, Rochester, MN, USA (P.A.P.); and The Methodist Hospital, Houston, TX, USA (M.Q.)

Reprint requests: American Society of Echocardiography, 2100 Gateway Centre Boulevard, Suite 310, Morrisville, NC 27560, ase@asecho.org.

† Writing Committee of the European Association of Echocardiography (EAE).

‡ American Society of Echocardiography (ASE).

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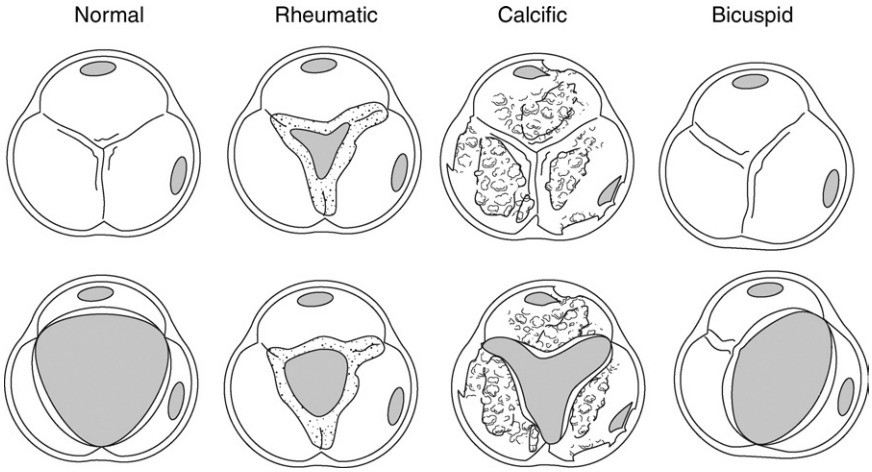

Figure 1 Aortic stenosis aetiology: morphology of calcific AS, bicuspid valve, and rheumatic AS (Adapted from C. Otto, Principles of Echocardiography, 2007).

grading the severity of stenosis, combining all Doppler and 2D data, 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 stenosis severity problematic. Finally, echocardiographic measurements of valve stenosis must be interpreted in the clinical context of the individual patient. The same Doppler echocardiographic measures of stenosis severity may be clinically important for one patient but less significant for another.

II. AORTIC STENOSIS

Echocardiography has become the standard means for evaluation of aortic stenosis (AS) severity. Cardiac catheterization is no longer recommended[1–3] except in rare cases when echocardiography is non-diagnostic or discrepant with clinical data.

This guideline details recommendations for recording and measurement of AS severity using echocardiography. However, although accurate quantitation of disease severity is an essential step in patient management, clinical decision-making depends on several other factors, most importantly symptom status. This echocardiographic standards document does not make recommendations for clinical management: these are detailed in the current guidelines for management of adults with valvular heart disease.

A. Causes and Anatomic Presentation

The most common causes of valvular AS are a bicuspid aortic valve with superimposed calcific changes, calcific stenosis of a trileaflet valve, and rheumatic valve disease (Figure 1). In Europe and the USA, bicuspid aortic valve disease accounts for ~50% of all valve replacements for AS.[4] Calcification of a trileaflet valve accounts for most of the remainder, with a few cases of rheumatic AS. However, worldwide, rheumatic AS is more prevalent.

Anatomic evaluation of the aortic valve is based on a combination of short- and long-axis images to identify the number of leaflets, and to describe leaflet mobility, thickness, and calcification. In addition, the combination of imaging and Doppler allows the determination of the level of obstruction; subvalvular, valvular, or supravalvular. Transthoracic imaging usually is adequate, although transesophageal echocardiography (TEE) may be helpful when image quality is suboptimal.

A bicuspid valve most often results from fusion of the right and left coronary cusps, resulting in a larger anterior and smaller posterior cusp with both coronary arteries arising from the anterior cusp (~80% of cases), or fusion of the right and non-coronary cusps resulting in a larger right than left cusp with one coronary artery arising from each cusp (about 20% of cases).[5,6] Fusion of the left and non-coronary cusps is rare. Diagnosis is most reliable when the two cusps are seen in systole with only two commissures framing an elliptical systolic orifice. Diastolic images may mimic a tricuspid valve when a raphe is present. Long-axis views may show an asymmetric closure line, systolic doming, or diastolic prolapse of the cusps but these findings are less specific than a short-axis systolic image. In children and adolescents, a bicuspid valve may be stenotic without extensive calcification. However, in adults, stenosis of a bicuspid aortic valve typically is due to superimposed calcific changes, which often obscures the number of cusps, making determination of bicuspid vs. tricuspid valve difficult.

Calcification of a tricuspid aortic valve is most prominent when the central part of each cusp and commissural fusion is absent, resulting in a stellate-shaped systolic orifice. With calcification of a bicuspid or tricuspid valve, the severity of valve calcification can be graded semi-quantitatively, as mild (few areas of dense echogenicity with little acoustic shadowing), moderate, or severe (extensive thickening and increased echogenicity with a prominent acoustic shadow). The degree of valve calcification is a predictor of clinical outcome.[4,7]

Rheumatic AS is characterized by commisural fusion, resulting in a triangular systolic orifice, with thickening and calcification most prominent along the edges of the cusps. Rheumatic disease nearly always affects the mitral valve first, so that rheumatic aortic valve disease is accompanied by rheumatic mitral valve changes. Subvalvular or supravalvular stenosis is distinguished from valvular stenosis based on the site of the increase in velocity seen with colour or pulsed Doppler and on the anatomy of the outflow tract. Subvalvular obstruction may be fixed, due to a discrete membrane or muscular band, with haemodynamics similar to obstruction at the valvular level. Dynamic subaortic obstruction, for example, with hypertrophic cardiomyopathy, refers to obstruction that changes in severity during ventricular ejection, with obstruction developing predominantly in mid-to-late systole, resulting in a late peaking velocity curve. Dynamic obstruction also varies with loading conditions, with increased ob-