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Valve Stress Echocardiography

A Practical Guide for Referral, Procedure, Reporting, and Clinical Implementation of Results From the HAVEC Group

Madalina Garbi, MD, MA,* John Chambers, MD,† Mani A. Vannan, MBBS,‡ Patrizio Lancellotti, MD, PhD§‖

ABSTRACT

Valve stress echocardiography (VSE) is increasingly used both within specialist valve clinics and within dedicated VSE services, mandating practical guidance for referral, procedure, reporting, and clinical implementation of results. Therefore, a didactic VSE guide was compiled based on current European Society of Cardiology and American College of Cardiology/American Heart Association valve disease management guidelines, review of existing evidence, and the authors' extensive experience with VSE. The VSE indications were grouped into 3 categories: symptoms despite nonsevere valve disease, asymptomatic severe valve disease, and valve disease with reduced left ventricular systolic function. The aim of the test, the type of stress to be used, the sequence of image acquisition, the information to be included in the report, and the implication of the VSE results for clinical management were described for every indication and summarized in user-friendly tables. (J Am Coll Cardiol Img 2015;8:724–36) © 2015 by the American College of Cardiology Foundation.

In patients who have asymptomatic severe valve disease, exercise testing is an established practice to detect occult symptoms (1–5). However, additional diagnostic and prognostic information can be obtained by adding echocardiographic imaging to exercise testing or to dobutamine infusion, in a wider range of indications (1–3,6). Valve stress echocardiography (VSE) is being increasingly used, both within the specialist valve clinics and within dedicated VSE services receiving referrals from cardiologists and cardiac surgeons outside the boundaries of the specialist valve clinic. To aid in this evolving clinical practice, and mirroring routine in the authors' own departments, the current paper presents a didactic guide for VSE procedures and reporting and also for VSE referral and interpretation of results; the information is based on guidelines, recommendations, referenced current evidence, and the authors' experience. The HAVEC (Heart Valve Clinic International Database) group recognized the need for concerted efforts to enhance the VSE evidence base before the update of current valve disease management guidelines to reflect expert practice trends.

REFERRAL GUIDE

The VSE indications can be classified into 3 categories: symptoms despite nonsevere valve disease, asymptomatic severe valve disease, and valve disease with reduced left ventricular (LV) systolic function. Throughout the text, the references associated with each indication denote whether the indication is well established and generally accepted, being consequently included in current European Society of Cardiology (ESC) and American College of Cardiology (ACC)/American Heart Association (AHA) guidelines (1,2) and recommendations (7), or is not well established but supported by some more recent evidence. Comments lacking a reference represent the opinion of the authors. The VSE indications' acceptance status and evidence have been summarized (**Table 1**) to highlight the gap between current trends and

From the *King's Health Partners, King's College Hospital NHS Foundation Trust, London, United Kingdom; †Cardiothoracic Centre, Guy's and St. Thomas' Hospital, London, United Kingdom; ‡Marcus Heart Valve Center, Piedmont Heart Institute, Atlanta, Georgia; §University of Liège Hospital, GIGA Cardiovascular Sciences, Departments of Cardiology, Heart Valve Clinic, CHU Sart Tilman, Liège, Belgium; and ‖GVM Care and Research, Lugo (RA), Italy. The HAVEC group is composed of volunteers (not sponsored) who have put together a collection of prospectively collected data on valvular heart disease. Centers involved in HAVEC have facilities to diagnose and regularly monitor patients with valvular heart disease. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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guidelines. The goal of the test depends on the VSE indication (**Table 2**).

SYMPTOMS DESPITE NONSEVERE VALVE DISEASE. Exertional breathlessness, chest pain, or unexplained acute pulmonary edema requires revaluation of valve disease severity based on flow-dependent changes or on its dynamic component (1,2).

Mitral regurgitation. Secondary mitral regurgitation (MR) as a result of ischemic heart disease is likely to worsen on exertion, but this outcome can occur for any MR etiology (1,2,8,9). In patients with unexplained acute pulmonary edema (1,8), stress may induce myocardial ischemia with associated dynamic ischemic MR.

Mild MR is an indication for exercise VSE before coronary artery bypass grafting (CABG), as suggested by evidence from the RIME (Randomized Ischemic Mitral Evaluation) trial (10). This trial found that mitral annuloplasty at the time of CABG in patients with moderate ischemic MR at rest or developed on exertion might improve functional capacity, LV reverse remodeling, MR severity, and B-type natriuretic peptide levels. The ESC guidelines (1) recommend mitral valve surgery at the time of CABG in patients with moderate MR and use of VSE to assess symptoms and exertion-induced MR severity and systolic pulmonary arterial pressure (SPAP) increases.

Mitral stenosis. A noncompliant mitral valve may be moderately stenotic at rest but hemodynamically severely stenotic during stress, as it fails to open further to accommodate the increase in flow (1,2,6,11–15). In addition, because indexed valve area thresholds are not defined, VSE may be useful for grading mitral stenosis (MS) in patients with a large body surface area (13). Gradient thresholds (1,2,11,16–19) for severe MS have been established as >15 mm Hg on exertion or >18 mm Hg during dobutamine infusion. In addition, SPAP >60 mm Hg on exertion (1,2,11,18) suggests severe MS. Proof of hemodynamic significance may help clinical decision-making in cases of valve morphology not suitable for balloon valvotomy and those of high surgical risk. Furthermore, even in cases of valve morphology suitable for balloon valvotomy, proof of increases in mean gradient and increases in SPAP to >60 mm Hg during VSE strengthens the decision to proceed if the MS is only moderate at rest.

Aortic regurgitation. Aortic regurgitation (AR) is reduced at high heart rates as diastole shortens even if the systemic pressure rises. Consequently, although exercise testing is recommended to confirm equivocal symptoms (2), echocardiographic imaging can only be added with the goal of revealing inducible myocardial ischemia but not with the goal of re-grading AR severity.

Aortic stenosis. As with MS, a noncompliant aortic valve may be moderately stenotic at rest but severely stenotic during stress (20,21) because the valve fails to open further. Consequently, gradient increase and calculated functional valve area failure to increase during VSE suggest severe aortic stenosis (AS) (5,8,11,13,20,21). VSE is indicated (1,2) to regrade AS severity in symptomatic patients. Furthermore, because coexistence of coronary artery disease is common in calcific AS, the VSE may also detect inducible ischemia.

VSE may help grade AS severity in paradoxical low-flow AS (22,23). Dobutamine should be used with caution and could be potentially contraindicated if (as is common in paradoxical low-flow AS) the LV has severe hypertrophy, especially of the basal interventricular septum and small cavity, because of the high likelihood of dobutamine-induced left ventricular outflow tract (LVOT) obstruction and drop in blood pressure during the test.

Prosthetic valves. A VSE is recommended to help diagnose an obstructive prosthetic valve (7). A significant mean gradient rise (for both aortic and mitral prosthetic valves) (16,24) and a calculated functional valve area failure to rise (for aortic prosthetic valves)

ABBREVIATIONS AND ACRONYMS

ACC = American College of Cardiology

AHA = American Heart Association

AR = aortic regurgitation

AS = aortic stenosis

CABG = coronary artery bypass grafting

ESC = European Society of Cardiology

LV = left ventricular

MR = mitral regurgitation

MS = mitral stenosis

SPAP = systolic pulmonary arterial pressure

VSE = valve stress echocardiography

TABLE 1 VSE Indications' Acceptance Status and Supportive Evidence

VSE Indication	ESC	ACC/AHA	Evidence (Ref. #)	Expert Practice
Symptomatic patient				
Nonsevere MR	Yes	Yes	(6,8,9,11)	Yes
Pulmonary edema	Yes	No	(8)	Yes
Mild MR before CABG	Yes	No	(10)	Yes
Nonsevere MS	Yes	Yes	(6,8,11,13–19)	Yes
Nonsevere AR	No	Yes*	No	Yes†
Nonsevere AS	Yes	Yes	(8,11,13,20,21,41)	Yes
Paradoxical low-flow AS	Yes	Yes	(8,11,22,23)	Yes
Equivocal AV PPM/stenosis	Yes	Yes	(7,8,11,24)	Yes
Equivocal MV PPM/stenosis	Yes	Yes	(7,8,11)	Yes
Asymptomatic patient				
Severe MR	Yes	Yes	(6,8,11,25–28)	Yes
Significant MS	Yes	Yes	(6,8,11,13–19)	Yes
Severe AR	No	Yes*	(29,30)	Yes
Severe AS	Yes	Yes	(3–5,8,11,13,20,21,31–37,39)	Yes
Low LVEF				
Low-flow AS	Yes	Yes	(8,11,23,38–45,47,48)	Yes
Low-flow AV prosthesis	No	No	No	Yes

*Exercise test only. †Exercise echocardiogram to assess existence of inducible ischemia.

ACC = American College of Cardiology; AHA = American Heart Association; AR = aortic regurgitation; AS = aortic stenosis; AV = aortic valve; CABG = coronary artery bypass grafting; ESC = European Society of Cardiology; LVEF = left ventricular ejection fraction; MR = mitral regurgitation; MS = mitral stenosis; MV = mitral valve; PPM = patient-prosthesis mismatch; VSE = valve stress echocardiography.