European Heart Journal – Cardiovascular Imaging (2016) **17**, 589–590
doi:10.1093/ehjci/jew025

Recommendations for the imaging assessment of prosthetic heart valves: a report from the European Association of Cardiovascular Imaging endorsed by the Chinese Society of Echocardiography, the Inter-American Society of Echocardiography, and the Brazilian Department of Cardiovascular Imaging†

Patrizio Lancellotti[1,2]*, Philippe Pibarot[3,4], John Chambers[5], Thor Edvardsen[6], Victoria Delgado[7], Raluca Dulgheru[1], Mauro Pepi[8], Bernard Cosyns[9], Mark R. Dweck[10], Madalina Garbi[11], Julien Magne[12,13], Koen Nieman[14,15], Raphael Rosenhek[16], Anne Bernard[17,18], Jorge Lowenstein[19], Marcelo Luiz Campos Vieira[20,21], Arnaldo Rabischoffsky[22], Rodrigo Hernández Vyhmeister[23], Xiao Zhou[24], Yun Zhang[25], Jose-Luis Zamorano[26], and Gilbert Habib[27,28]

[1]Department of Cardiology, GIGA-Cardiovascular Sciences, University of Liège Hospital, Liège, Belgium; [2]Gruppo Villa Maria Care and Research, Anthea Hospital, Bari, Italy; [3]Québec Heart and Lung Institute/Institut Universitaire de Cardiology et de Pneumologie de Québec, Québec, Canada; [4]Department of Cardiology, Laval University and Canada Research Chair in Valvular Heart Disease, Québec, Canada; [5]Guy's and St Thomas' Hospitals, London, UK; [6]Department of Cardiology, Oslo University Hospital, Rikshospitalet and University of Oslo, Oslo, Norway; [7]Department of Cardiology, Heart Lung Center Leiden University Medical Center, Leiden, The Netherlands; [8]Centro Cardiologico Monzino, IRCCS, Milan, Italy; [9]Cardiology, Centrum voor Hart en Vaatziekten, UZ Brussel, Bruxelles, Belgium; [10]BHF/University Centre for Cardiovascular Science, University of Edinburgh, Edinburgh, UK; [11]King's Health Partners, King's College Hospital NHS Foundation Trust, London, UK; [12]CHU Limoges, Hôpital Dupuytren, Service Cardiologie, Limoges F-87042, France; [13]INSERM 1094, Faculté de médecine de Limoges, 2, rue Marcland, 87000 Limoges, France; [14]Department of Cardiology, Erasmus MC, Rotterdam, The Netherlands; [15]Department of Radiology, Erasmus MC, Rotterdam, The Netherlands; [16]Department of Cardiology, Medical University of Vienna, Vienna, Austria; [17]Cardiology department, CHRU de Tours, F-37000 Tours, France; [18]François Rabelais University, Faculty of Medicine, F-37000 Tours, France; [19]Servicio Cardiodiagnostico Investigaciones Médicas de Buenos Aires, Argentina; [20]Heart Institute (InCor), São Paulo University Medical School, São Paulo, Brazil; [21]Hospital Israelita Albert Einstein, São Paulo, Brazil; [22]Hospital Pro Cardíaco Echocardiography Department Coordinator, Rio de Janeiro, Brazil; [23]Hospital Fuerza Aérea de Chile, Cardiología Clínica Las Condes, Valparaíso University, Valparaíso, Chile; [24]Cardiology, Chinese PLA General Hospital in Beijing, China; [25]Shandong University Qilu Hospital in Jinan, Shandong, China; [26]University Alcala de Henares, Hospital Ramon y Cajal, Madrid, Spain; [27]Aix-Marseille Université, 13005 - Marseille, France; and [28]Cardiology Department, APHM, La Timone Hospital, 13005 - Marseille, France

Received 6 January 2016; accepted after revision 7 January 2016

Prosthetic heart valve (PHV) dysfunction is rare but potentially life-threatening. Although often challenging, establishing the exact cause of PHV dysfunction is essential to determine the appropriate treatment strategy. In clinical practice, a comprehensive approach that integrates several parameters of valve morphology and function assessed with 2D/3D transthoracic and transoesophageal echocardiography is a key to appropriately detect and quantitate PHV dysfunction. Cinefluoroscopy, multidetector computed tomography, cardiac magnetic resonance imaging, and to a lesser extent, nuclear imaging are complementary tools for the diagnosis and management of PHV complications. The present document provides recommendations for the use of multimodality imaging in the assessment of PHVs.

Keywords echocardiography • cardiac magnetic resonance • cinefluoroscopy • computed tomography • nuclear imaging • prosthetic heart valve

* Corresponding author. Tel: +32 4 366 71 94; Fax: +32 4 366 71 95. E-mail: plancellotti@chu.ulg.ac.be

† The full-length version of this article can be viewed at *European Heart Journal – Cardiovascular Imaging* online.

EACVI Documents Reviewers: Nuno Cardim (Portugal), Erwan Donal (France), Maurizio Galderisi (Italy), Kristina H. Haugaa (Norway), Philipp A. Kaufmann (Switzerland), Denisa Muraru (Italy).

Published on behalf of the European Society of Cardiology. All rights reserved. © The Author 2016. For permissions please email: journals.permissions@oup.com.

Downloaded from by guest on November 20, 2016

Introduction

Valvular heart disease affects >100 million people worldwide and represents a growing problem because of the increasing burden of degenerative valve disease in the ageing population and of the still high incidence of rheumatic heart disease in developing countries.[1] About 4 million prosthetic heart valve (PHV) replacements have been performed over the past 50 years, and this remains the only definitive treatment for most patients with severe valvular heart disease.[2] The total number of replacements is projected to be 850 000 per year by 2050.[3]

PHV dysfunction is rare but potentially life-threatening. Although often challenging, establishing the exact cause of PHV dysfunction is essential to determine the appropriate treatment strategy.[4,5] In clinical practice, a comprehensive approach that integrates several parameters of valve morphology and function assessed with 2D/3D transthoracic (TTE) and transoesophageal (TOE) echocardiography is a key to appropriately detect and quantitate PHV dysfunction. Cinefluoroscopy, multidetector computed tomography (CT), cardiac magnetic resonance imaging (CMR), and to a lesser extent, nuclear imaging are complementary tools for the diagnosis and management of PHV complications.[4,5] The present document provides recommendations for the use of multimodality imaging in the assessment of PHVs.

Key points

2D TTE is recommended as first-line imaging in PHV. TTE is also the method of choice for Doppler signal recordings. Both TTE and TOE are needed for complete evaluation in a patient with suspected PHV dysfunction. 3D echocardiography, especially with TOE, can provide additional information and is increasingly used. For both TTE and TOE, it is essential to obtain images in multiple views and multiple planes to ensure complete visualization of the valvular and paravalvular region. TTE/TOE has higher sensitivity in mitral than aortic position for examining disc valve motion. For the evaluation of PHV regurgitation, TOE is superior in mitral/tricuspid position while TTE is better in aortic position. TOE, especially when completed by 3D evaluation, remains superior for assessing paravalvular regurgitation.

Non-echo imaging modalities are generally not performed for routine evaluation of PHV, but rather when valvular dysfunction or other complications are suspected. They can provide incremental information on valvular integrity and valvular/paravalvular pathology. Cinefluoroscopy has a complementary role in evaluating disc mobility of mechanical PHVs and valve ring structure. Cardiac CT is also an important adjuvant imaging technique that permits visualization of calcification and degenerative changes of biological prosthesis, pannus formation, the presence of thrombus, and assessment of movement of occluders in mechanical valves. The use of CMR is not yet routine practice but is increasing. Nuclear imaging currently has very limited application in the evaluation of PHV other than in the setting of suspected infective endocarditis.

Mechanical PHVs have specific patterns of echoes that can help identify the type of prosthesis. The echocardiographic assessment of PHVs can be limited by the shadowing effect particularly for the mitral prosthesis from the TTE approach and partially for the aortic prosthesis from the TOE views.

All normal functioning mechanical PHVs cause some degree of obstruction to blood flow, closure backflow (necessary to close the valve), and leakage backflow (after valve closure). Quantitative parameters of PHV function include transprosthetic flow velocity (highest velocity signal in PHVs) and pressure gradients, EOA and DVI. Although good correlation exists between Doppler and invasive measurements, overestimation of pressure gradients by Doppler is frequent in mechanical PHVs. Comparison of the haemodynamic function of different designs of valve cannot be made using label size. The label size cannot be used as surrogate for LVOT diameter in the calculation of the EOA using the continuity equation.

Patient-prosthesis mismatch (PPM) should be distinguished from PHV dysfunction. PPM is present early after surgery and on all subsequent echocardiograms. The echocardiographic diagnosis of pannus formation is often a diagnosis of exclusion but may be detected better by CT. At present, integrating multiple qualitative, semi-quantitative, and quantitative findings is the recommended approach for assessing PHV regurgitation.

Follow-up and monitoring

Patients who have recently undergone valve replacement should not be considered as cured and require careful and, when necessary, frequent follow-up.[6] Ideally, a comprehensive baseline TTE should be obtained at the first post-operative visit usually after 4–6 weeks when the chest wound has healed, chest wall oedema has resolved, and LV systolic function has recovered. However, if the patient is being transferred to another hospital's care and may not return, it may be better to perform the study before discharge. It is then not recommended to perform routine scans in asymptomatic patients with normally functioning mechanical valves or until 5 (ESC) to 10 (ACC/AHA) years after implantation for those with normally functioning biological valves.[4,5] However, it is suggested that routine TTE should still be performed annually for (i) new designs of biological valve for which durability data are not established; (ii) patients with aortic dilatation at the time of surgery; and (iii) patients after left-sided mitral valve replacement [to check for the development of tricuspid regurgitation (TR) and RV dysfunction]. Echocardiography also becomes indicated if symptoms develop or in case of signs suggesting valve dysfunction or alteration (i.e. thickening of a bioprosthesis, which can represent an early sign of structural valve dysfunction). When TTE/TOE is inconclusive, additional imaging approaches (cinefluoroscopy, cardiac CT, CMR) can be indicated.

Conflict of interest: None declared.

References

1. Nkomo VT, Gardin JM, Skelton TN, Gottdiener JS, Scott CG, Enriquez-Sarano M. Burden of valvular heart diseases: a population-based study. *Lancet* 2006;**368**:1005–11.
2. Dunning J, Gao H, Chambers J, Moat N, Murphy G, Pagano D *et al.* Aortic valve surgery: marked increases in volume and significant decreases in mechanical valve use—an analysis of 41,227 patients over 5 years from the Society for Cardiothoracic Surgery in Great Britain and Ireland National database. *J Thorac Cardiovasc Surg* 2011;**142**:776–82.
3. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Blaha MJ *et al.* Executive summary: heart disease and stroke statistics-2014 update: a report from the American Heart Association. *Circulation* 2014;**129**:399–410.
4. Vahanian A, Alfieri O, Andreotti F, Antunes MJ, Baron-Esquivias G, Baumgartner H *et al.* Guidelines on the management of valvular heart disease (version 2012). *Eur Heart J* 2012;**33**:2451–96.
5. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA *et al.* AHA/ACC Guideline for the management of patients with valvular heart disease. *J Am Coll Cardiol* 2014;**63**:e57–185.
6. Lancellotti P, Rosenhek R, Pibarot P, Iung B, Otto CM, Tornos P *et al.* ESC Working Group on Valvular Heart Disease position paper—heart valve clinics: organization, structure, and experiences. *Eur Heart J* 2013;**34**:1597–606.

Downloaded from by guest on November 20, 2016