Do differences in early hemodynamic performance of current generation biologic aortic valves predict outcomes 1 year following surgery?

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Objective: Small early postoperative hemodynamic differences were noted in a randomized comparison of 3 current-generation bioprosthetic aortic valves. Whether these differences persist and influence clinical outcomes 1 year following implantation is unknown.

Methods: Three hundred adults with severe aortic stenosis undergoing valve replacement were randomized to receive the Epic (St Jude, St Paul, Minn) (n = 99), Magna (Edwards LifeSciences Inc, Irvine, Calif) (n = 100), or Mitroflow (Sorin Biomedica Spa, Saluggio, Italy) (n = 101) bioprostheses. Hemodynamic valve performance was examined by echocardiography at 1 year, and clinical outcomes were assessed in 241 patients (79 Epic, 77 Magna, and 85 Mitroflow; $P = .437$).

Results: Mean age was 75 ± 8 years and 164 were men (68%). Between dismissal and 1 year there were 9 deaths (3.7%) (Epic: 3.7%, Magna: 5.0%, and Mitroflow: 2.3%; $P = .654$), 6 episodes of heart failure (2.5%) (Epic: 1.3%, Magna: 1.3%, and Mitroflow: 5.8%; $P = .265$), 27 instances of atrial fibrillation/flutter (11.2%) (Epic: 8.1%, Magna: 11.0%, and Mitroflow: 7.9%; $P = .577$) and no strokes/transient ischemic attacks. One-year echocardiography demonstrated small hemodynamic differences between Epic, Magna, and Mitroflow bioprostheses in mean gradient (15.2 ± 5.5, 12.3 ± 4.3, and 16.2 ± 5.7 mm Hg, respectively; $P < .001$) and indexed aortic valve area (0.93 ± 0.28, 1.04 ± 0.28, and 0.96 ± −0.26 cm^2/m^2, respectively; $P = .015$). Several early trends persisted when stratifying data by echocardiographic annulus diameter, universal annulus size, and implant size, particularly with annular size ≥23 mm. Overall left ventricular mass index regression between dismissal and 1 year was −16.5 ± 28.1 g/m^2, and was similar among groups ($P = .262$). There were no aortic valve reoperations.

Conclusions: Despite midterm persistence of small hemodynamic differences amongst current-generation porcine and pericardial aortic valves, our prospective randomized comparison reveals that clinical outcomes and mass regression are equivalent between devices at 1 year. These encouraging trends must continue to be assessed during longitudinal follow-up. (J Thorac Cardiovasc Surg 2015;149:163-73)

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See related commentary on pages 173-4.

Supplemental material is available online.

In elderly patients undergoing surgical aortic valve replacement (AVR), biologic prosthetic valves may be preferred over mechanical prostheses because they overcome the need for long-term anticoagulation therapy and diminish corresponding lifestyle restrictions. However, among patients in whom a bioprosthetic implant is deemed appropriate, equipoise persists regarding merits of porcine versus bovine pericardial aortic implants.[1,2] Further, and despite assertions of improved performance

Abbreviations and Acronyms
AVA = aortic valve area
AVAi = aortic valve area index
AVR = aortic valve replacement
LV = left ventricular

of third-generation aortic valve prostheses,[3-8] it remains uncertain as to whether there are differences in the hemodynamic profile and long-term durability of valves with different constructions.

In a prospective randomized study of 300 patients with severe aortic stenosis presenting for surgical AVR, we previously compared the immediate postoperative performance of 3 commonly used current generation biologic aortic valve prostheses: the Epic porcine valve (St Jude Medical, St Paul, Minn), the Magna bovine pericardial valve (Edwards LifeSciences, Irvine, Calif), and the Mitroflow bovine pericardial valve (Sorin Biomedical Spa, Saluggia, Italy).[9] Although we identified small but consistent early postoperative hemodynamic differences between the 3 groups, whether such differences persist and their effect on midterm outcomes 1 year following dismissal from hospital are unknown. We prospectively follow these patients and compare herein hemodynamic performance, prosthetic valve durability, and clinical outcomes at 1 year following index aortic valve implantation.

METHODS

This prospective randomized study was approved by the Mayo Clinic Institutional Review Board.

Study Subjects

As previously detailed,[9] 300 consecutive patients referred for biologic AVR between August 2009 and November 2011 were considered for enrollment in this study. Exclusion criteria included age younger than 18 years, emergency surgery, prior prosthetic heart valve implantation in any location, prior aortic valve procedure, prior aortic root replacement, concomitant replacement of nonaortic valves, active endocarditis, and severe aortic valve insufficiency. Patients with a history of healed aortic valve endocarditis and those undergoing concomitant procedures (ie, coronary artery bypass grafting and valve repair) remained eligible for inclusion.

Herein we examine outcomes of 241 of the 300 (80%) patients who were available for follow-up at 1-year post-AVR. A patient flow diagram is outlined in Figure 1. All patients provided informed consent and identified willingness to comply with study protocols.

AVR

Techniques for randomization and valve replacement have been previously detailed.[9] Using statistical software (SAS version 9.2, SAS Institute, Inc, Cary, NC) the statistician generated randomization numbers printed on cards and sealed in envelopes. All patients underwent standard cardiopulmonary bypass and cold-blood cardioplegic arrest. Following aortotomy, excision of the native valve, and aortic annular debridement, the aortic annulus was measured using a calibrated universal sizer (19, 21, 23, 25, 27, and 29 mm). Thereafter, envelopes were opened and randomization groups identified: Epic, Magna, or Mitroflow. Using prosthesis-specific sizers provided by the manufacturers, the aortic annulus was again measured. Surgeons made a concerted effort to implant the largest possible prosthesis. Biologic prostheses were implanted using noneverting pledgeted stitches.

The Epic valve is a triple-composite bioprosthetic valve constructed from select porcine aortic valve cusps matched for optimal leaflet coaptation. Following fixation, tissue is mounted on a polyester-covered flexible copolymer stent. The Magna valve is manufactured from glutaraldehyde-fixed bovine pericardium mounted on a 3-pronged polyester Elgiloy stent. The Mitroflow valve is a stented bioprosthetic valve constructed from glutaraldehyde-fixed bovine pericardium sutured on a flexible, polyester cloth-covered acetyl homopolymer stent. The thickness of pericardial tissue was matched to the diameter of the stent in these valves. All prosthetic valves used in this study were between sizes 19 and 27.

Data Collection

Study participants returned for assessment at 1 year following surgery. The primary end point was hemodynamic performance of the biologic prosthetic valve at 1-year post-AVR, an evaluation of which is detailed below (see Echocardiography). Secondary outcomes were clinical events at 1-year follow-up. Specifically, patients were examined and evaluated for incidence of stroke, transient ischemic attack, hospital admission for congestive heart failure, development of atrial fibrillation/flutter, and reoperative AVR. Mortality data following hospital discharge was obtained by review of medical records, the electronic Accurint database (www.Accurint.com), contact with next of kin, and death certificates.

Echocardiography

In addition to preoperative and intraoperative echocardiography assessment, patients underwent further comprehensive 2-dimensional and Doppler echocardiographic evaluation using state-of-the-art technology before hospital dismissal, and—among patients with midterm follow-up data—at 1 year following AVR.

As previously detailed,[9] left ventricular (LV) ejection fraction was evaluated by 2-dimensional echocardiography in the LV short-axis view, and using a modified technique detailed by Quinones and colleagues,[10] or by visual estimate.[11] In alignment with best practice, continuous-wave and pulsed Doppler measurements were recorded[12] taking an average of 3 beats. In patients with atrial fibrillation an average of 5 to 10 beats was taken. LV outflow tract diameter was measured in the parasternal long-axis view during mid-systole, and in the native aortic valve by measuring the inner edges from where the anterior cusp meets the ventricular anteroseptum, to where the posterior cusp meets the anterior mitral valve leaflet. In prosthetic aortic valves, the measurement was from the outer edge of the anterior sewing ring to the outer edge of the posterior sewing ring. Mean transvalvular aortic gradient, peak velocity, and aortic valve time–velocity integral were automatically calculated by echocardiographic software. Multiple echocardiographic windows were explored to obtain the highest continuous-wave Doppler envelope of the aortic valve. The aortic valve area (AVA) was automatically calculated by the continuity equation, and indexed to body surface area (AVAi). Stroke work loss was reported as a percent and calculated using a previously detailed formula.[13] Finally, LV mass was calculated in accordance with the previously validated[13-15] American Society of Echocardiography formula,[16] and using 2-dimensional or M-mode measurements, and indexed to body surface area.

One cardiologist specializing in echocardiography imaging (H.I.M.) supervised uniform echocardiography data collected and reported in this study.