Comparison of the quantity of calcific deposits in bovine pericardial bioprostheses in the mitral and aortic valve positions in the same patient late after double-valve replacement

William Clifford Roberts, MD,[a,b,d] Carlos Ernesto Velasco, MD,[a] Jong Mi Ko, BA,[d] and Gregory John Matter, MD,[c] Dallas, Tex

Among patients undergoing cardiac valve replacement, the aortic valve is most commonly replaced, the mitral valve next, and, infrequently, both the mitral and aortic valves. When the latter situation occurs and when the substitute valves inserted are both bioprostheses, it is possible to compare the rates of degenerative change because one bioprosthesis serves as a control for the other. In 1983, Warnes and associates[1] reported on 5 patients with porcine bioprostheses in both the mitral and aortic valve positions from 18 to 107 months, and in each of the 4 patients in which the bioprosthesis was in place for greater than 18 months, the quantity of calcific deposits on the cusps of the bioprosthesis in the mitral valve position was much greater than that on the prosthesis in the aortic valve position. The present report was prompted by observing a patient who had a bovine parietal pericardial bioprosthesis in both the mitral and aortic positions explanted after they had been in place for 77 months; the quantity of calcium in the bioprosthesis in the aortic valve position was massive, and that in the bioprosthesis in the mitral position was minimal.

CLINICAL SUMMARY

A patient, who was born on March 25, 1949, had acute rheumatic fever in childhood and hypothyroidism since age 20 years. She was in her usual good health until April 2001 (age 52 years), when exertional dyspnea appeared, and it soon progressed to orthopnea, which prompted hospital admission. Echocardiographic and cardiac catheterization data are shown in Table 1. Electrocardiographic analysis disclosed sinus rhythm.

On May 22, 2001, both the mitral and aortic valves were replaced with Carpentier Edwards pericardial bovine bioprostheses treated with the XenoLogix tissue treatment process (Edwards LifeSciences, Irvine, Calif), which removes approximately 98% of phospholipids, which are calcium-binding sites. The excised anterior mitral leaflet weighed 0.77 g, and the 3-cuspid aortic valve weighed 0.74 g (Figure 1, *A* and *B*). Both valves were free of calcium.

The patient was thereafter well until April 2002, when a febrile illness developed. *Streptococcus sanguis* was cultured from the blood. She was treated with antibiotics, and her usual health returned. Vegetations were never observed on either bioprosthesis by means of echocardiographic analysis. Another echocardiogram in March 2003 disclosed stenosis of the bioprosthesis in the aortic valve position.

She continued to be well until August 2007, when exertional dyspnea recurred, and within 3 weeks, she was essentially bedridden. She was rehospitalized on September 24, 2007, and repeat cardiac catheterization (Table 1) and echocardiographic analysis showed mild bioprosthetic mitral regurgitation and nearly nonmovable bioprosthetic cusps in the aortic valve position. The bioprosthesis in the aortic valve position could not be crossed at cardiac

TABLE 1. Cardiac catheterization data in the patient presented

Variable	May 18, 2001 (before the first operation)	October 10, 2007 (before the second operation)
Pulmonary artery (mm Hg)	75/40	102/54
Right ventricle (mm Hg)	75/28	102/24
Right atrium (mm Hg)		
A wave	30	28
V wave	23	25
Mean	22	20
Pulmonary artery wedge (mm Hg)		
A wave	37	42
V wave	38	46
Mean	34	33
Left ventricle (mm Hg)	159/28	
Aorta (mm Hg)	165/95	130/82
Cardiac index ($L \cdot min^{-1} \cdot m^{-2}$)	1.8	2.0
Ejection fraction (%)	40	
Body weight (lbs)	156	138
Height (inches)	62	62

–, No information available.

From the Departments of Internal Medicine (Division of Cardiology),[a] Pathology,[b] and Cardiothoracic Surgery,[c] and the Baylor Heart and Vascular Institute,[d] Baylor University Medical Center, Dallas, Tex.

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Address for reprints: William C. Roberts, MD, Baylor Heart and Vascular Institute, Baylor University Medical Center, 3500 Gaston Ave, Dallas, TX 75246 (E-mail: wc.roberts@baylorhealth.edu).

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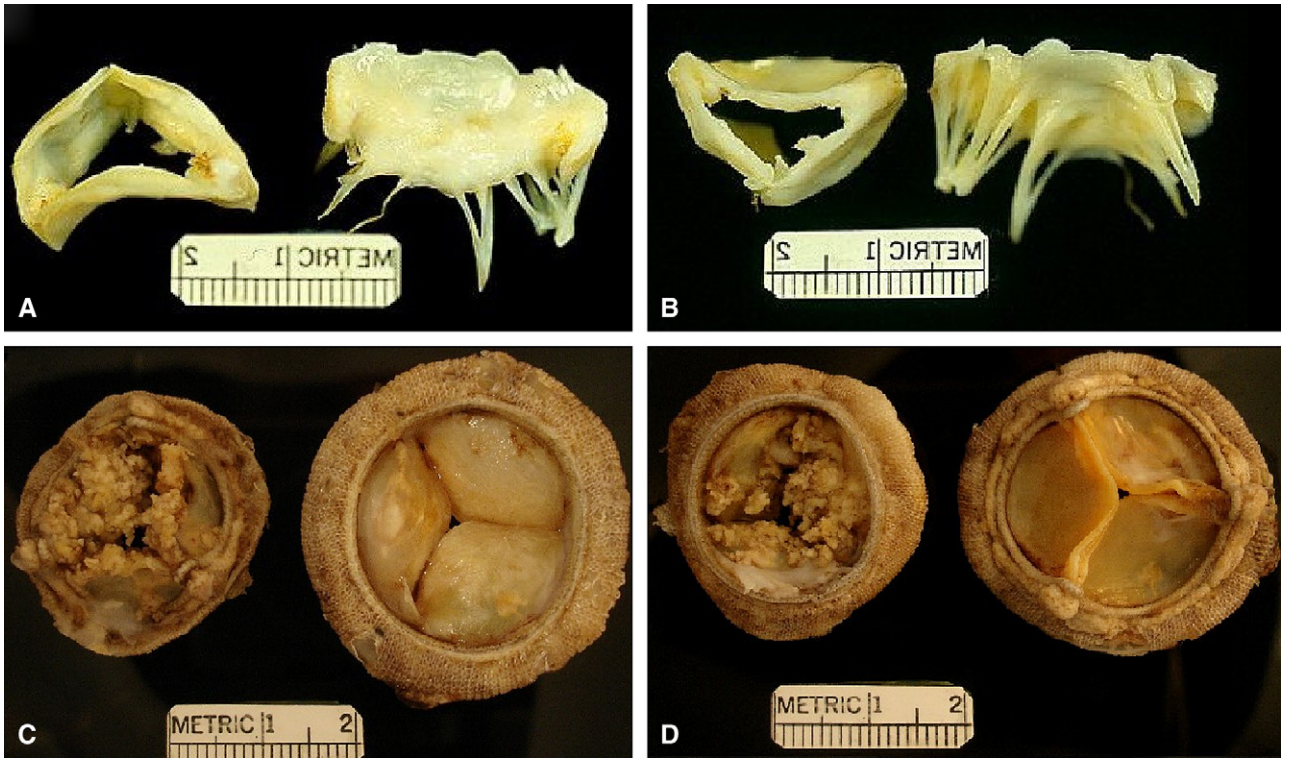

FIGURE 1. Native mitral and aortic valves (A and B) and bovine pericardial bioprostheses in the mitral and aortic valve positions (C and D) in the patient described. A, Anterior mitral leaflet from the atrial aspect and aortic valve from the ventricular aspect. B, Anterior mitral leaflet from the ventricular aspect and aortic valve from the aortic aspect. Both native valves are devoid of calcific deposits. C, Bioprosthesis in the mitral position from the atrial aspect and biopros thesis in the aortic position from the aortic aspect. D, Bioprosthesis in the mitral position from the ventricular aspect and bioprosthesis in the aortic position from the ventricular aspect. Heavy calcific deposits are present on both surfaces of the bioprosthesis in the aortic valve position.

catheterization. The coronary arteries were normal on angiographic analysis.

On October 12, 2007, both bioprostheses were replaced with mechanical prostheses, and a tricuspid valve annuloplasty was performed. At the time of the operation, a small paravalvular leak was seen in the mitral position. The bioprosthesis in the mitral position (no. 25) weighed 4.04 g, and the bioprosthesis in the aortic position (no. 21) weighed 3.86 g (Figure 1, *C* and *D*). Radiographs of the operatively excised bioprostheses showed huge calcific deposits in the aortic prosthesis and small deposits in the mitral prosthesis (Figure 2). Her postoperative course was relatively uneventful. As of November 2008, she is active, and her activities are not limited. By means of

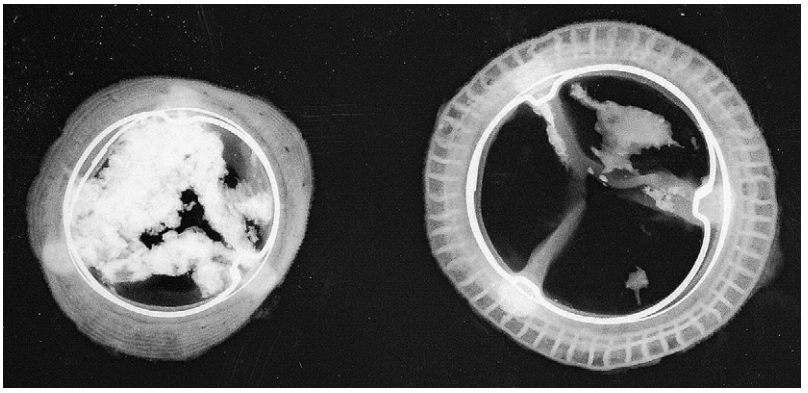

FIGURE 2. Radiograph of the bioprostheses excised from the aortic valve position *(left)* and the mitral valve position *(right)*. The calcific deposits are huge on the left and small on the right.

echocardiographic analysis, her pulmonary arterial systolic pressure had decreased to 34 mm Hg, and left ventricular ejection fraction had increased to 55%. There was only trace tricuspid valve regurgitation.

DISCUSSION

The patient described had parietal pericardial bovine bioprostheses in both the mitral and aortic valve positions for 77 months and during that period developed huge quantities of calcium on the cusps of the bioprosthesis in the aortic valve position and only small quantities of calcium on the cusps of the bioprosthesis in the mitral valve position. Because the closing pressure on the mitral bioprosthesis is usually about a third higher than that on the aortic bioprosthesis (peak left ventricular systolic pressure vs end-diastolic aortic pressure; normally approximately 120 vs 80 mm Hg), it might be expected that the degeneration of a bioprosthesis in the mitral position would be greater (more calcium and more tears) and more rapid than that of a bioprosthesis in the aortic position, but the opposite was the case in the patient described herein. Why might that be the case? Some possibilities include the following:

1. Parietal pericardial bovine bioprostheses are not the same as porcine aortic valve bioprostheses. The former are thicker and less flexible and possibly withstand the left ventricular peak systolic pressure and the aortic end-diastolic pressure more easily than the more delicate porcine aortic cusps.
2. The bovine bioprosthesis in the aortic position was defective and not properly prepared, whereas the one in the mitral position was not.
3. The febrile illness the patient had beginning 11 months after the initial cardiac operation could have been active infective endocarditis that affected the bioprosthesis in the aortic position but not the bioprosthesis in the mitral position.
4. Smaller bovine parietal pericardial bioprostheses calcify more rapidly and more extensively than do larger bovine pericardial bioprostheses.
5. The paravalvular leak in the mitral position and the absence of a leak in the aortic position provided a ''bypass shunt,'' diminishing the effect of the full force of the peak left ventricular systolic pressure on the bioprosthetic cusps in the mitral position.

None of these 5 possibilities can be proved or disproved, but this report might stimulate careful follow-up of similar patients to determine whether this distribution of calcium in the 2 left-sided bioprostheses is a pattern or an exception.

Reference

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Is minimized extracorporeal circulation effective to reduce the need for red blood cell transfusion in coronary artery bypass grafting? Meta-analysis of randomized controlled trials

Umberto Benedetto, MD, Emiliano Angeloni, MD, Simone Refice, MD, Fabio Capuano, MD, Massimo Goracci, MD, Antonino Roscitano, MD, and Riccardo Sinatra, MD, Rome, Italy

Perioperative red blood cell (RBC) transfusion is the single factor most consistently associated with an increased risk of postoperative morbid events after isolated coronary artery bypass grafting (CABG), and each unit of RBC transfused is associated with incrementally increased risk for adverse outcome.[1] Miniaturized extracorporeal circulation (mini-ECC) has been proposed to limit perioperative blood product use. Mini-ECC consists of a closed ECC system with no cardiotomy suction or venous reservoir. The rationale is to avoid air blood contact and minimize priming volume, thus reducing hemostasis alteration and intraoperative

From the Cardiac Surgery Department, II School of Medicine, University of Rome La Sapienza, Policlinico S. Andrea, Rome, Italy.

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Address for reprints: Umberto Benedetto, MD, Cardiac Surgery Department, II School of Medicine, University of Rome ''La Sapienza,'' Via di Grottarossa 1039 (E-mail: u2benedetto@libero.it).

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