Glutaraldehyde-fixed bovine jugular vein as a substitute for the pulmonary valve in the Ross operation

Antonio F. Corno, MD, FRCS, FECTS,[a] Michel Hurni, MD,[a] Helen Griffin, RN,[a] Xavier Jeanrenaud, MD,[b] and Ludwig K. von Segesser, MD, FACS, FECTS,[a] Lausanne, Switzerland

In the Ross operation (autotransplantation of the pulmonary valve in the aortic position), aortic or pulmonary homografts are generally used as a pulmonary valve substitute.[1] The progressively reduced availability of homografts within the past few years and the continuous research for an ideal valved conduit[2] prompted us to search for alternative options. We therefore decided to perform a prospective study to evaluate the use of the Contegra pulmonary valved conduit (Medtronic, Inc, Minneapolis, Minn) as a pulmonary valve substitute during the Ross operation. The Contegra conduit is a new biologic valved conduit consisting of a zero-pressure glutaraldehyde-preserved heterologous bovine jugular vein having a trileaflet venous valve (Figure 1). This biologic valved conduit had already undergone experimental studies in animals[3] and preliminary clinical experience in complex congenital heart defects, with satisfactory results in our own practice.[4]

Materials and Methods

After having received approval from the institutional review board, we enrolled all patients with indications for the Ross procedure in a prospective study, starting in July 1999. In all cases informed consent was obtained from the patients; in the 7 patients younger than 18 years, the informed consent was obtained from the parents.

From July 1999 to November 2000, 10 patients with aortic valve disease underwent a Ross operation with the pulmonary valve being replaced with a Contegra pulmonary valved conduit. Their mean age was 19.9 years (range 9-42 years), mean body weight 56.9 ± 22.3 kg (range 26-91 kg), mean height 162.9 ± 15.0 cm (range 137-179 cm), and mean body surface area 1.6 ± 0.4 m^2 (range 1.03-1.90 m^2).

Among the 10 patients, 9 had aortic valve stenosis (in 8/9 with a bicuspid valve) and 1 had aortic valve regurgitation. Two children (9 and 10 years old) had moderate degrees of aortic regurgitation after percutaneous balloon dilatation performed in the neonatal period. One adolescent (15 years old) had a previous aortic valvotomy performed in infancy. Another adolescent (13 years old) had a previous aortic valve replacement with a prosthetic valve and aortic root enlargement (6 years before). Two of 3 adults had calcifications of the aortic valve, one of them with previous aortic valve commissurotomy (23 years before).

In all patients the Ross operation was performed as an aortic root replacement. Conventional cardiopulmonary bypass was used with single venous cannulation and antegrade and retrograde blood cardioplegia. The autotransplanted pulmonary valve was replaced in all cases with a Contegra conduit having a tricuspid valve and a 22-mm internal diameter.

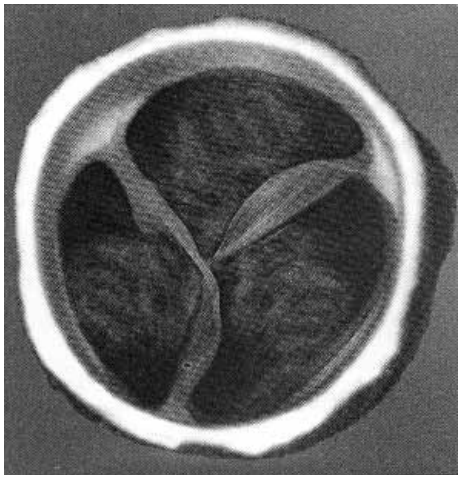

Figure 1. Photograph from above of the trileaflet venous valve in the glutaraldehyde-preserved bovine jugular vein.

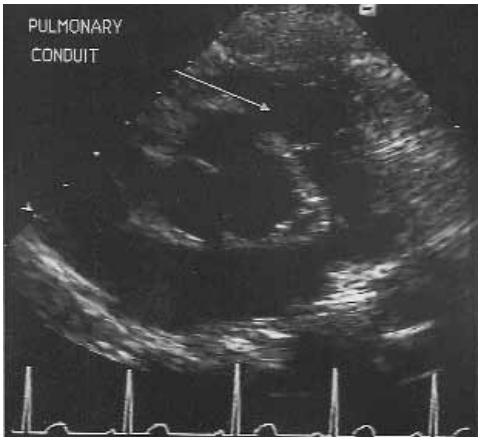

Figure 2. Late (16 months after Ross operation) postoperative echocardiogram in a 10-year-old child showing the valve within the right ventricular–pulmonary arterial conduit.

From the Departments of Cardiovascular Surgery[a] and Cardiology,[b] Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland.

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Address for reprints: Antonio F. Corno, MD, FRCS, FECTS, Centre Hospitalier Universitaire Vaudois, 46 rue du Bugnon, CH-1011 Lausanne, Switzerland (E-mail: antonio.corno@chuv.hospvd.ch).

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Left and right ventricular outflow tracts were evaluated for the presence and degree of aortic and pulmonary valve regurgitation and for the presence and degree of any pressure gradient with intraoperative transesophageal echocardiography and surface echocardiography 1 week after the operation and at any cardiologic follow-up (Figure 2).

The right ventricular pressure gradient was compared with the pressure gradient recorded in a group of 7 patients, mean age 30.4 years (range 16-46 years), who underwent a Ross operation in the previous period with a conventional homograft (size 22-25 mm) used to reconstruct the right ventricular outflow tract.

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Results

At a mean follow-up of 8 months (range 1-17 months), all patients are alive and asymptomatic, without cardiac medication or anticoagulation, and free of reoperation. At the most recent echocardiographic follow-up, pulmonary valve regurgitation was absent in 6 of 10 patients and trivial in the other 4 patients. The average peak pressure gradient was 19.8 ± 9.9 mm Hg (range 6-38 mm Hg) with an average mean pressure gradient of 11.0 ± 6.4 mm Hg (range 3-24 mm Hg); in almost all cases, the pressure gradient was localized at the level of the distal anastomosis of the conduit. It is important to underline a mean pressure gradient of only 10 mm Hg, with a peak gradient of 16 mm Hg recorded in the heaviest patient of our series (91 kg body weight).

There was no statistical difference in the pressure gradient measured in our 7 patients after a Ross operation with conventional homograft implantation on the right ventricular outflow tract, where the mean peak pressure gradient was 22.7 ± 9.8 mm Hg and the mean pressure gradient was 12.3 ± 6.5 mm Hg.

No progression of pulmonary valve regurgitation or of the pressure gradient has been shown with echocardiography during the follow-up in all patients.

Discussion

The second most common cause for reoperation after the Ross procedure is pulmonary homograft replacement, particularly in the pediatric population, where a small homograft is inserted initially.[5]

This observation, together with the progressively reduced availability of homografts within the past few years, prompted us to search for alternative options. The good results obtained with Contegra conduits in the right ventricular outflow tract for reconstruction of complex congenital heart defects suggested to us that this conduit would be suitable as a pulmonary replacement during the Ross operation.

The advantages observed in our initial clinical experience with a total of 23 implants of this conduit are the following: (1) reliable off-the-shelf availability; (2) proximal anastomosis without the need for augmentation because of sufficient length available at both the inflow and outflow; (3) easy tailoring and sewing; and (4) adequate hemodynamic performance.

The preliminary results obtained with this conduit as a pulmonary valve replacement during the Ross operation are encouraging: the new pulmonary valve remains free from regurgitation (more than trivial) at a mean follow-up of 8 months.

The pressure gradient recorded at echocardiography, not different than the gradient observed with conventional homografts, was in almost all cases localized at the level of the distal anastomosis of the conduit and therefore not due to the valved conduit itself, confirming the adequacy of the hemodynamic performance of the largest size available (22 mm internal diameter) for the largest spectrum of the normal population. Of course, the pressure gradients recorded at rest should be evaluated during exercise, particularly for larger patients or those who have a very active lifestyle.

Conclusions

The preliminary results of the recent introduction of the Contegra valved conduit as a pulmonary valve substitute during the Ross operation have been encouraging, with no early or late mortality, no reoperations, and satisfactory hemodynamics.

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