BRIEF COMMUNICATIONS

SIX-YEAR FOLLOW-UP OF A PULMONARY AUTOGRAFT IN THE MITRAL POSITION: THE ROSS II PROCEDURE

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The autologous pulmonary valve was translocated into the mitral valve position in a rheumatic and symptomatic 12-year-old girl with severe mitral valve regurgitation. The top hat technique was used. The native mitral valve was totally preserved. The patient continues to do well with a normally functioning translocated pulmonary autograft after 6 years of follow-up. We propose to call this procedure the "Ross II procedure."

Clinical summary. A 12-year-old girl weighing 30 kg with a body surface area of 1.16 m^2 was referred to us with the diagnosis of severe rheumatic mitral valve regurgitation. She was in New York Heart Association class III-IV despite receiving diuretics and angiotensin-converting enzyme inhibitors. Both weight and height were below the fifth percentile for age. She had signs and symptoms of severe mitral valve regurgitation. A 2-dimensional echocardiogram demonstrated a rheumatic mitral valve with large lack of coaptation of valve leaflets, prolapse of the anterior leaflet, and thickening of the tips of both leaflets. There was severe mitral regurgitation with an eccentric jet, which was directed posteriorly and filled a massively dilated left atrium. The other valves were normal. The left ventricle was dilated but had normal systolic function.

The patient was operated on with the use of routine cardiopulmonary bypass and retrograde continuous warm blood cardioplegia. The mitral valve appearance was consistent with healed rheumatic valvulitis with a severely thickened, retracted posterior leaflet. The anterior leaflet was thin and pliable with mild prolapse. An attempt at repairing the valve was unsuccessful. Because of the patient's age and unsuitability for permanent anticoagulation, we decided to use the patient's own pulmonary valve. The pulmonary valve was harvested and implanted inverted in the mitral position inside a 26-mm Dacron tube, a technique described by Yacoub and Kittle[1] as "the top hat." The native valve was left intact in its position. Right ventricular–pulmonary artery continuity was re-established with a size 24 cryopreserved pulmonary homograft.

An intraoperative transesophageal echocardiogram demonstrated a well-functioning pulmonary autograft in the mitral position with only trivial regurgitation and no restriction to flow. The pulmonary homograft in the pulmonary position was also functioning well with no pulmonary stenosis or regurgitation. The native mitral valve was seen in the left ventricle with preserved mitral annular contraction. Both ventricles showed normal systolic function. The patient made an uneventful recovery.

The patient has had annual follow-up examinations, including complete transthoracic 2-dimensional echocardiographic assessment. She is free of symptoms in New York Heart Association class I and continues to thrive. Her maintenance drug program includes oral penicillin V prophylaxis 250 mg twice daily and aspirin 100 mg daily. The latest echocardiogram 6 years later showed the pulmonary autograft in the mitral position functioning well with mild thickening of the cusps (Fig 1). There was mild mitral regurgitation and a mean diastolic gradient of 8 mm Hg. The effective orifice area was calculated as 1.7 cm^2. Left atrial size had decreased significantly and both ventricles were normal in size and function (Fig 2). The pulmonary homograft in the pulmonary position functioned normally.

Discussion. Valvular repairs are preferable but not feasible all the time. Valvular replacement with a mechanical prosthesis or bioprosthesis is not without drawbacks. Homograft replacement has inherent limitations of acellularity, degenerative changes, calcification, and limited life span. The search for an ideal valvular replacement that would resist degeneration and infection, has a good effective orifice area, low pressure gradients, and freedom from thromboembolic consequences or leak is still far from reach.[2] This would be particularly important in young persons to avoid a lifetime of anticoagulation or the possibility of increasingly hazardous reoperations.

Aortic valve replacement with the pulmonary autograft (the Ross operation) is a good option, and in several cohorts of patients impressive results have been demonstrated.[2,3] Although the use of the pulmonary autograft in the mitral position was mentioned in Ross's original article,[4] only one report of implanting the native pulmonary valve in the mitral

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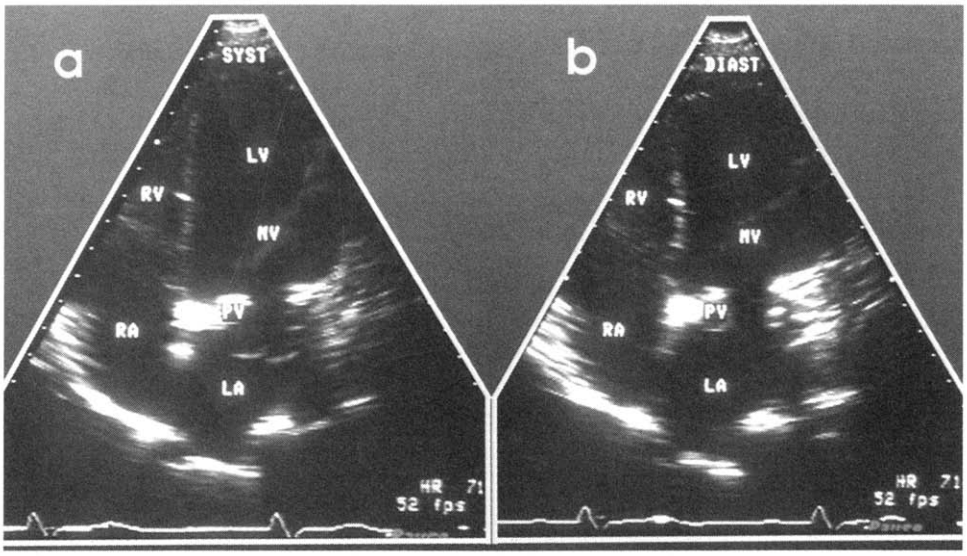

Fig 1. Apical 4-chamber echocardiographic view of the pulmonary autograft in the mitral position 6 years after the operation. **A,** Systolic frame. **B,** Diastolic frame. *LA,* Left atrium; *LV,* left ventricle; *MV,* mitral valve; *PV,* pulmonary autograft in mitral position; *RA,* right atrium; *RV,* right ventricle; *HR,* heart rate.

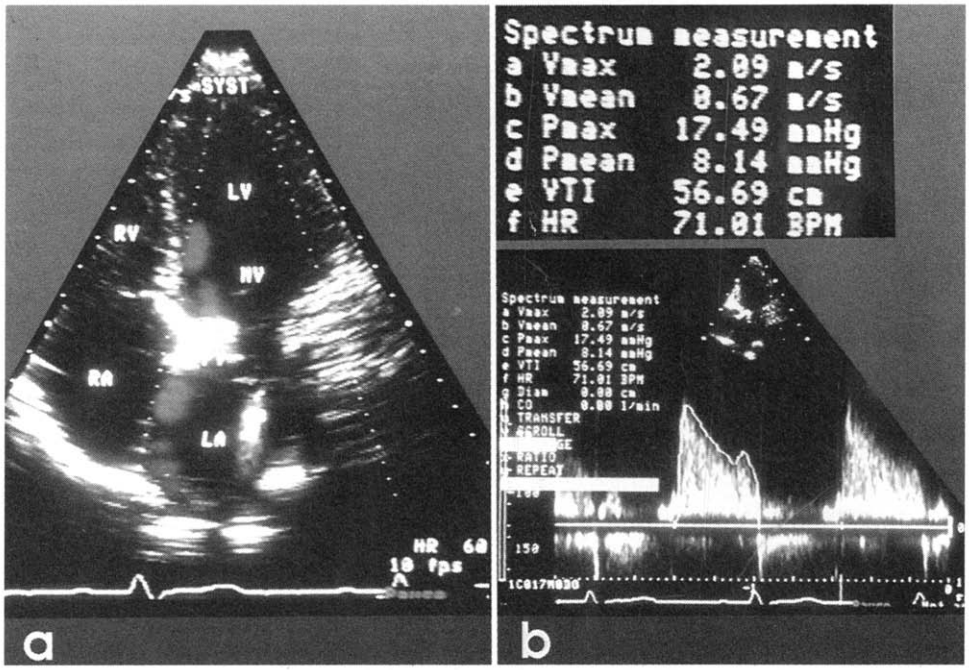

Fig 2. A, Doppler flow imaging showing very mild regurgitation of the autograft and **B,** continuous wave Doppler, Mean diastolic gradient = 8 mm Hg. *Vmax,* Maximum velocity; *Vmean,* mean velocity; *Pmax,* maximum pressure; *Pmean,* mean pressure; *VTI,* velocity time interval. For other abbreviations see Fig 1.

position has appeared in the recent medical literature.[5] Ross had an initial series, but unfortunately the follow-up is fragmentary. Nevertheless, he demonstrated that the technique is feasible and that the pulmonary valve can function well inverted in the mitral position for up to 14 years.[5]

The pulmonary autograft proved tolerant to the high systemic pressure. The cusps slowly thickened and adapted to the new situation. It has also been reported that explanted valves showed normal cusp cellularity with no evidence of tissue degeneration.[2] The autograft has the advantage of

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being living autogenous tissue. Hence the potential for growth exists when the pulmonary autograft is used in the aortic position, and that is the reason the Ross operation is considered ideal for aortic valve replacements in infants and children. However, the potential for growth is lost when the pulmonary autograft is used in the mitral position because it has to be housed within the Dacron tube. On the other hand, inasmuch as the autograft is lying in the left atrium as a top hat, a partial or total preservation of the mitral valve apparatus is feasible, as was done in our patient. The autograft is a living autogenous tissue, fully flexible, and it cannot obstruct the left ventricular outflow tract because of its position inside the left atrium (Figs 1 and 2).

The improved clinical condition of our patient, freedom from anticoagulation, absence of thromboembolism, and the maintained excellent performance of the pulmonary autograft in the mitral position 6 years later cautiously support this procedure as a viable alternative in specific clinical situations requiring replacement of the mitral valve. However, a larger number of patients is needed with longer follow-up periods before one can confidently advocate this procedure. Inasmuch as it is another innovation from a pioneer surgeon, we suggest calling this procedure the Ross II procedure.

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PARTIAL LEFT VENTRICULECTOMY IN AN INFANT WITH DILATED CARDIOMYOPATHY

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Partial left ventriculectomy for dilated cardiomyopathy (DCM) was first reported by Batista and associates[1] in 1996. Several authors have reported their clinical experience with this operation in adults.[1-3] However, its use in infants has not been reported. We have performed partial left ventriculectomy in an infant with DCM.

Clinical summary. A 5-month-old girl was admitted on an emergency basis with symptoms of severe congestive heart failure. The cardiothoracic ratio (CTR) on chest radiography was 67%. Echocardiography revealed left ventricular dilatation and a thin myocardium. At the apex, sponge-like myocardium[4] was detected. The diastolic dimension was 44.5 mm, the systolic dimension was 42.4 mm, and the ejection fraction was 13.5%. The patient was treated with dopamine, amrinone, and furosemide, and her condition stabilized. The CTR was reduced from 67% to 63%.

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Laboratory investigation revealed no signs of acute myocarditis. Cardiac catheterization showed normal coronary arterial anatomy. Myocardial biopsy revealed no abnormalities. The diagnosis of DCM was made, and conventional treatment was started.

Echocardiography and chest cardiography 2 months later revealed an increase in the diameter of the left ventricle and a decrease in the ejection fraction. Her general condition was deteriorating. Growth hormone therapy[5] was started. Mitral regurgitation and left ventricular enlargement (diastolic dimension, 51.3 mm; systolic dimension, 49.5 mm; ejection fraction, 7.4%) were detected by echocardiography 2 weeks later, at which time she became seriously ill. The CTR increased to 67% (Fig 1). Reduced urine volume, elevated hepatic transaminase concentrations, and metabolic acidosis also were detected. Emergency partial left ventriculectomy was carried out. The 8-month-old patient weighed 5.2 kg. Using cardiopulmonary bypass and cardioplegic arrest, a partial left ventriculectomy and mitral valvuloplasty with Alfieri repair[3] were performed. Transesophageal echocardiography and continuous monitoring of mixed venous oxygen saturation (Svo_2) with a thermodilution cannula were used. The inner wall of the apex of the left ventricle contained sponge-like coarse trabeculations. The posterior left ventricular muscle between the two papillary muscles was resected as much as possible, especially at the apex. Weaning from cardiopulmonary bypass was smooth. No mitral regurgita-