# Simultaneous enlargement of the pulmonary annulus and the pulmonary cusp with a transannular patch

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Creation of a functional pulmonary valve as part of the primary surgical repair might avoid pulmonary insufficiency and right ventricular dilatation complications. Numerous techniques and materials have been used to prevent pulmonary insufficiency after reconstruction of the right ventricular outflow tract (RVOT) obstruction.[1] Providing pulmonary coaptation by using a transannular patch with an incorporated monocuspid valve is very difficult and requires too much surgical experience. The aim of our technique was to develop a competent valve with no systolic gradient that could be constructed from a pericardial patch by using the patient's native commissure mechanism.

## Methods

Nineteen patients underwent repair of tetralogy of Fallot (n = 6) and pulmonary stenosis (n = 13) with this surgical technique.

After aortic crossclamping, the pulmonary trunk was opened 2 mm above the pulmonary commissures, and the orientation of the commissures and the anterior (nonseptal) cusp was inspected to ensure its suitability for new reconstructive technique. Pulmonary incision was extended into the anterior pulmonary sinus, through the pulmonary annulus, and into the anterior cusp of the pulmonary valve, taking care to avoid damaging the valve commissures, as shown in Figure 1. The incision is best directed toward the mid-cusp line (an imaginary line that divides the anterior pulmonary cusp into 2 equal halves; Figure 1, *A*). The incision down to the pulmonary annulus level provides adequate enlargement of the roof of the right ventricle. Then transannular incision was extended to the main pulmonary artery. Relief of the RVOT was performed by widely resecting all fibrous tissue and only large hypertrophied infundibular muscle bundles. Commissurotomy was performed whenever pulmonary valve commissural fusion was present. The width of the pericardial patch at the level of the right ventricle–pulmonary artery junction was determined according to a *z* value of 0 to +2. After infundibular resection and ventricular septal defect closure, the crossclamp was removed, and right ventricular outflow reconstruction was performed on the beating heart. Suturing of the patch was begun from the proximal end of the right ventriculotomy. Both sides of the ventricular patch were sutured in place until reaching the pulmonary valve annulus, and then suturing of the patch with the same diameter was continued through the right and left sides of the anterior leaflet (Figure 1, *B* and *C*). The patch was sewn into place until reaching the free margin of the anterior cusp, and the remaining part of it beyond the free margin of the reconstructed neocusp was trimmed in a crescent shape, providing coaptation with the other cusps (Figure 1, *D*). A 6-0 absorbable suture was sewn in a form passing in and out of the free margin of the reconstructed cusp to strengthen the free edge of the reconstructed anterior cusp and to prevent its prolapse during the early postoperative period, according to the method of David and colleagues (Figure 1, *E*).[2] Another pericardial patch suture line is started distally and continues toward the level of the pulmonary artery annulus. The width of this patch across the pulmonary annulus was adjusted to have a little greater than that of the first patch. The proximal end of the patch is sewn to the right ventricular patch at a point 4 to 5 mm proximal to the pulmonary annulus level (Figure 1, *F*). By suturing the pericardial patch below the hinge area of the reconstructed anterior cusp, bulging of the patch was allowed as a neosinus (Figure 1, *G*).

## Results

Early postoperative echocardiography showed good motion of reconstructed cusps. All patients followed up for 1 to 3 years (mean, 20.1 months) were considered to provide midterm results. None of these patients needed reoperation. No dysfunction of the valve motion was identified during the follow-up period in all patients. The 8 patients had no or trivial pulmonary insufficiency. There was mild insufficiency in 10 patients and moderate insufficiency in 1 patient.

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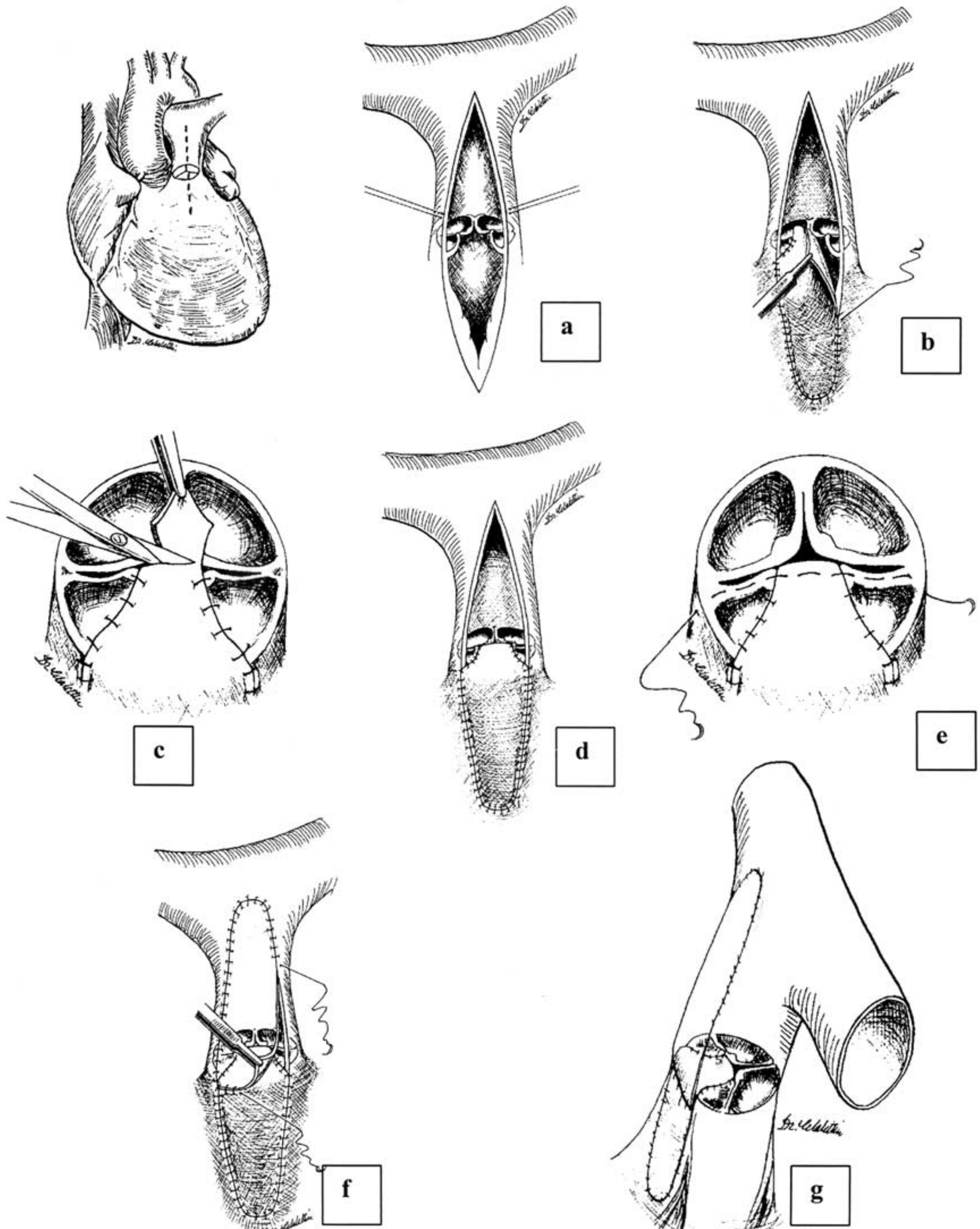


**Figure 1.** The line of incision for patch enlargement of the pulmonary annulus and pulmonary valve is shown. Transannular incision is carried along the midcusp line of the anterior cusp. A, Pulmonary arteriotomy is then extended through the pulmonary valve annulus and into the anterior cusp up to its free margin. The anterior cusp is divided into 2 equal parts. B, Both sides of the ventricular patch are sutured in place until reaching the pulmonary valve annulus, and then suturing of the patch with the same diameter is continued through the right and left sides of the anterior leaflet. C and D, The patch is sewn into place until reaching the free margin of the anterior cusp, and the remaining part of it beyond the free margin of the reconstructed neocusp is trimmed into a crescent shape, providing coaptation with the other cusps. E, Polytetrafluoroethylene suture is sewn in a form passing in and out of the free margin of the reconstructed cusp. F, Pulmonary arteriotomy is a closed, separated pericardial patch. The suture line is started distally and continues toward the level of the pulmonary annulus. G, By suturing the pulmonary patch below the hinge area of the reconstructed anterior cusp, bulging of the patch is allowed as a neosinus.

## Discussion

Standard methods to prevent or repair pulmonary insufficiency have included valve replacement, placement of valved conduits, or the creation of monocusp valves.[3] The most important factor for pulmonary insufficiency after insertion of the monocusp can be explained by the technical factors (eg, the irregular movement of the valve during closure as a result of cusp buckling and too large or small monocusp depth).[4]

This easily arranged approach could be used to develop a competent valve with no systolic gradient that could be constructed from pericardial patch with the own native commissure mechanism of the patient. The acute hemodynamically performance was excellent, and preliminary midterm results in the clinical study are reasonable. We believe that our technique has several advantages of utmost importance. First, we minimized both the surgical incision and the resection of muscle in an attempt to preserve infundibulum function. Second, the width of the reconstructed cusp patch was identical to the width of the patch of the pulmonary annulus, thus making the reconstructed cusp patch not too wide. Third, the shape of the reconstructed cusp became the same as the original cusp shape. Fourth, we tried to save the native commissure and remnant cusp. The movement of the reconstructed cusp is more physiologic because of using the native commissure mechanism. These structures could be enlarged as the annulus grew and could be helpful in the coaptation of the valve leaflets. Fifth, the level of the reconstructed cusp patch is the same as the level of the native posterior cusp or pulmonary annulus. Sixth, a large, bulging, rectangular pericardial patch to close the pulmonary arteriotomy at the pulmonary annular level constructing a wider neosinus increases cusp depth, and this is an advantage for valve coaptation.[5] Finally, in this technique the reconstructed cusp is being an integral part of the ventricular wall and ensuring optimal function during systole and diastole without any significant obstruction. The commissures of the pulmonary valve are maintained, which appears to be the major difference between this technique and the previous reports using monocusp patches. This easily constructed valve can be used as an excellent short-term adjunct to RVOT reconstruction.

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