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SENNING OPERATION FOR TRANSPOSITION OF THE GREAT ARTERIES*

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Key words : Senning operation, surgical therapy, transposition of the great arteries

Physiological correction by complete transposition of the great arteries (TGA) became a practical reality with the intra-atrial redirection of the venous return procedure as described by Mustard[1] in 1964. This procedure has been performed extensively for the correction of TGA in almost every cardiac surgical center in the world, including Turkey[2-5]. The Senning operation, which preceded the Mustard one, was immediately abandoned by everybody following the presentation of Mustard's successful series of operations[6]. However, several serious complications of the Mustard operation, such as arrhythmias and venous obstructions, have been reported by many different authors[2,7-9]. Finally, in 1977, Quaegebeur et al[10] published an article called "Revival of the Senning operation in the treatment of transposition of the great arteries" in which they described, in very favorable terms, their observations of two cases in which the Senning operation had been used and which had been followed up for many years.

Consequently, they performed twenty Senning operations over the next two years with less morbidity and mortality than were to be expected with the Mustard operation. During the next few years, there were reports from several centers suggesting that better results were to be obtained from the Senning operation than from the Mustard operation[11,12]. Consequent on these reports and following our experience of early and late complications arising after the Mustard operation, we decided to try the Senning operation for TGA, and to compare the results with those of the Mustard operation.

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Case Reports

The first attempt was surgically successful. The patient was out of pump in sinus rhythm and in good condition hemodynamically, but brain edema a few days after surgery caused his death.

With the second case the operation was a complete success. E.K., a four-year-old boy was admitted to our department with the diagnosis of simple d-TGA. A previous balloon atrial septostomy had been carried out during cardiac catheterization and the diagnosis of TGA had been established when he was 30 days old. On 15.10.1983, he was operated upon using conventional cardiopulmonary bypass techniques, with direct cannulation of the aorta and the venae cavae. There was 26 °C hypothermia, and cold K^+ cardioplegia and topical myocardial cooling were used.

A longitudinal incision was used to open the right atrium parallel to and a few millimeters anterior to the crista terminalis (Figure 1, R-R'). The opening was then

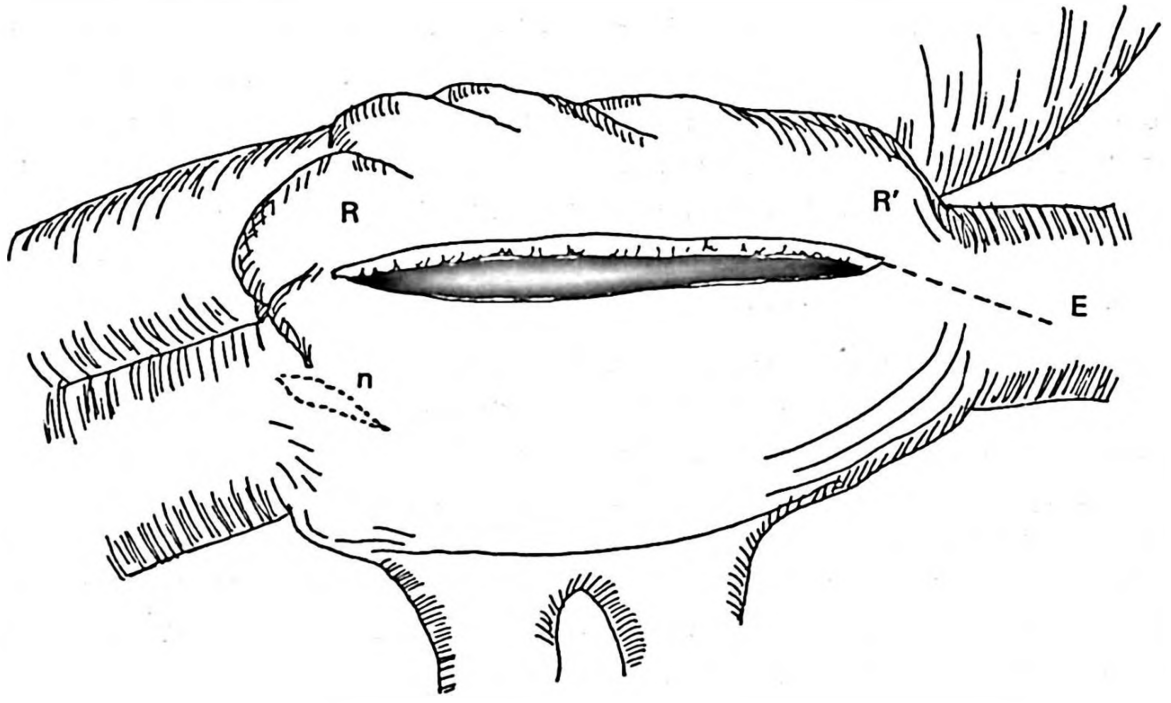


Figure 1

Key to Figures

n	: Sinus node
TV	: Tricuspid valve
EV	: Eustachian valve
CS	: Coronary sinus
MV	: Mitral valve.

enlarged towards the lateral insertion of the Eustachian valve (Figure 1, R'-E). There was a large fossa ovalis type atrial septal defect (ASD) due to previous balloon septostomy (Figure 2). A prosthetic patch was sutured at the ASD margin and two incisions were made to obtain an atrial septal flap towards the dorsal attachment of the atrial septum (Figure 3, S-S'). A left atriotomy was performed

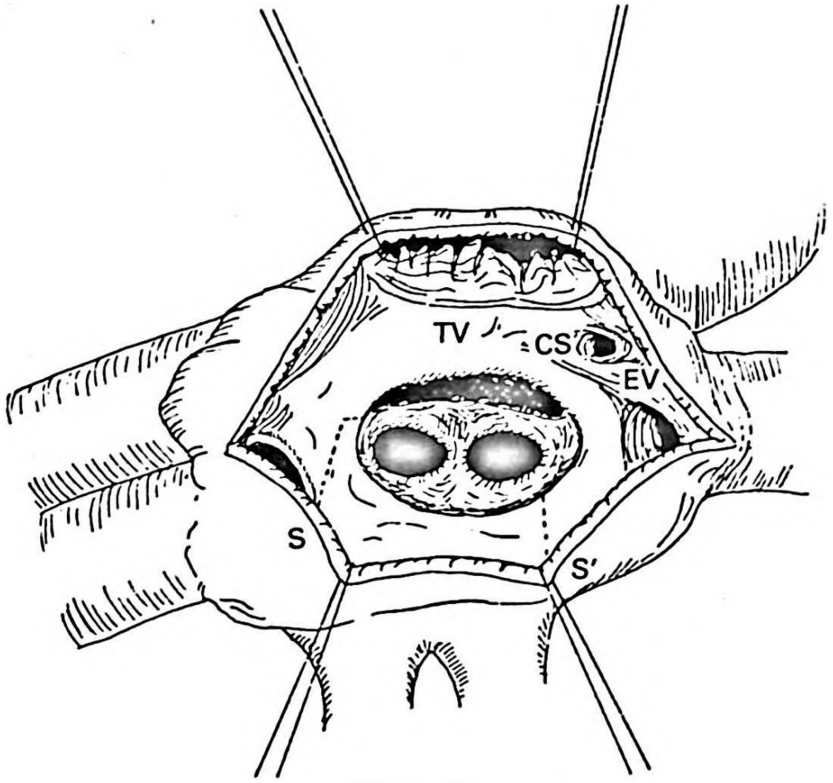


Figure 2

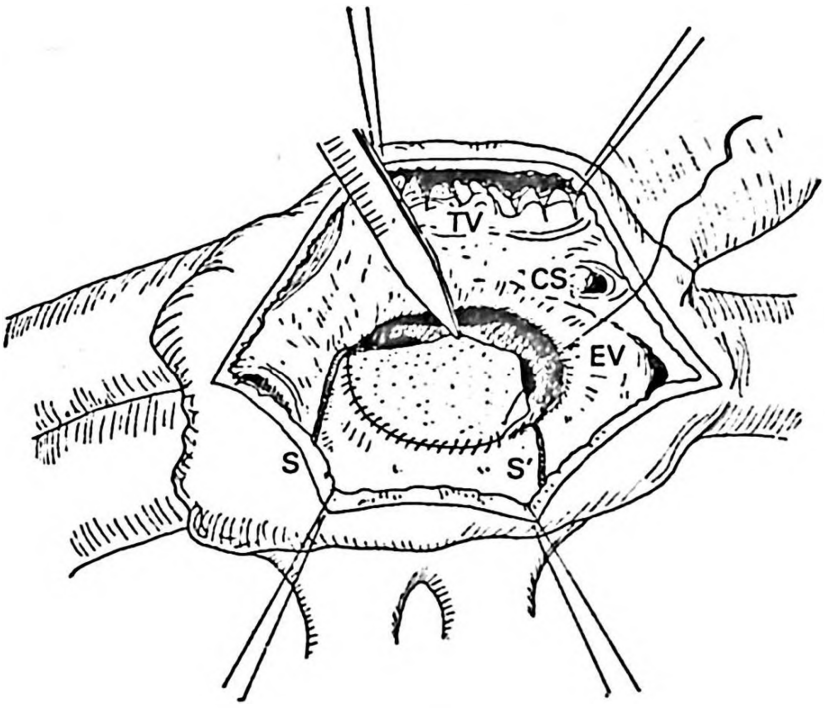


Figure 3

parallel to the interatrial groove between the two right pulmonary veins and then this incision was enlarged towards the posterior wall of the left atrium and the right superior pulmonary vein (Figure 4, L-L'). Thereafter the free margin of the atrial flap was sutured to the posterior wall of the left atrium in such a way as to leave the left pulmonary veins under the flap and the mitral valve over the flap (Figure 5).

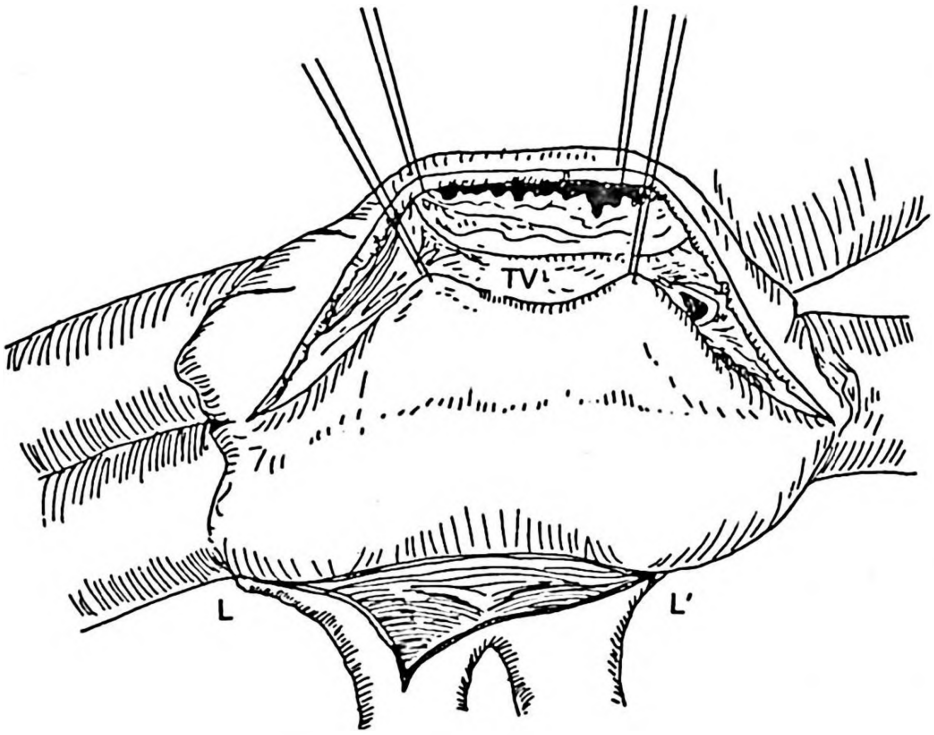


Figure 4

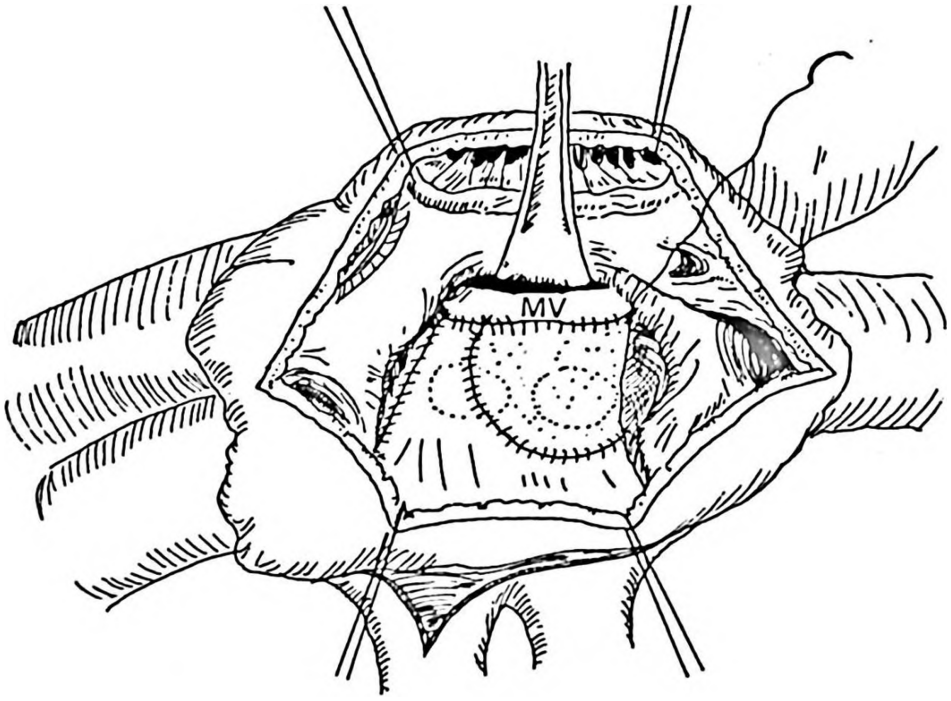


Figure 5

The new systemic venous atrium was completed by suturing the dorsal edge of the right atrial incision to the anterior remnant of the atrial septum, using the Eustachian valve. The coronary sinus was left in the pulmonary venous atrium (Figure 6). The pulmonary venous pathway was completed by suturing the anterior edge of the right atrial incision. The residual cephalad and caudal edges of the anterior right atrial incision were sutured over the vena cava. The superior vena cava sutures were placed superficially to avoid injury to the sinus node (Figure 7).

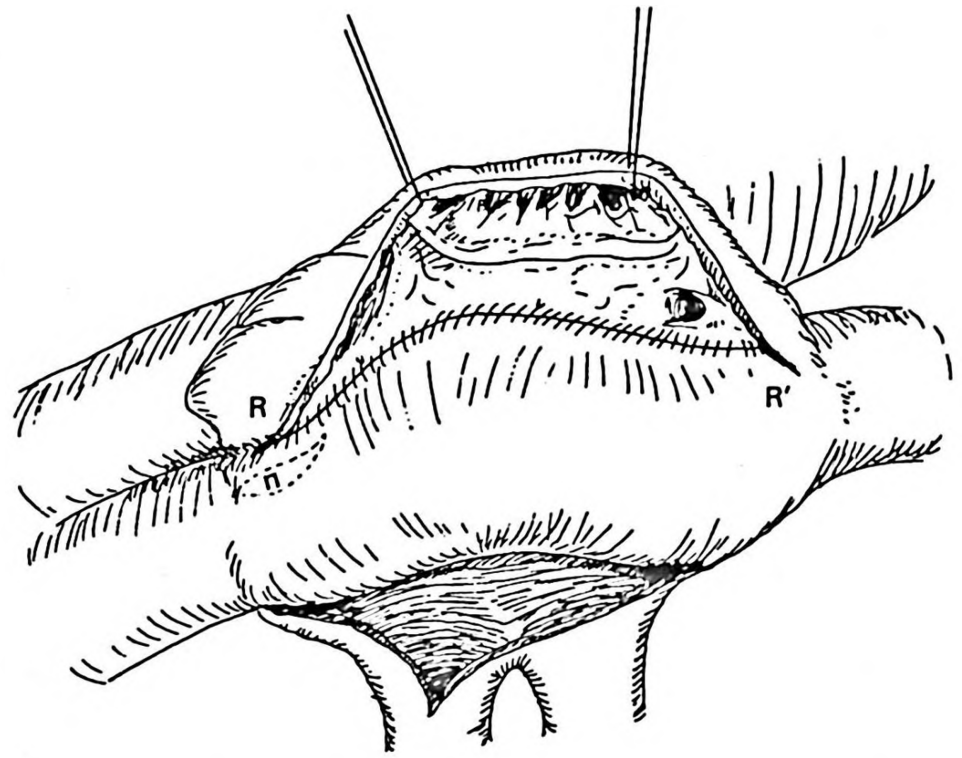


Figure 6

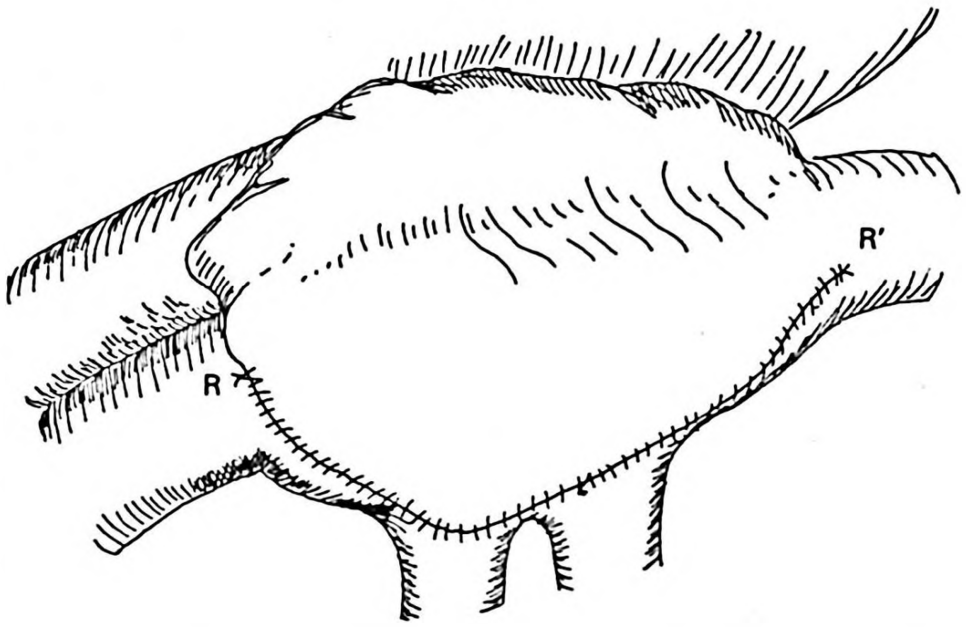
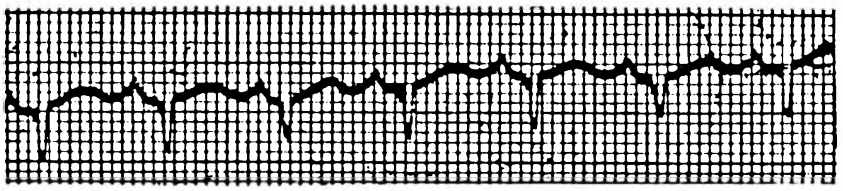


Figure 7

In the early postoperative period the patient showed no rhythm problem and cardiac performance was good without inotropic support. Five months after the operation the functional capacity of the patient was in class I. The ECG recording presented sinus rhythm (Figure 8).



Figures 8
Postoperative ECG of second case.

Discussion

Corrective procedures for the treatment of TGA may be divided into two categories: a) Hemodynamic correction at atrial level (Mustard[1,2] and Senning[6,13] procedures), b) Anatomic corrections at ventricular or great arterial level (Rastelli[14] and Jatene[15] procedures). The corrective procedure most frequently employed involves a redirection, at the atrial level, of systemic venous flow to the left pulmonary ventricle, and of the pulmonary venous flow to the right systemic ventricle.

To date the Mustard operation has been successfully carried out on neonates, infants and children in many clinics, with a remarkably low operative risk; approximately less than 5% in simple TGA[2,4]. The first Mustard operation in Turkey was performed on 8 July 1970 and the patient is still doing well[5]. Ten similar cases were operated upon following this first one, but recently the Mustard procedure has been connected with various late complications including pulmonary venous obstruction and superior or inferior vena cava obstruction[7-12]. While performing the Mustard operation, reseptation of the atria is obtained with the use of non-vital, biological or prosthetic material, which later can result in structural degeneration, such as a reduction in the diameter or fibrous thickening. These processes and the shape, size and suture lines of the baffle may be responsible for the systemic and pulmonary venous obstruction[7-11]. Furthermore, the function of the atrial chambers can be impaired by the passive bulging of the baffle. Clarkson et al[16] and Trusler et al[2] report less effective filling and diminished right ventricular contractility in many children treated with the Mustard procedure. Numerous conduction disturbances have also been reported following the Mustard operation. Sudden unexpected death is recognized as being relatively common in the late postoperative period and supraventricular arrhythmias are thought to be one possible cause[9].

As a result the Senning operation and its modifications are once more being regarded as a valid alternative to the Mustard procedure. The impressive experience of Quagebeur et al[10] stimulated a revival of the Senning operation. In the early postoperative period the mortality rate is similar in both the Senning and Mustard operations. While performing the Senning operation, but not the Mustard procedure, the size and shape of the baffle are determined in each patient by the size of the heart, and suture lines are easily identifiable[11,12]. Pulmonary or systemic venous obstruction is therefore unlikely to be produced by the operation. Furthermore the vital atrial tissue used should allow a normal growth of the atrium, avoiding late obstructive complications, and should leave the atrial functional capability unaffected. According to pressure recordings and angiography, the atria after the Senning repair show vigorous contractions[11,13]. On the other hand a lower incidence of arrhythmias has been observed after the Senning operation, which results in less trauma to the interatrial conducting tissue, particularly the posterior internodal pathway[11].

On the basis of these observations we can say that the Senning operation can be applied to almost every patient with TGA and gives good immediate results and low operative risks. The long term results of right ventricular performance and tricuspid valve competence following this operation are still undetermined, but we believe that this procedure should be considered as the preferable alternative in the surgical treatment of TGA.

Summary

The Senning operation is a physiological corrective procedure for the treatment of transposition of the great arteries. Recently, after such disquieting complications as venous obstructions and arrhytmias were observed following the Mustard operation, the Senning operation has again come into favor. For this reason we decided to try the Senning operation on two patients so as to see and compare the results with those of the Mustard operation. One operation was successful; the patient is still alive and there are no complications. The other patient died due to brain edema a few days after surgery.

REFERENCES

1. Mustard WT, Keith JD, Trusler GA, et al. The surgical management of transposition of the great vessels. *J Thorac Cardiov Surg* 48:953, 1964.
2. Trusler GA, Williams WG, Izukawa T, Olley PM. Current results with the Mustard operation in isolated transposition of the great arteries. *J Thorac Cardiovasc Surg* 80:381, 1980.
3. Subramanian S, Wagner H. Correction of transposition of the great arteries in infants under surface-induced deep hypothermia. *Ann Thorac Surg* 16:391, 1973.
4. Stark J, Leval MR, Waterston DJ, et al. Corrective surgery of transposition of the great arteries in the first year of life. *J Thorac Cardiovasc Surg* 68:673, 1974.

5. Aytaç A. Büyük damarların transpozisyonunda Mustard ameliyatı. *Türk Kardiyoloji Cemiyeti Arşivi (Archives of Turkish Society of Cardiology)* 4:134, 1972.
6. Senning A. Surgical correction of transposition of the great vessels. *Surgery* 45:966, 1959.
7. Egloff LP, Freed MD, Dick M, et al. Early and late results with the Mustard operation in infancy. *Ann Thorac Surg* 26:474, 1978.
8. Mair DD, Danielson GK, Wallace RB, et al. Long-term follow-up of Mustard operation survivors. *Circulation* 50(Suppl):46, 1974.
9. Scott LP, Saalouke MS, Shapiro SR, et al. Sudden unexpected death following Mustard's procedure for d-transposition of the great vessels. *Circulation* 53 and 54(Suppl II):89, 1976.
10. Quaegebeur JM, Rohmer J, Brom AG. Revival of the Senning operation in the treatment of transposition of the great arteries. Preliminary report on recent experience. *Thorax* 32:517, 1977.
11. Locatelli G, Benedetto GD, Villani M, et al. Transposition of the great arteries. Successful Senning's operation in 35 consecutive patients. *Thorac Cardiovasc Surg* 27:120, 1979.
12. Coto EO, Norwood WI, Lang P, Castaneda AR. Modified Senning operation for treatment of transposition of the great arteries. *J Thorac Cardiovasc Surg* 78:721, 1979.
13. Senning A. Correction of the transposition of the great arteries. *Ann Surg* 182:287, 1975.
14. Rastelli GC, Wallace RB, Ongley PA. Complete repair of transposition of the great arteries with pulmonary stenosis. A review and report of a case corrected by using a new surgical technique. *Circulation* 39:83, 1969.
15. Jatene AD, Fontes VF, Paulista PP, et al. Anatomic correction of transposition of the great vessels. *J Thorac Cardiovasc Surg* 72:364, 1976.
16. Clarkson PM, Neutze JM, Barratt-Boyes BG, et al. Late postoperative hemodynamic results and cineangiocardiographic findings after Mustard atrial baffle repair for transposition of the great arteries. *Circulation* 53:525, 1976.