

DAMUS-KAYE-STANSEL PROCEDURE FOR LEFT VENTRICULAR OUTFLOW TRACT OBSTRUCTION LATE AFTER MODIFIED FONTAN OPERATION IN PATIENTS WITH DOUBLE-INLET LEFT VENTRICLE: REPORT OF TWO CASES

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Systemic ventricular outflow tract obstruction (LVOTO) is one of the complications after Fontan-type operations in patients with L-transposition of great arteries (L-TGA) and double-inlet left ventricle (DILV) with previous pulmonary artery banding (PAB). This LVOTO develops after PAB, as well as after Fontan operations.^{1,2} The method of relieving LVOTO in patients after Fontan-type operations remains controversial. The Damus-Kaye-Stansel (DKS) procedure seems to be one of the options, but it is less of a possibility in these patients, who usually have direct pulmonary arterial closure. Only a few reports have been published about use of the DKS procedure for LVOTO after the Fontan operation.³ In the present reports, we describe 2 such cases.

Clinical summary

PATIENT 1. An 11-year-old boy had received the diagnosis of DILV, L-TGA, and aortic coarctation and had undergone PAB and coarctectomy at 1 year of age. He underwent total cavopulmonary connection and atrioventricular valve annuloplasty at 5 years of age. The pulmonary trunk was then closed. As LVOTO gradually developed with the pressure gradient of 110 mm Hg, he underwent enlargement of the bulboventricular foramen at 8 years of age. The pressure gradient decreased to 10 mm Hg but increased again to 118 mm Hg on exercise at 10 years of age. Inasmuch as the angiogram showed a normally mobile pulmonary valve, he underwent a DKS procedure. The pulmonary trunk was divided. The pulmonary valve had 3 mobile and thin leaflets. Because the pulmonary trunk was one and one-half times larger than the aortic root, the DKS procedure was done with an oval bovine pericardial patch (Fig 1, A). After the aortic root had been obliquely incised and the touching parts of the pulmonary stump and the aortic incision had been sutured, the patch was placed. He had a 20 mm Hg pressure gradient across the LVOT and 2 plus pulmonary regurgitation (Fig 2, A).

PATIENT 2. An 11-year-old boy had received a diagnosis of DILV and L-TGA and had undergone PAB at 1 year of age.

He underwent total cavopulmonary connection at 4 years of age. The pulmonary trunk was divided. The pressure gradient on the LVOT increased from 0 to 86 mm Hg by the time he was 11 years of age. Because the angiogram showed a normally mobile pulmonary valve and little size discrepancy between the 2 arterial roots, he underwent a DKS procedure with aortic transection and reconstruction of the bivalved systemic outflow (Fig 1, B). After transection of the aortic root, a bivalved common stump was fashioned by suturing the touching parts of the 2 proximal arterial stumps. The distal aortic stump was sutured to the posterior and lateral walls of the common stump after the anterior distal aortic stump had been incised longitudinally. The new LVOT was augmented with a double-sheeted triangular bovine pericardial patch. Postoperative catheterization showed no pressure gradient across the LVOT and trivial pulmonary regurgitation (Fig 2, B).

Comment. The following 3 methods have been reported to relieve LVOTO after a Fontan operation^{4,5}: enlargement of the bulboventricular foramen, apico-descending aortic bypass, and a DKS procedure. Although enlargement of the bulboventricular foramen has been reported more often for repair of LVOTO after a Fontan operation,^{1,5} the method has the risks of atrioventricular block, aortic regurgitation, and redevelopment of LVOTO, as in patient 1. The apico-descending aortic bypass has the disadvantage of using an artificial prosthesis. A DKS procedure seems to be the best option to relieve LVOTO. Thus the present patients should have undergone the DKS procedure at the time of the Fontan operation, even though the preoperative catheterization showed no pressure gradient across the LVOTO.

A DKS procedure is dependent on a competent pulmonary valve. Therefore a DKS procedure is usually not possible after a Fontan operation, because the pulmonary valve is directly closed in the Fontan operation. In our institute, the pulmonary trunk was closed but the pulmonary valve remained open at the time of the total cavopulmonary connection. Although neither patient has received anticoagulant drugs, their native pulmonary valves had normally mobile and thin leaflets. Therefore a DKS procedure was selected.

Because the pulmonary trunk was too short to directly anastomose to the aorta after the total cavopulmonary connection, the following 2 modifications of the DKS procedure were selected: patch reconstruction of the new LVOT and reconstruction of the bivalved systemic outflow by aortic transection. The former method is technically easy but has the risks of stenosis at the new LVOT and pulmonary regurgitation,

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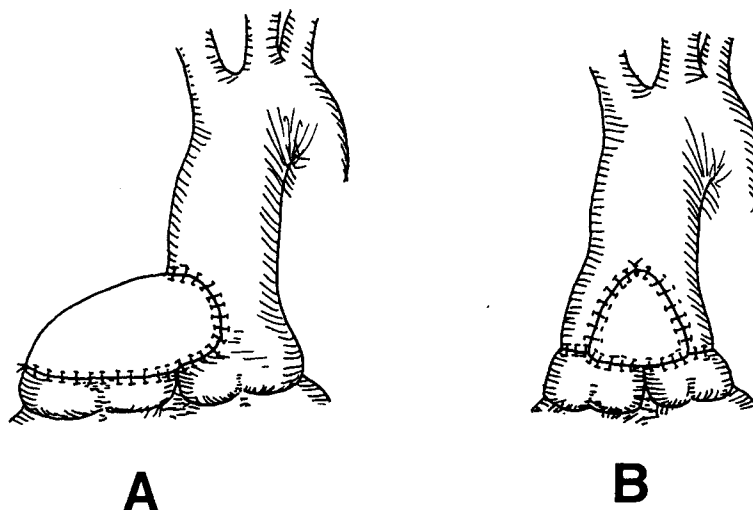


Fig 1. Scheme of Damus-Kaye-Stansel procedure in both patients. **A**, In patient 1, patch reconstruction of the additional LVOT was done. **B**, In patient 2, reconstruction of the bivalved systemic outflow after aortic transection was done.

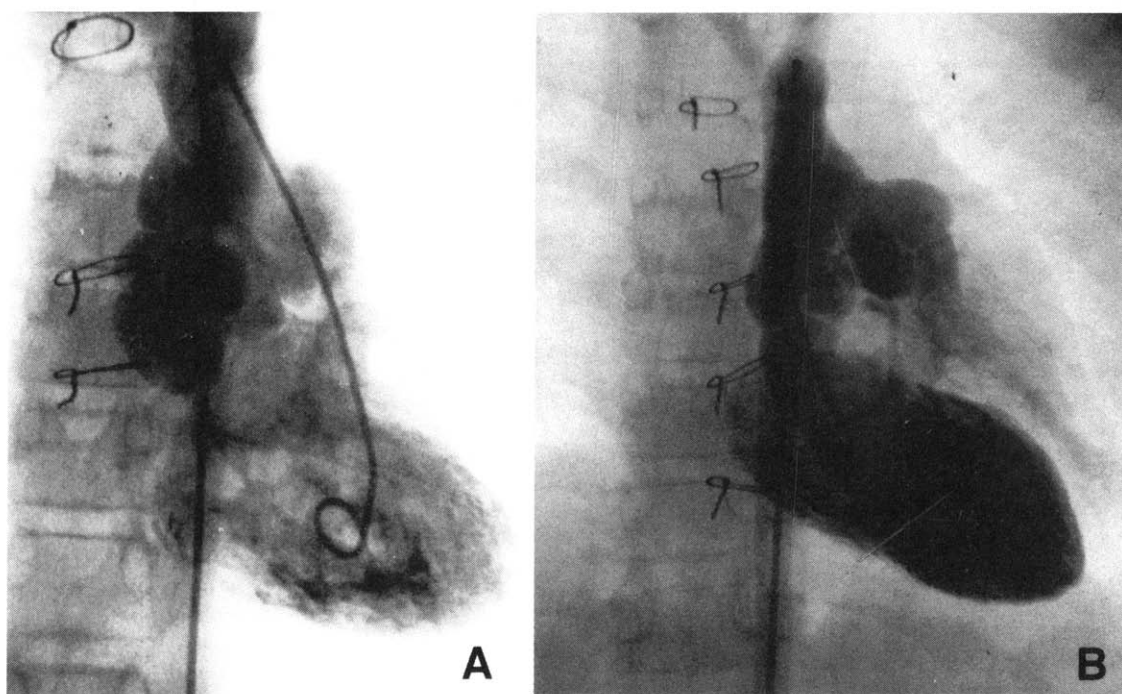


Fig 2. Ventriculograms after the operation. **A**, Patient 1. **B**, Patient 2.

which may develop because blood flow through the pulmonary valve is not straight and the orifice of the aortic incision may be insufficient. Therefore the latter method seems to be the best for a DKS procedure after a Fontan operation. In patient 1, because there were dense adhesions around the ascending aorta and the pulmonary artery, which was much larger than the aorta, the former method was selected.

Although residual mild LVOTO and mild pulmonary regurgitation remained, the patient's activity and symptoms improved. In patient 2, the latter method was selected. Both arterial blood flows went straight, as shown in Fig 2, *B*, resulting in no LVOTO and only slight pulmonary regurgitation.

In conclusion, although further follow-up is necessary, especially for pulmonary regurgitation and redevelopment of

LVOTO, a DKS procedure can be a useful method for relieving LVOTO even after a Fontan-type operation if the pulmonary valve is available.

REFERENCES

1. Karl TR, Watterson KG, Sano S, Mee RBB. Operations for subaortic stenosis in univentricular hearts. *Ann Thorac Surg* 1991;52:420-7; discussion 427-8.
2. Jensen RA Jr, Williams RG, Laks H, Drinkwater D, Kaplan S. Usefulness of banding the pulmonary trunk with single ventricle physiology at risk for subaortic obstruction. *Am J Cardiol* 1996; 77:1089-93.
3. Morishita A, Imai Y, Takanashi Y, Hoshimo S, Terada M, Aoki M. A modified Damus-Kaye-Stansel anastomosis for restrictive bulboventricular foramen developed 5 years after Fontan procedure. *Kyobu-Geka* 1995;48:1105-9.
4. Waldman JD, Lamberti JL, George L, et al. Experience with Damus procedure. *Circulation* 1988;78(Suppl):III32-9.
5. Razzouk AJ, Freedom RM, Cohen AJ, et al. The recognition, identification of morphologic substrate, and treatment of subaortic stenosis after Fontan operation. *J Thorac Cardiovasc Surg* 1992;104:1750-3.

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