Damus anastomosis associated with REV/Rastelli procedure allows to extend indications for anatomical repair in complex transposition of great arteries

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Abstract

We report here the indications and the results of a surgical option associating a Damus procedure with a ‘Réparation à l’Etage Ventriculaire’ (REV)/Rastelli procedure, for anatomical repair of patients presenting with complex transposition of great arteries (TGA), restrictive/remote ventricular septal defect (VSD) and pulmonary stenosis (PS). Five consecutive patients (median age: 11 months (range: 20 days to 15 years)) presenting with complex TGA-VSD-PS and anatomical lesions resulting in a contraindication to a Nikaidoh procedure were included. Two of them presented with a postoperative restrictive left ventricle-to-aorta baffle and secondarily underwent a modified Damus procedure a few days after the REV or Rastelli procedure. In the other 3 patients, the Damus procedure was primarily performed at the time of the REV or Rastelli procedure. No death occurred. At the last follow-up (mean: 31 ± 37 months), all patients displayed an excellent functional status and an unobstructed left ventricular outflow tract in echocardiography. Associating a Damus procedure with a REV/Rastelli procedure can be considered as an effective and low-risk surgical option to extend the indications for anatomical repair in patients with complex TGA-VSD-PS and anatomical findings precluding other surgical options.

Keywords: Biventricular repair · Complex congenital heart disease · Damus–Kay–Stansel anastomosis · Rastelli procedure · Réparation à l’Etage Ventriculaire · Transposition of great arteries

OBJECTIVE

Surgical options for transposition of great arteries with ventricular septal defect and left ventricular outflow tract obstruction (TGA-VSD-LVOTO) are multiple: arterial switch operation, ‘Réparation à l’Etage Ventriculaire’ (REV) and Rastelli procedures, Bex-Nikaidoh procedure (aortic translocation) and en bloc rotation of the truncus arteriosus [1]. Some anatomical lesions in complex forms of TGA-VSD-LVOTO can preclude these surgical options or at least make them risky. An additional modified Damus–Kay–Stansel (DKS) procedure (connection of the proximal pulmonary artery (PA) trunk to the lateral side of the ascending aorta) was reported in 2 patients with Taussig-Bing malformation [2] and 9 patients with congenitally corrected TGA and LVOTO [3]. Our aim is to report the indications and results of this surgical option associating a modified DKS procedure with a REV/Rastelli procedure, in order to extend the indications for anatomical repair in patients with complex TGA-VSD-LVOTO.

CLINICAL SUMMARY AND TECHNICAL REPORT

Five consecutive patients (median age: 11 months (range: 23 days to 15 years) presenting with complex TGA-VSD-LVOTO were included. Previous palliation procedures were modified Blalock-Taussig shunts (\(n = 4\)), Rashkind atrioseptostomy (\(n = 2\)) and percutaneous pulmonary valve dilation (\(n = 1\)). Age, anatomical lesions and surgical procedures are presented in Table 1. Pre- and perioperative examinations ascertained in all cases a remote or highly restrictive VSD with a high risk of restrictive left ventricle (LV)-to-aorta rerouting on the one hand, and anatomical lesions and coronary anomalies resulting in a contraindication for a Bex-Nikaidoh procedure on the other hand. All patients had a major coronary anomaly (Table 1). The biventricular repair strategy was chosen and performed in all patients. Associated conal septal resection (\(n = 3\)) and VSD enlargement (\(n = 3\)) were performed if necessary. Two patients presented with a postoperative low cardiac output related to a restrictive LV-to-aorta baffle after an REV procedure and a Senning/Rastelli procedure, respectively. They underwent a secondary modified DKS procedure 1 and 5 days after anatomical repair. In the remaining 3 patients, the DKS procedure was primarily associated with the REV (\(n = 2\)) and Rastelli (\(n = 1\)) procedure because of an expected high risk of restrictive LV-to-aorta connection. The surgical procedure is illustrated in Fig. 1. When this technique was performed secondarily, care was taken at the time of the Rastelli procedure to close the pulmonary valve and root while preserving the integrity of the pulmonary valve leaflets: a pledgetted stitch was placed at the
level of the nodules of Morgagni and the wall of the PA root was then sewn using pledgetted stitches.

No death occurred. At the last follow-up (mean: 32 ± 36 months), all patients displayed an excellent functional status and an unobstructed LV outflow tract (LVOT) in echocardiography.

**DISCUSSION**

The indications of the different surgical options for patients with TGA–VSD–LVOTO are well investigated. Patients with a resectable valvular and/or subvalvular LVOTO and a non-dysplastic pulmonary valve should be candidates for an arterial switch operation, regardless of the severity of the LVOT peak gradient [4]. When a mildly dysplastic pulmonary valve can serve as a satisfactory pulmonary valve and not as a neoaortic valve, the technique of en bloc rotation of the truncus arteriosus [5] can provide a good solution. In patients with a more severe LVOTO, the Rastelli or REV operations [6] should be performed. When such an intracardiac tunnelling is considered impossible or too risky due to a remote or restrictive VSD (despite the resection of the conal septum or the enlargement of the VSD) (Supplementary material, Fig. S1), a severe straddling of the atroventricular valves or a reduced-sized right ventricle (RV), the aortic translocation

<table>
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CCTGA: congenitally corrected transposition of great arteries; dTGA: dextroposed transposition of great arteries; LSVC: left superior vena cava; LVOTO: left ventricular outflow tract obstruction; VSD: ventricular septal defect; REV: Réparation à l’Etage Ventriculaire.
(Bex-Nikaidoh) procedure can provide excellent results [7]. Nevertheless, this procedure is technically more demanding and involves the risks associated with aortic valve detachment and reinserion and coronary transfer, specifically in the youngest patients with a normal size pulmonary annulus. This aggressive and delicate procedure can be contraindicated in case of major coronary anomalies. In this specific population of patients with a complex form of TGA–VSD–LVOTO precluding the previously mentioned techniques, associating a DKS procedure with a REV/Rastelli procedure can be considered as an effective and low-risk surgical option to extend the indications for anatomical biventricular repair. Such a technique was previously reported in 2 patients with Taussig–Bing malformation in 1987 [2] and more recently in 9 patients with congenitally corrected TGA and LVOTO in 2013 [3]. In these series, the DKS anastomosis was justified either by a hypertrophied subaortic conus [2] or a restrictive VSD [3], but such anatomical features did not represent a contraindication to a Nikaidoh procedure in these series. On the contrary, in the present series, the additional DKS anastomosis was required because of contraindications (major coronary anomalies) to the Nikaidoh procedure, making the DKS–Rastelli/REV procedure the last surgical option for avoiding the univentricular option.

The double-lumen LVOT created by the restrictive LV-to-aorta baffle on the one hand and the associated DKS anastomosis on the other hand (Fig. 1) decreases LV afterload and avoids the risk of low cardiac output, especially in the immediate postoperative period during which the restrictive feature of the LV-to-aorta baffle is enhanced by the bypass-related myocardial oedema. The LVOTO below the Damus anastomosis is usually left untreated to avoid any neoaortic valve regurgitation or atioventricular block. This technique was initially performed as a rescue secondary procedure in our institution (patients 1 and 5), and then as a primary associated technique in these very selected high-risk patients.

This biventricular strategy allows one to avoid a univentricular palliative procedure and its related adverse long-term physiological consequences. Nevertheless, this DKS–REV/Rastelli biventricular option exposes one to the risk of reoperation on the LVOT (related to a potential LV-to-aorta baffle constriction on the one hand, and progression of the native pulmonary stenosis (PS) on the DKS on the other hand) and the right ventricular outflow tract (especially when an RV-to-PA conduit is used for the Rastelli procedure). Thus, the unknown long-term outcomes of this biventricular option warrant a long-term follow-up in order to identify how this approach compares with a univentricular strategy.

**CONCLUSIONS**

Associating a DKS procedure with an REV/Rastelli procedure can be considered as an effective and low-risk surgical option to extend the indications for anatomical repair in patients with complex TGA–VSD–PS and anatomical findings precluding all other surgical options. A long-term follow-up is needed to assess the risks of reoperation.

**SUPPLEMENTARY MATERIAL**

Supplementary material is available at ICVTS online.

**Conflict of interest:** none declared.

**REFERENCES**


