Nikaidoh vs Réparation à l'Etage Ventriculaire vs Rastelli

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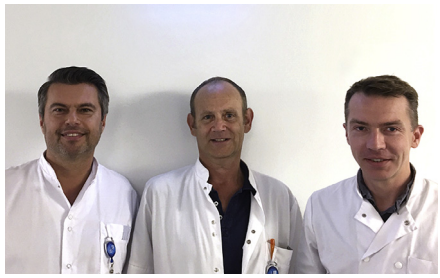
This review describes the different surgical options for transposition of the great arteries, ventricular septal defect (VSD), and left ventricular outflow tract obstruction. When the pulmonary valve can be used, an arterial switch operation with VSD closure and resection of pulmonary stenosis may be possible. This is not the scope of our review: we focus on the Rastelli, REV (Réparation à l'Etage Ventriculaire), and Nikaidoh techniques, and we also describe the "en bloc rotation" technique. Each of these procedures has a different history, and these techniques have not been used uniformly around the world. We describe the advantages and disadvantages of each technique together with their outcomes as reported in the literature. Some forms of transposition of the great arteries, VSD, and left ventricular outflow tract obstruction can only be corrected by the Nikaidoh operation, although this operation can be definitely contraindicated in other instances. Surgical eras and length of follow-up are not the same for all procedures, and there has been surgical bias in choosing 1 technique over another. This makes comparison between techniques difficult, although certain trends are observed.

Keywords: transposition surgery, Nikaidoh, Rastelli, REV, aortic root translocation

Introduction

Transposition of the great arteries (TGA), ventricular septal defect (VSD), and left ventricular outflow tract obstruction (LVOTO) are rare forms of congenital heart disease. In TGA, VSD, and LVOTO, the position of the great arteries and the coronary anatomy can vary. VSDs may be committed or noncommitted and can be small or large. LVOTO can vary greatly.[1] When the pulmonary valve is big enough and functional, an arterial switch operation with VSD closure and LVOTO resection is possible. This is not the subject of this review. With pulmonary valve hypoplasia or severe valvular dysfunction, the arterial switch is no longer an option. The left ventricle (LV) must be either tunneled to the aorta, or the aorta must be translocated to the LVOT. The Rastelli operation was the first procedure (1968) to correct TGA, VSD, and LVOTO, with the LV as systemic ventricle.[2] Bex et al followed with a report on posterior aortic translocation in 1980.[3] Nikaidoh described a similar technique of aortic translocation to correct TGA, VSD, and LVOTO in 1984.[4] A modification (Ross-switch-Konno) was introduced by Bautista-Hernandez et al in 2007.[5] The REV (Réparation à l'Etage Ventriculaire) was developed by Lecompte and modified by Metras and Kreitmann later on.[6,7] Rotation of the arterial trunk complex was described by Yamagishi et al in 2003 and by Mair et al in 2006.[8,9] Minor modifications of these operations have been published but will not be discussed.



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Central Message

Different procedures can be used to repair transposition of the great arteries, ventricular septal defect, and left ventricular outflow tract obstruction. Rastelli, REV (Réparation à l'Etage Ventriculaire), Nikaidoh, and "en bloc rotation" techniques are all described with their respective history, advantages, and drawbacks.

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Surgical Options

Rastelli Operation

Before the Rastelli operation, TGA, VSD, and LVOTO were treated by Senning or Mustard procedure and VSD closure. If needed, resection of LVOTO was performed. With the Rastelli operation, however, the LV remains in the systemic circulation. The LV to aortic tunnel is made through a right ventriculotomy that is also used to connect the right ventricle (RV) to the pulmonary arteries with a valved conduit. This conduit is extracardiac and is usually placed leftward of the ascending aorta.

REV Operation

Two essential features of REV are resection of the infundibular septum and direct connection of the pulmonary trunk to the RV. Even when the VSD is big, the conal septum must be resected as much as possible. A Lecompte maneuver is part of the REV procedure. Resection of the outlet septum will make the LV to aorta connection much straighter than in the Rastelli operation. In the Metras modification, a tubular segment of autologous ascending aorta is used to construct the RV to pulmonary artery (PA) connection. A Lecompte maneuver is not used here, and the connection is placed left- or right-sided to the aorta. The intracardiac tunnel is made in a similar fashion as in the REV operation, with resection of the conal septum.

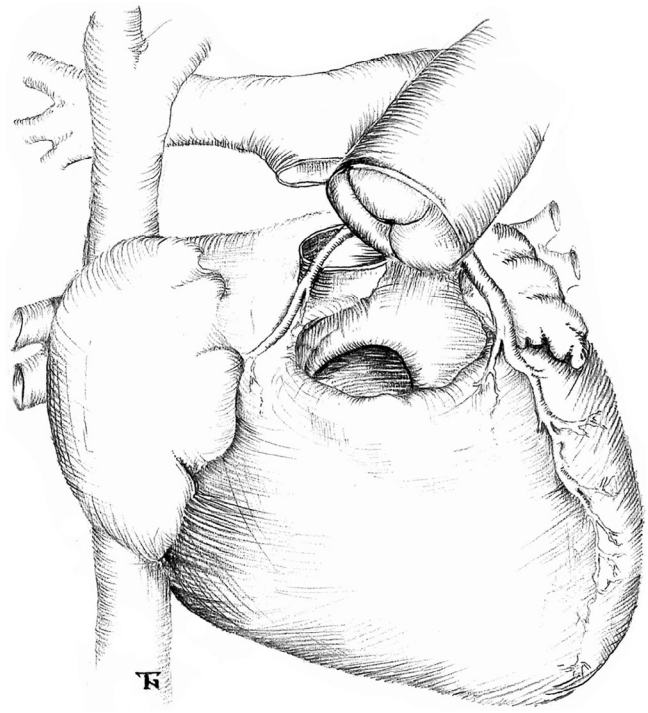

Figure 1 Partial detachment of the aortic root. The area under the left coronary artery remains attached to the right ventricle.

Posterior Aortic Translocation and "En Bloc Rotation" Techniques

In posterior aortic translocation (Nikaidoh-Bex operation), the aorta is detached from the RV and translocated posteriorly onto the LVOT. An advantage is the straight-lined connection between LV and aorta, much less reduction of RV volume, and an RV to PA conduit that is orthotopically placed. The superiority of posterior aortic translocation will be questionable when the LVOT is very small as this limits the distance to which the aorta can be moved backward.

The ascending aorta can be transected slightly above or at the level of the sinotubular junction. This transection is always necessary when the aortic root will be rotated; in other instances, there is no need for aortic transection. Aortic root detachment can be complete or incomplete. When detachment is incomplete, the aorta remains attached under the left coronary artery (LCA) and is rotated clockwise into the LVOT (Fig. 1). The pulmonary valve annulus and the infundibular septum are transected so that the LVOT opens widely. If necessary, subpulmonary obstructive tissue can be further resected. This technique was described by Nikaidoh in 1984.[4] In our experience, coronary artery detachment and relocation is not necessary; the LCA can remain in place, whereas the right coronary artery (RCA) needs to be mobilized sufficiently to allow (clockwise) rotation of the aortic root. Contrary to our own experience, Nikaidoh found that partial detachment resulted in more patients needing relocation of the RCA more anteriorly than when the aortic root was fully mobilized.[10] Complete mobilization of the aortic root is the current choice. Complete detachment can be used with or without rotation of the aortic root and with or without detachment and relocation of the coronary arteries.

Different strategies to preserve aortic valve function have been reported: operation without cross-clamping the aorta, administration of saline into the aortic root via the cardioplegia needle, and fibrillating heart technique; all these techniques aim to preserve aortic root integrity and prevent distortion of the valve. When the aorta is transected, preserve aortic root integrity is no longer possible.

Our approach to the Nikaidoh operation has always been to leave the aorta intact and partially attached under the LCA.[10] This facilitates posterior translocation and preserves aortic valve function. To ensure that aortic root geometry is not disturbed, we use a continuous saline flush through the cardioplegia needle to keep the aortic valve closed. There is no need for aortic transection, Lecompte maneuver, or coronary detachment. Constructing the RV-PA conduit (bovine jugular vein conduit) such that it wraps around the aorta does not result in dysfunction and has proved to be a satisfactory way to reconstruct the right ventricular outflow tract (RVOT). The graft can be placed to the right or to the left of the aorta.

More radical techniques have been reported by Yamagishi and by Mair: an autologous half-turned truncal block that involves both semilunar valves is fully detached from the heart and turned 180° before it is re-inserted with the aortic valve on top of the LVOT and the pulmonary valve over the RVOT.[8,9]

The "en bloc rotation" technique provides sufficient length of the autologous pulmonary posterior wall for direct anastomosis by itself. The risk of late right ventricular outflow tract obstruction (RVOTO) is thought to be reduced by elimination