Arterial switch operation with in situ coronary reallocation for transposition of great arteries with single coronary artery

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Received 19 April 2003; received in revised form 8 October 2003; accepted 30 October 2003

Abstract

Objective: Transposition of great arteries (TGA) with single coronary artery pattern is one of the high-risk groups for arterial switch operation (ASO). Any traction or kinking during coronary transfer can lead to a fatal outcome. With increase in experience, surgical results improved, but it did not completely eliminate the risks of coronary translocation. Many techniques have been described for transfer of single coronary and each one has its own merits and problems. We here in describe a new technique of in situ coronary reallocation during ASO for TGA with single coronary and also report the early and mid-term results with this new technique.

Methods: From September 1988 to June 2002, five consecutive cases of TGA with single coronary artery were operated employing this new technique. Their age ranged from 16 days to 9 months. ASO was done by transecting the great arteries just above the commissures. For coronary reallocation, hockey stick-shaped incisions were made in the facing sinuses of the proximal aorta and the pulmonary artery. These flaps were sutured in such a way that the coronary ostium was committed to the neo-aorta with the rest of surgical procedure done in the usual manner.

Results: All five patients had ASO. Additionally, four patients had closure of an associated ventricular septal defect and one patient had repair of the coarctation of the aorta. There was no in hospital mortality. All patients had follow-up echocardiograms at regular intervals, which showed no significant right or left ventricular outflow obstruction, no regional wall motion abnormalities and no neo-aortic or neo-pulmonary regurgitation. Three of five patients had cardiac catheterization and angiocardiography, which showed normal coronary arteries with no obstructive lesions and no neo-aortic regurgitation. Their follow up ranged from 5 to 50 months and there was no late mortality.

Conclusion: This new coronary reallocation technique avoids problems related to coronary translocation such as traction and kinking. It spares the need for dissection of proximal coronary artery and its branches, and thereby eliminates the risk of development of fibrosis and stenosis. The same technique can be used regardless of the sinus of origin of the coronary artery. It is a reliable and a reproducible technique. The early and mid-term results appear excellent in this series.

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Keywords: Transposition of great arteries; Single coronary artery; Arterial switch operation; Coronary reallocation

1. Introduction

Coronary artery transfer is the most important step to achieve successful outcome in conventional arterial switch operation (ASO) in transposition of great arteries (TGA). Coronary artery pattern has been one of the major risk factors for early and late death. The risk of death is increased when the left main coronary artery or either of its branches arises from sinus 2, intramural course of the coronary artery, and single coronary artery [1]. The single coronary artery commonly arises from right facing sinus (sinus 2-LAD, CX, RCA). In most series ASO with single coronary artery transfer was associated with a greater degree of mortality [2–5]. Many techniques have been described, but each one has its own merits and problems [2,3,6,9]. We here in describe a new technique of in situ coronary reallocation for single coronary artery pattern in patients with TGA undergoing ASO and also report its early and mid-term results.
2. Materials and methods

From September 1998 to June 2002, five consecutive cases of TGA and its variants, with single coronary artery were operated employing this new technique. The clinical spectrum is described in Table 1. The technique of ASO repair without coronary artery transfer for a two coronary system was described earlier [10] and the same principle has been adopted for single coronary arterial system. After median sternotomy and routine cardiopulmonary bypass (CPB), the ductus was ligated and divided. Under cardioplegic arrest the right atrium was opened and VSD if present, closed with a Gore-Tex (polytetrafluoroethylene) patch using polypropylene (Ethicon Inc., Somerville, WJ) continuous sutures. In one patient, coarctation of aorta (CoA) repair (end to end anastomosis) was done during cooling without circulatory arrest. Later coronary reallocation along with ASO was done as described below.

The great arteries were transected just above the commissures. A hockey stick-shaped incision was made in the proximal aorta, starting from close to the facing commissure, leaving a margin of a few millimeters for suturing. Another hockey stick-shaped incision was made in the proximal pulmonary artery from the middle of the facing sinus, leaving a margin of a few millimeters of pulmonary artery wall from the base for suturing (Fig. 1). With 7–0 double armed polypropylene (Ethicon Inc., Somerville, WJ) suture, starting from the angles of the incisions (end of the incisions) and keeping the inner part of the pulmonary wall in between the aortic incision, the outer flap of the aortic wall was sutured to the outer flap of the pulmonary wall with one end of the suture. With the other end of the suture the inner flap of the pulmonary wall was sutured from inside the aorta. Then the free edge of the inner flap of the aortic wall was sutured to the outer wall of the pulmonary artery with 7–0 polypropylene (Ethicon Inc., Somerville, WJ) suture (Fig. 2). After Lecompte maneuver, the distal aorta was anastomosed to the neo-aorta. The aortic cross clamp was released and the suture line anastomosis was inspected for potential aortopulmonary leaks. Then the neo PA was

Table 1

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Age</th>
<th>Weight (kg)</th>
<th>Sex</th>
<th>TGA spectrum</th>
<th>Associated anomaly</th>
<th>Coronary origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 months</td>
<td>4.0</td>
<td>M</td>
<td>VSD</td>
<td>–</td>
<td>Sinus 2</td>
</tr>
<tr>
<td>2</td>
<td>16 days</td>
<td>2.9</td>
<td>M</td>
<td>IVS</td>
<td>–</td>
<td>Sinus 1</td>
</tr>
<tr>
<td>3</td>
<td>7 months</td>
<td>3.8</td>
<td>F</td>
<td>VSD</td>
<td>CoA</td>
<td>Sinus 2</td>
</tr>
<tr>
<td>4</td>
<td>9 months</td>
<td>5.8</td>
<td>F</td>
<td>VSD</td>
<td>–</td>
<td>Sinus 2</td>
</tr>
<tr>
<td>5</td>
<td>1 month</td>
<td>3.2</td>
<td>M</td>
<td>VSD</td>
<td>–</td>
<td>Sinus 2</td>
</tr>
</tbody>
</table>

TGA, transposition of great arteries; VSD, ventricular septal defect; IVS, Intact ventricular system; CoA, coarctation of aorta.

Fig. 1. Hockey stick-shaped incisions (dashed lines) for making, flaps in the proximal great arteries. Prox AO, proximal aorta; Prox PA, proximal pulmonary artery; Dist PA, distal pulmonary artery; Dist AO, distal aorta.

Fig. 2. Suturing of the flaps in the proximal great arteries (arrows indicate direction of flap suturing). Prox AO, proximal aorta; Prox PA, proximal pulmonary artery.
incised longitudinally and enlarged with a pericardial patch and anastomosed to the distal PA. (Figs. 3 and 4)

3. Results

One patient had ASO alone, four patients had ASO with trans atrial VSD closure. Another patient had single stage repair of CoA along with VSD and ASO, without circulatory arrest. CPB time ranged from 170 to 265 min (mean 226 min), and AO cross clamp time ranged from 54 to 135 min (mean 101 min). Ventilation period ranged from 2 to 5 days (mean 3.2 days) and ICU stay 4 to 12 days (mean 6.6 days). Delayed sternal closure was done in three patients. There was no hospital mortality.

All patients had postoperative echocardiogram at regular intervals, which showed no significant RVOT or LVOT obstruction, no regional wall motion abnormalities, and no neo-aortic or neo-pulmonary regurgitation. Three patients had cardiac catheterization and coronary angiogram, which showed good filling of coronary arteries without any obstructive lesion and no evidence of neo-aortic regurgitation (Fig. 5). The follow up ranged from 5 to 50 months and there was no late mortality.

4. Discussion

Although increased surgical experience improved the results of ASO in high-risk coronary artery groups, it did not completely eliminate the risk. Coronary transfer requires high technical expertise and any traction or kinking during transfer can lead to fatal outcome. Since coronary transfer is associated with a high mortality, several workers reported ASO without coronary transfer.

Aubert et al. reported a technique of ASO, by creating an aortopulmonary window and suturing a pericardial patch around the coronary ostia [6]. This led to pericardial patch shrinkage in the long term. Takeuchi reported modification of the Aubert technique [7]. He used the great arterial wall to create a tunnel, thereby avoiding use of a pericardial patch. Although, early mortality was less, late RV outflow tract obstruction due to an oversized intraarterial baffle and late ostial stenosis remains a concern. The techniques reported by Yacoub [2], Planche [3] and Shukla [8] require careful planning and are also technically demanding. The technique described by Parry [9] using pericardial hood augmentation is not free from complications. Immediate compression of the large pericardial hood by the neo-pulmonary artery and shrinkage of the pericardial patch on long-term follow-up are major concerns.

The coronary artery translocation is the most widely practiced technique. But there are circumstances in which
this approach may precipitate ischemia due to kinking and over stretching. The surgical technique, which leaves the coronary artery in a truly anatomic position, is less likely to cause coronary insufficiency. Taking these things into consideration, we developed a new technique of ASO with coronary reallocation without translocation to neo-aorta. In this technique, the coronary artery is left in its original anatomical position. The flaps are made in the great arteries and sutured in such a way that the coronary ostium is committed to the neo-aorta. We described the same technique earlier for the two coronary system [10] and a similar principle is used in the single coronary pattern successfully. It avoids problems related to coronary translocation such as traction and kinking. There is no need for dissection of the proximal coronary and its branches. It avoids long-term problems related to dissection and manipulation. In our series all patients had tissue-to-tissue anastomosis around the coronary ostium without using prosthetic material to promote good future growth in these children. The same technique can be used whether the coronary artery arises from the right or left facing sinus.

There was no hospital mortality. At follow up, all these patients had echocardiogram at regular intervals. No patient had residual problems like RV or LV outflow obstruction, and neo-aortic or neo-pulmonary regurgitation. Of the three patients who had cardiac catheterization and angiocardio-graphy, all had normal coronaries with unobstructed coronary flow. There was no significant ventricular outflow obstruction or neo-aortic regurgitation.

5. Conclusion

This new technique of coronary artery reallocation is reliable and reproducible. It avoids problems related to coronary translocation and also achieves anatomic correction like conventional ASO. The early and mid-term results are excellent, and the long-term results are awaited.

Acknowledgements

We thank Mrs Revathy Vijay Kumar, secretary, Mr Dhanabalan, artist and Mr Parry Uma, medical Illustrator for their help in preparing this manuscript.

References