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BENHA MEDICAL JOURNAL

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Published by Benha Faculty of Medicine

Volume 21 Number 3
Sept. 2004
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Abstract

Objective: To evaluate the outcome of the arterial switch operation (ASO) used to treat various anatomico-pathologic entities of transposition of great arteries.

Patients and Methods: Fifty patients who underwent the arterial switch operation (ASO), done by one surgeon (Rene Pretre), at the university hospital Zurich, Switzerland during the period between July 1998 and November 2003, were retrospectively studied. Of the fifty patients included, there were 31 boys and 19 girls with a median age of 7 days and weight of 3.3 kg. The lesions treated included 41 d-transposition of great arteries (d-TGA), 8 double outlet right ventricle with subpulmonary ventricular septal defect (DORV/SP-VSD) and one congenitally corrected transposition of great arteries (CC-TGA) with heart failure. Forty-five patients underwent primary ASO. Four patients with concomitant hypoplastic aortic arch and isthmus stenosis underwent a two-stage repair. The patient with CC-TGA underwent PA banding followed by a double switch operation.

Results: There were 2 (4%) early deaths, one intraoperative due to myocardial ischemia and another early postoperative due to right side heart failure. Two (4%) patients required reoperation for left coronary ostial stenosis (venous patch ostial enlargement) and another patient (2%) un-
Despite pulmonary artery angioplasty for pulmonary artery stenosis. After a median follow-up period of 20.5 (2-64) months, the last echocardiography revealed mild aortic insufficiency, pulmonary artery stenosis and mild mitral insufficiency in 5 (10.4%), 2 (4.2%) and one (2%) patients respectively.

Conclusion: Arterial switch operation has excellent immediate results and remains the operation of choice for treatment of transposed great arteries. Mid-term follow-up is characterised by few problems on the coronary arteries and the aortic valve. The freedom from marked cardiac events and the harmonious growth of cardiac structures are encouraging regarding long-term prognosis.

Introduction

The arterial switch operation (ASO), introduced in 1976 by Jatene and colleagues at Sao Paulo, Brazil, is the treatment of choice for transposition of great arteries with intact ventricular septum (TGA-IVS), TGA with ventricular septal defect (TGA-VSD) and other physiologically similar entities such as double outlet right ventricle (DORV) with a subpulmonic ventricular septal defect (VSD) (Brown et al. 2001) and (Duncan et al. 2004). Recently the ASO, as part of the double switch operation which combines ASO and Senning operation, is also considered the operation of choice for treatment of patients with congenitally corrected TGA who developed right sided heart failure (Duncan et al. 2003) and (DeVaneey et al. 2003). As experience with this operation has increased, mortality probability has been lowered and is consistently below 10% in most contemporary series. Most children who have undergone the ASO have normal growth, development and cardiac functions. The procedure is associated with lower perioperative mortality than many other congenital cardiac operations despite being technically more challenging and time-consuming (Gandhi et al 2002). In contrast to the atrial switch operation, proposed in the fifties by Senning (1959), the ASO has the advantages of maintenance of sinus node function, preservation of the left ventricle as the systemic ventricle.
and the mitral valve as the systemic atrioventricular valve. However, the ASO involves translocation of the coronary arteries, the pulmonary valve becomes the systemic outflow valve, and the pulmonary arteries may become distorted because of their atypical relationship to the great vessels (Gandhi et al., 2002). We aimed to assess the results of a series of patients operated upon by the same surgeon to find out the outcome of the ASO done for some pathologic entities suitable for bi-ventricular repair.

**Patients and Methods**

Patients who underwent the ASO, performed by one surgeon, at Zurich university hospital, Switzerland between June, 1998 and November, 2003 were retrospectively studied by reviewing their medical records and follow up data. There were fifty patients of median age of 7 days and median weight of 3.5 kg. Their demographic data are summarized in (Table 1). Diagnosis was established in all patients with echocardiography. Cardiac catheterization was performed in all cases (Table 2). The anatomic variables recorded were: presence or absence of VSD, the position of the great arteries relative to each other; right ventricular hypoplasia (defined as tricuspid valve annulus of z-score < -2 or a non—apex-forming right ventricle), and aortic arch anomalies including interruption, coarctation or arch hypoplasia. Coronary anatomy was determined by preoperative echocardiography, coronary angiography and direct visualization at the time of surgery. Coronary artery patterns were classified as previously outlined by Yacoub and Radley-Smith, 1978. Four patients had intramural coronary arteries, 2 left, one right and one left anterior descending artery. Thirty (60%) patients had transposition of the great arteries with an intact ventricular septum (TGA/IVS), one of whom had right ventricular hypoplasia. Eleven (22%) patients had transposition of the great arteries with ventricular septum defect (TGA/VSD) and 8 (16%) patients had double outlet right ventricle with subpulmonary ventricular septal defect (DORV/SP-VSD). 4 of whom had associated aortic arch obstruction requiring surgery. The last patient had congenitally cor-
rected transposition of the great arteries (CC-TGA) with heart failure. The position of the great arteries (aorta in relation to the PA) was anteroposterior in 78% and side-by-side in 24% of patients.

Forty (80%) patients received prostaglandin infusion and underwent preoperative balloon atrial septostomy (Rashkind maneuver), either in the ICU under echocardiographic guidance (28 patients) or in the cardiac catheterization laboratory (12 patients), to allow sufficient blood mixing between the two parallel circulations at the ductal and atrial levels respectively in order to maintain an adequate arterial oxygen saturation and to prevent the occurrence of metabolic acidosis. The other ten (20%) patients had adequate arterial oxygen saturation, over 85%, due to good blood mixing at more than one level. The thirty patients with TGA/IVS underwent primary ASO. The eleven patients with TGA/VSD and four out of the eight patients with DORV/SP-VSD underwent primary ASO with VSD closure. Four patients with DORV/SP-VSD who had concomitant hypoplastic aortic arch and isthmus stenosis underwent two-stage repair. The first stage was performed through a left thoracotomy incision where an aortic arch repair plus a pulmonary artery band placement, to decrease pulmonary blood flow, were done. ASO plus pulmonary artery band takedown were performed 2 to 3 weeks after the first stage operation. The patient with CC-TGA underwent a pulmonary artery band placement for left ventricular re-training followed 6 months by a pulmonary artery band takedown and double switch operation where a Senning plus an arterial switch procedures were performed (Table 3).

**Surgical technique of the ASO**

After the aortic and bivacaval cannulation were performed and the aortic root antegrade cardioplegia cannula as well as the retrograde coronary sinus cardioplegia cannula were inserted, cardiopulmonary bypass was established under moderate hypothermia i.e. median temperature of 28 (26-32) °C. Circulatory arrest never used in this group of pa-
tients. The ductus arteriosus was ligated and severed at the beginning of cardiopulmonary bypass. The aorta was cross clamped and the heart arrested with a cardioplegic solution infused in the aortic root. Subsequent doses of cardioplegia were given either retrograde or selectively in the coronary ostia every 20 minutes at 15-20ml/kg. The aorta was transected above the sino-tubular junction and the coronary arteries were harvested with a button of aortic wall. The main pulmonary artery was transected beneath its bifurcation and the right and left pulmonary arteries were dissected down to the pulmonary hilum to ensure a subsequent tension-free translocation of the pulmonary bifurcation over the posteriorly located ascending aorta (the Lecompte manoeuvre). The Lecompte manoeuvre was then performed and the neo-aortic root (native pulmonary root) was anastomosed to the ascending aorta with a continuous 6/0 resorbable monofilament sutures in running fashion. The anterior neoaortic commissure was marked with a fine suture to avoid its injury during coronary button reimplantation. Once the neoaortic anastomosis has been completed, the aortic cross clamp is temporarily released allowing the neoaortic root to distend. The coronary buttons were mobilized for a distance of 4 to 6 mm and allowed to rotate to the location of the distended neoaortic root where they will reside without tension or torsion and this location is marked with a sterile pen, then the aortic cross clamp was reapplied again. Reimplantation of the coronary buttons to the neo-aortic root at the previously marked proper sites were done using a continuous 7/0 resorbable monofilament sutures in running fashion. A properly fashioned pant-loon-shaped generous patch (2.5 to 3.5 times larger than the combined area of the transferred coronary buttons) of fresh autologous pericardium was used to bridge the defect created by the harvest of the coronary arteries in the native aortic root (neo-pulmonary) with resorbable suture.

The right atrium was opened and the ventricular septal defect, when present, was exposed through the tricuspid valve orifice with temporary detachment of the
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anterior leaflet of the tricuspid valve, when seemed necessary for better exposure. The ventricular septal defect was then closed with a patch of Gore-Tex or pericardium sutured on the right side of the septum with continuous suture of non-absorbable thread. In patients with DORV/SP-VSD, a patch committing the LV to the neo-aorta was placed. Any pathologic or induced atrial septal defect was closed mostly directly or rarely with a patch when necessary and the heart was refilled with blood and lungs were ventilated to expel air from the left side of the heart before closure of the last stitches. The right atrium was then closed, the heart de-aired and the aortic cross clamp was removed. The reconstructed neo-pulmonary root was anastomosed to the pulmonary artery on beating heart during rewarming. Cardiopulmonary bypass was discontinued once rewarming and resumption of adequate heart function had been fulfilled.

After cessation of cardiopulmonary bypass, blood modified ultrafiltration was done to reduce the amount of interstitial oedema induced by extracorporeal circulation. Any potential pulmonary vasoconstrictive drug, as epinephrine, was administered via a left atrial line to reduce the potential for further pulmonary vasoconstriction. The sternum was usually closed immediately with loops of resorbable sutures. The sternum was left open, for few days, only when transsternal extracorporeal membrane oxygenator (ECMO) cannulae were in place or when sternal closure compromised cardiac functions. Transesophageal echocardiography (TEE) was used to detect any residual defect.

Statistical analysis was performed by the SPSS (version 8) for windows statistical package.

Results

The intraoperative and immediate postoperative variables are shown in (Table 4). The mortality and reoperations among the fifty patients are shown in (Table 5). Two (4%) patients died, one with TGA/IVS and one with DORV/SP-VSD. The former died intraoperatively due to myocardial ischemia and the latter died within the first week postoperatively of many as-
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associated problems. Both patients had type C (1/2 LcxR) coronary artery pattern with intramural course of the left coronary artery. The first patient developed akinesia in the territory of the left coronary artery that did not improve after an attempt of coronary revascularisation with the left internal mammary artery. After completion of repair, the second patient who had hypoplastic RV developed hypotension that necessitated pharmacologic and ECMO support. TEE showed a residual VSD with right to left shunt and subpulmonary stenosis. Reoperation was arranged with a contegra graft (Bovine jugular vein graft) placed between RV and PA with VSD closure. TEE showed mild aortic incompetence, moderate to severe mitral incompetence and tricuspid incompetence. The patient could not be weaned from ECMO due to cardiac failure and finally separated after permission from his family.

Postoperatively, echocardiographic wall motion analysis was used as a screening method to identify patients with suspected myocardial ischemia. Four (8.3%) patients were found to have echocardiographic wall motion abnormalities after a median follow up interval of 4.5 (3-6) months. These findings were confirmed at thallium-201 myocardial perfusion scans where myocardial perfusion defects in the corresponding anatomic locations were detected. Coronary angiography revealed left coronary ostial stenosis in 2 patients who successfully underwent coronary artery patch-plasty with a vein graft without recurrence of ischemia after 12 and 18 months follow up. One patient developed severe pulmonary artery stenosis 3 months after the ASO and underwent a successful percutaneous PA dilatation without need of reintervention after 12 months follow up. The last follow up echocardiographic evaluation was judged normal in 39 (81.3%) of 48 operative survivors. It revealed mild valvular insufficiency in 6 patients (5 aortic and one mitral) and PA stenosis in 2 patients (Table 6). Regurgitation of the neo-aortic valve remained stable in all five patients over a median follow up interval of 14 months.
### Table 1. Patient's demographic characteristics

<table>
<thead>
<tr>
<th></th>
<th>TGA/VPS</th>
<th>TGA/VSD</th>
<th>DOR/VSP-VSD</th>
<th>CC-TGA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>30 (60%)</td>
<td>11 (22%)</td>
<td>8 (16%)</td>
<td>01 (2%)</td>
<td>50 (100%)</td>
</tr>
<tr>
<td>Age (in Days)</td>
<td>6 (3-10)</td>
<td>8.5 (3-32)</td>
<td>43 (4-100)</td>
<td>2220</td>
<td>7.1 (2-220)</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>18:12</td>
<td>7:4</td>
<td>5:5</td>
<td>10</td>
<td>31:19</td>
</tr>
<tr>
<td>Weight (Kg/m)</td>
<td>2.5 (2-4.5)</td>
<td>3.2 (2-4.2)</td>
<td>3.4 (2.9-5.3)</td>
<td>18.7</td>
<td>3.4 (2-18.7)</td>
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</tbody>
</table>

### Table 2. Summary of the patient's angiographic findings

<table>
<thead>
<tr>
<th></th>
<th>TGA/VPS</th>
<th>TGA/VSD</th>
<th>DOR/VSP-VSD</th>
<th>CC-TGA</th>
<th>Total</th>
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<tbody>
<tr>
<td>AAO</td>
<td>00</td>
<td>00</td>
<td>04</td>
<td>00</td>
<td>04</td>
</tr>
<tr>
<td>RV Hypoplasia</td>
<td>01</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>01</td>
</tr>
<tr>
<td>GArelation</td>
<td>- AP</td>
<td>22</td>
<td>07</td>
<td>08</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td>- Side by side</td>
<td>08</td>
<td>04</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>CA Pattern</td>
<td>A (1LV+2R)</td>
<td>22</td>
<td>09</td>
<td>05</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td>B (1LV+LpR)</td>
<td>01</td>
<td>00</td>
<td>01</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>C (1LV+RlR)</td>
<td>01</td>
<td>01</td>
<td>01</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>D (1LV+2Cr)</td>
<td>03</td>
<td>01</td>
<td>01</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>E (1LV+2Cr)</td>
<td>03</td>
<td>00</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Intramural CA</td>
<td>02</td>
<td>01</td>
<td>01</td>
<td>01</td>
<td>04</td>
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### Table 3. Interventional and surgical procedures performed in 50 patients.

<table>
<thead>
<tr>
<th></th>
<th>TGA/VPS</th>
<th>TGA/VSD</th>
<th>DOR/VSP-VSD</th>
<th>CC-TGA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>30 (60%)</td>
<td>11 (22%)</td>
<td>8 (16%)</td>
<td>01 (2%)</td>
<td>50 (100%)</td>
</tr>
<tr>
<td>Rankin&amp;PGI</td>
<td>30 (100%)</td>
<td>03 (3%)</td>
<td>03 (37.5%)</td>
<td>00</td>
<td>40 (80%)</td>
</tr>
<tr>
<td>ASD (primary)</td>
<td>30</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>30 (60%)</td>
</tr>
<tr>
<td>ASD&amp;VSDC (primary)</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00 (0%)</td>
</tr>
<tr>
<td>AAC and PABASO</td>
<td>00</td>
<td>04 (50%)</td>
<td>00</td>
<td>00</td>
<td>04 (8%)</td>
</tr>
<tr>
<td>PABASO</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>01</td>
<td>01 (2%)</td>
</tr>
</tbody>
</table>

Table 4: Operative and postoperative variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross clamp time (Min)</td>
<td>117 (98-220)</td>
<td></td>
</tr>
<tr>
<td>Total bypass time (Min)</td>
<td>168 (154-310)</td>
<td></td>
</tr>
<tr>
<td>Delayed atriocoronary closure</td>
<td>12/48 (25%)</td>
<td></td>
</tr>
<tr>
<td>ECMO support</td>
<td>0/5-8 (10.4%)</td>
<td></td>
</tr>
<tr>
<td>Mechanical ventilation (days)</td>
<td>3/2-12</td>
<td></td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>5/2-7</td>
<td></td>
</tr>
<tr>
<td>Postoperative hospital stay (Days)</td>
<td>107/22</td>
<td></td>
</tr>
</tbody>
</table>

Data reported as median (range) and number (percent).

Table 5: Mortality and reoperation among 50 patients

<table>
<thead>
<tr>
<th>Procedure</th>
<th>TGA/VSD</th>
<th>TGA/VSD</th>
<th>DOR/VSD/PSP-VSD</th>
<th>CC-TGA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>30</td>
<td>11</td>
<td>08</td>
<td>01</td>
<td>50</td>
</tr>
<tr>
<td>Mortality</td>
<td>01</td>
<td>00</td>
<td>01</td>
<td>00</td>
<td>02</td>
</tr>
<tr>
<td>LCA Patch-plast</td>
<td>01</td>
<td>01</td>
<td>00</td>
<td>00</td>
<td>02</td>
</tr>
<tr>
<td>PA dilation</td>
<td>00</td>
<td>01</td>
<td>00</td>
<td>00</td>
<td>01</td>
</tr>
</tbody>
</table>

TXL: pulmonary artery. LCA: left coronary artery.

Table 6: Late echocardiographic findings in 48 patients

<table>
<thead>
<tr>
<th>Findings</th>
<th>TGA/VSD</th>
<th>TGA/VSD</th>
<th>DOR/VSD/PSP-VSD</th>
<th>CC-TGA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>29</td>
<td>11</td>
<td>07</td>
<td>01</td>
<td>48</td>
</tr>
<tr>
<td>Mild NAI</td>
<td>03</td>
<td>02</td>
<td>00</td>
<td>00</td>
<td>05</td>
</tr>
<tr>
<td>Mild MI</td>
<td>01</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>01</td>
</tr>
<tr>
<td>PA stenosis</td>
<td>02</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>02</td>
</tr>
</tbody>
</table>

NAI: Narural Insufficiency. MI: Mitral Insufficiency.

Discussion

In 1959 in Stockholm, Ake Senning performed the first surgical correction for transposition of the great arteries (TGA) that bears his name. This procedure, also known as the atrial or venous switch operation. However, intermediate- to long-term survivors developed RV failure, systemic and pulmonary venous pathway leaks and obstructions, varying degrees of tricuspid valve insufficiency, atrial arrhythmias, and unexpected late sudden deaths (Kjirjavainen et al, 1999). In 1976 in Sao Paulo, Brazil, Jatene successfully performed the first arterial switch operation (ASO), which increasingly gained popularity, was reproducible with an acceptable learning curve, and resulted in lower mortality rates.
than the Senning operation. More important, it represented an anatomic and physiologic repair of transposition, placing the left ventricle (LV) in the systemic position, thus avoiding potential long-term RV failure that complicated the atrial baffle operations. This fact, and mortality that reaches zero in many centers that perform the ASO, have made the Senning operation a palliative procedure. As a result, the Senning operation has become nearly obsolete in the surgical management of neonates with TGA (Pretre et al, 2001). However, there are still some instances where the Senning operation may be indicated for patients with TGA. These include complex coronary anatomy precluding an ASO, or late referral in patients with TGA plus VSD, which is very commonplace in developing countries. In this situation, pulmonary hypertension and a left ventricle that is inadequate or untrainable may both contraindicate an ASO (Reddy et al, 1996).

Results for the arterial switch operation continue to improve due to refinements in operative and perioperative management that have mitigated the effects of many features previously thought to increase operative risk such as infants with TGA-IVS and late presentation, premature or low birth weight patients, patients with DORV and subpulmonary VSD, and patients with associated arch abnormalities (Masuda et al, 1999) and (Brown et al, 2001). The results in the present series support the expectation of successful treatment for some of these groups. The early mortality after arterial switch operation in our series of patients was 4%, that compares favourably with 9.5% obtained by Brown and colleagues, 2001. It also compares with the 2.6% mortality reported by another group performing an average of 10 arterial switch operations per year (Conte et al, 1997).

The outcome of the arterial switch operation is, in great part, conditioned by the transfer of the coronary arteries (Wernovsky et al, 1995). Travel of the coronary artery between the great arteries and its intramural origin remain particularly dangerous (Brown et
al, 2001). We have encountered these presentations in 5 (10%) of our patients, 2 of whom died of subsequent myocardial infarction and heart failure following longitudinal splitting of their intramural segment. So, we do not agree with Duncan and associates, 2004 that unroofing or longitudinal splitting of the intramural part of the coronary artery, on the aortic luminal side, is a wise decision. Following the arterial switch operation, progressive occlusion of a coronary trunk from fibrocellular intimal proliferation have been reported (Tumeiere et al. 1997). The histopathological mechanism of the proliferation is unknown but apparently threatens the child during the first year of life (Tsuda et al. 1992). These changes may remain asymptomatic even without echocardiographic abnormalities or result in myocardial ischemia or sudden death (Massin et al. 1997). In the current series, two patients developed myocardial ischemia due to left main ostial stenosis 4 and 6 months postoperatively. They successfully underwent coronary artery patch-plasty with a vein graft. However, no patient died suddenly during follow-up period of 20.5 (2-62) months.

Massin and associates, 1997 and Nakanishi and colleagues, 1996 have attributed the aortic regurgitation following the ASO to a progressive dilation of the neo-aortic annulus and sino-tubular junction. However, more recent studies have attributed the aortic regurgitation to widening or deformation (following coronary reimplantation) of the neo-aortic root that is usually markedly observed in the first year of life followed by active aortic growth with tendency towards normalization of the valve and sinus size (Hutter et al. 2001) and (Houvels-Gurich et al. 2003). Mild neo-aortic insufficiency was developed within the first 6 months after the ASO in 5 (10%) of our patients, however it did not progress during a median follow-up period of 22 months.

Neopulmonary stenosis may occur in the subvalvular, valvular, or most commonly in the supra-valvular regions (Lupinetti et al. 1992). It has been suggested that materials other than autologous fresh pericardium perpetuate a higher incidence of late obstruction.
tion (Williams et al, 1997) and (Carrel et al, 1998). Neopulmonary stenosis in our series was solely observed at the supravalvular level with a prevalence of 6% (3 patients). Although one patient responded to percutaneous dilatation, the long-term fate of the pulmonary arteries remains uncertain and needs further evaluation. We do agree with Gandhi and colleagues, 2002 that more extensive mobilization of the distal pulmonary arteries and more generous pantaloon patches may have helped to ameliorate the occurrence of postoperative PS. In our population, the interval from the time of ASO to the time of reintervention for PS was 18 months, suggesting that follow-up is mandated to truly appreciate the magnitude of the problem as have been suggested by Spiegelberg and colleagues, 1995.

Although aortic arch obstruction is present in 5% to 9% of patients with d-TGA, it is much more frequent in the Taussig-Bing heart (DORV with sub-pulmonary VSD), occurring in more than 50% of these patients. These patients could be repaired in two stages, with the coarctation repaired through a left thoracotomy incision and the intracardiac malformation palliated with a PAB. This was followed several months or years later by debanding and ASO (Tchervenkov et al, 1995). In the current series, we have used the 2 stage approach in 4 (50%) patients having DORV/SP-VSD without mortality or morbidity.

The combination of atrioventricular discordance and ventriculoarterial discordance, termed congenitally corrected transposition of the great arteries (ccTGA). The ability of the morphologic right ventricle and the tricuspid valve to withstand a lifetime of exposure to systemic pressure largely determines the ultimate outcome of these patients. Progressive dysfunction of the morphologic right ventricle has been described in a substantial percentage of unoperated patients with ccTGA (Duncan et al 2003) as was the case in one patient in this series. Although the Senning operation seems outdated and is used only in exceptional cases to treat patients with TGA, increasing interest and experience is be-
ing gained with this procedure in patients with congenitally correct-
ed transposition as part of the double switch operation (Senning operation plus ASO). This operation reposition the morphologic LV in the systemic circulation, also referred to as the "anatomic re-
pair" of CCTGA, and is currently the treatment of choice for pa-
tients with this anomaly (Langley et al. 2003). Before double switch 
onoperation is attempted, the LV must be retrained through pulmo-
nary artery (PA) banding that is required to achieve adequate LV 
muscle mass (Imai et al, 2001). Proponents of the anatomic repair 
have demonstrated better results when the double switch is per-
formed before the age of 15 to 16 years (Imai et al, 2001). Results 
have been less satisfactory in old-
er patients, and in some instanc-
es, the LV is simply no longer trainable, leaving transplantation 
as the only salvage alternative. The results of this complex proce-
dure are good to excellent, with mortality rates ranging from 0% to 
15% (Imai et al, 2001) and (Lang-
ley et al, 2003). Our patient suc-
cessfully underwent the double 
switch operation, 6 months after 
being subjected to PA banding.

In conclusion, this study con-
irms that ASO has excellent early 
results and remains the operation 
of choice for treatment of various 
entities of transposition of great 
arteries. Mid-term follow-up is 
characterised by few problems on 
the coronary arteries, pulmonary 
arteries and the aortic valve. The 
freedom from sudden cardiac 
events and the harmonious 
growth of cardiac structures are 
encouraging regarding long-term 
prognosis.

References

Brown J., Park H. and Turren-
tine M. (2001) : Arterial switch 
onoperation: factors impacting survi-
val in the current era. Ann Thorac 

Carrel T., Mattila I., Pfamm-
matter J. and Leijala M. (1998) : 
Direct reconstruction of the pul-
monary artery during the arterial 
switch operation: an interesting 
surgical option with excellent he-
modynamic results. Ann Thorac 
Surg ;65: 1115-1119.

Conte S., Jacobsen J., Jensen


