Bidirectional glenn shunt without cardiopulmonary bypass
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Abstract
Background: Various methods have been described for fashioning of the superior bidirectional cardiopulmonary shunt. We herein present our early experience for performing this procedure without cardiopulmonary bypass in some patients. Patients and methods: From January 2004 to December 2006, 46 patients with single ventricle anomaly with pulmonary stenosis underwent bidirectional glenn (BDG) shunt without cardiopulmonary bypass. All patients underwent BDG without CPB and by using temporary venoatrial shunt. Results: The outcome was favorable with mean systematic oxygen saturation increased from 68.85±2.58% to 87.35±1.69%. Mean SVC clamp was 15.92±1.97 minutes (range from 14 to 20 minutes). There was no observable clinical neurological deficit after operation with no postoperative mortality and smooth postoperative course. Conclusion: The use of a temporary extra cardiac venoatrial shunt when performing BDG without CPB is safe, offers better results by avoiding the problem of CPB, easily reproducible and recommended in selected patients' population.

Introduction
BDG is the first surgery for palliation for patients with single ventricle physiology. Various techniques have been described for performing this cavopulmonary anastomosis with or without the use of CPB.

Material & methods
From January 2004 to December 2006, 46 children with single ventricle and pulmonary stenosis anomaly underwent a BDG shunt without CPB or with temporary venoatrial shunt.

The criteria to select patients for BDG without CPB were- mean pulmonary artery pressure≤15 mm Hg, good ventricular function, no AV valve regurgitation. Unrestrictive AV valve regurgitation, unrestrictive atrial septal defect (ASD), and no restrictive pulmonary arterial architecture. The preoperative, operative and postoperative details for the patients are shown in table 1.

Procedure
A median sternotomy was performed in all patients. The thymus gland was removed completely and pericardium was opened. The right and left superior vena cavae (if present) were dissected and mobilized up to the inominate vein. Also the right and left pulmonary arteries were dissected and mobilized. PDA was dissected and looped. Azygos vein was doubly ligated and divided.
After systemic heparinization (2mg/kg) a veno venous (veno atrial) shunt was established between distal SVC and inominate vein and the right atrium using two right angled metal tipped cannulae after de airing the circuit. After establishing the shunt, the cannulae were placed parallel to the patient for better drainage without rising them above the patient body level.

At this stage, BDG was performed as usual where the SVC was clamped and divided just above the cardiac end. The proximal end of the divided SVC was over sewn with 6-0 prolene suture. The right pulmonary artery was partially occluded with large c-shaped Cooley vascular clamp and opened at its superior aspect. The distal end of the SVC was anastomosed end-to-side to the right pulmonary artery incision using prolene suture creating a very wide anastomosis as much as possible.

After establishing the shunt, the clamps were removed. PDA was ligated and the temporary veno venous shunt was disconnected and general homeostasis achieved. During the entire procedure, the patient's head was elevated to minimize the brain congestion by more venous drainage.

Results
46 patients with single ventricle with PS underwent BDG without CPB. The age ranged from 1 to 15 years. There were no operation mortalities, oxygen saturation improved to mean of 87.35±1.69%, the mean cross clamping time was 15.92±1.97 minutes and the mean postoperative mechanical ventilation was 2.06±2.1 hours. Two patients developed right sided pleural effusion and one patient developed chylothorax. Those 3 patients were managed conservatively with chest drain insertion, diuretics and fat free diet and discharged free with clear chest X ray.

<p>| Table 2: shows preoperative diagnosis, previous operation and complication |
|--------------------------|--------------------------|--------------------------|-------------------------|</p>
<table>
<thead>
<tr>
<th>No. of patients</th>
<th>Preoperative diagnosis</th>
<th>Previous operation</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>TA,ASD,VSD,PS</td>
<td>MBT(3 patients)</td>
<td>Right sided chylothorax (1 patient)</td>
</tr>
<tr>
<td>2</td>
<td>PA,VSD</td>
<td></td>
<td>Pleural effusion (2 patients)</td>
</tr>
<tr>
<td>5</td>
<td>TGA,VSD,PS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>DORV,PS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>DILV,VSD,PS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Single ventricle</td>
<td></td>
<td></td>
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</tbody>
</table>

Discussion
William W.L. Glenn a professor of surgery at Yale University first reported the clinical application of this concept in 19581,3. The Glenn shunt and its modification have become the mainstay of first stage palliation for patients with single ventricle pulmonary stenosis physiology3. BDG may be performed as an interim step in the partway to Fontan type circulation, as part 1 to 1.5 ventricle repaired and some times to reduce right ventricular volume overload3.

When first performed, CPB was an essential part of the procedure in 1990. Lambarti and associates reported new technique of preforming BDG without CPB by establishing temporary veno atrial shunt between SVC and right atrium to decompress the systemic hypertension during clamping the SVC.

For the best outcome of glenn flow, the proper alignment of SVC and RPA is the key factor since venous pressure head is the only factor that maintains the glenn circuit. The slightest variation in the alignment while performing anastomosis can lead to loss of laminer flow3.
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We have followed up the patients for 2 months to 24 months and have found no instance of pulmonary arteriovenous fistula or increased incidence of pleural effusion.

Bidirectional cavopulmonary shunt procedure remains an attractive option in these patients which, besides palliating them to a large extent, also reduces the cost and an option of a BT shunt.

Further, a cavopulmonary shunt reduces the morbidity and possible mortality of an acute blockage of a modified BT shunt, as it is a more dependable shunt with native tissue to tissue anastomosis capable of grouping with the child. May be this and the reduced cost, will make this shunt more attractive in children, particularly for surgeons practicing in the developing world.

The bi-directional cavo-pulmonary shunt was first performed in 1966.

In contrast to our veno-venous temporary shunt, Murthy et al reported a different temporary bypass shunt which is a veno-arterial shunt between the SVC or innominate vein and the main pulmonary artery using two venous metal cannulae and closed circuit toward pulmonary artery branch on the opposite side of the BDG. They believe that this shunt not only decompress the venous blood during the SVC clamping but it also improves the pulmonary blood flow thereby increasing the oxygen saturation during the procedure.

Conclusion
Performing the superior BDG for single ventricle patients without cardiopulmonary bypass by using temporary extracardiac venovenous shunt is safe and offers good results and better brain protection during SVC clamping and avoids the problem of cardiopulmonary bypass.

Reference