THE USE OF BOVINE JUGULAR VEIN IN THE FONTAN CIRCULATION

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ABSTRACT

Objective: To report our experience in the use of bovine jugular vein (Contegra) in the completion of single ventricle repair.

Methods: This is a prospective study on a selective group of single ventricle patients who underwent total cavopulmonary connection at Queen Alia Heart Institute between July 2002 and April 2003. All patients had cardiac catheterization preoperatively. Pressure measurements were taken at different points before and after the procedure. All patients had an extracardiac connection on cardiopulmonary bypass without cross clamp and anticoagulated using heparin infusion postoperatively for at least 5 days.

Results: Five patients were enrolled in the study (2-5 years of age), chest tubes drainage were minimal. Hospital stay was between 1-2 weeks. There were no evidence of conduit thrombosis, arrhythmias or mortality at three months of follow up.

Conclusion: Contegra is a safe extracardiac conduit for the completion of single ventricle repair in selected group of patients. Its use is time sparing intraoperatively and decreases hospital stay and morbidity postoperatively. However, its use in a wider range of complex single ventricle patients needs to be evaluated.

Key words: Fontan procedure, Contegra, Single ventricle

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Introduction

The Bovine jugular vein graft (Contegra; Medtronic, Inc. Minneapolis, Minn) is frequently used as an alternative in the reconstruction of the right ventricular outflow tract (RVOT) (1-3) in a large number of congenital heart disease eg: Truncus arteriosus (TA), tetralogy of Fallot (TOF), pulmonary atresia (PA).......etc. Also it has been recommended as a substitute for pulmonary artery in Ross operation (autotransplantation of the pulmonary valve in the aortic position) (4,5). The progressively reduced availability of homograft within the past few years and the continuous research for an ideal valved conduit promoted us to search for alternative options. The contra conduit is a new biologic valved conduit consisting of a zero-pressure glutaraldehyde-preserved heterologous bovine jugular vein having trileaflet venous valve (Fig. 1).

In our study we implanted this valved conduit in 5 patients as an extracardiac connection in fontan circuit between the inferior vena cava and pulmonary artery around the curvature of the right atrium.

Methods

This study was conducted on a selected group of patients between July 2002 to April 2003 having physiology of single ventricle and planned for total cavopulmonary connection. Preoperative information includes history in particular age > 2 years, previous operations (None, BTS or Bidirectional Glenn) and Physical examination, Laboratory tests: (complete blood count, prothrombin time, partial thromboplastin time and liver function tests). Cardiac catheterization to

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show the size of the pulmonary arteries, pulmonary artery pressure and status of the systemic AV-valve and systemic ventricle. Intraoperative pressure measurements were of the pulmonary arteries before and after the procedure, CVP and the conduit pressure above and below the valve. Cardiopulmonary bypass without cross clamp was also estimated. Postoperatively all patients were anticoagulated using Heparin infusion 10-20 IU/kg/hr controlled by the PTFE being between 1.5-2 folds for 5 days and Salicylic 5 mg/kg started from the second day postoperatively. Time of stay in the ICU and hospital were estimated. Postoperative complications were recorded including period/amount of chest tubes drainage, clotting of the conduit, liver congestion and arrhythmias using frequent CXRs, EKG and 2 D echo

Results

Five patients were enrolled in the study, age between 2-5 years with the mean of 3.1 years with male: female ratio 4:1. Details about their diseases and previous operations were summarized in Table I. The preoperative pulmonary artery pressure (PAP) were between 14-18 mmHg excluding patient number three where the PAP was not reported because it was not feasible during cardiac catheterization to measure it (Fig. 2). Intraoperative PAP was recorded before and after the occlusion of the main pulmonary artery blood flow (PABF) and were found between 13-18 mmHg before the closure of PABF and between 7-16 mmHg after the occlusion of the PABF. Central venous pressures (CVP) were between 13-17 and conduit pressure between 13-17 above the valve of the conduit and between 12-14 below valve (Fig. 3). Chest tube drainage has dropped steeply between the days three and five then continued to dry out gradually over one week (Fig. 4). Pump time was between 1.5-2.5 hours, intensive care unit (ICU) stay were 2 days except for patient 3 stayed for another extra day and a maximum hospital stay was 16 days.

No mortality was reported in this study after a follow up ranging between 3-12 months.

No evidence of graft thrombosis or liver congestion. No arrhythmias reported after this short-term follow-up.

Table I. Distribution of the studied patients related diseases and preoperative operations

<table>
<thead>
<tr>
<th>Patients No.</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Original Diagnosis</th>
<th>Previous Surgery</th>
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<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Male</td>
<td>TA*, NRGV**</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Female</td>
<td>TA*, PS^, NRGV**</td>
<td>Rt^ BTS^</td>
</tr>
<tr>
<td>3</td>
<td>2.5</td>
<td>Male</td>
<td>PA^, IVS^</td>
<td>Rt^ BTS^</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Male</td>
<td>TA*, NRGV**</td>
<td>Bidirectional Glenn</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Male</td>
<td>DORV^, Small LV^, PS^</td>
<td>None</td>
</tr>
</tbody>
</table>

*TA: Truncus arteriosus ^PS: Pulmonary stenosis
**NRGV: Normally related great vessels
^IVS: Intact ventricular septum ^LV: Left ventricle
^DORV: Double outlet right ventricle
^Rt: Right ^BTS: Blalock Taussig Shunt

Table II. The distribution of Pump time, ICU* stay and hospital stay among the patients

<table>
<thead>
<tr>
<th>Patients No.</th>
<th>Age (years)</th>
<th>Pump time (hours)</th>
<th>ICU* stay (days)</th>
<th>Hospital stay (days)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>16</td>
</tr>
</tbody>
</table>

*ICU: Intensive care unit

Discussion

The final stage of palliating the single ventricle patients is fontan procedure by which the systemic venous blood is diverted passively to the pulmonary arteries bypassing the small systemic venous chamber. Since its application till recently a lot of modifications had been done trying to keep the fontan circuit live longer with lower complications. The upper part of the circuit (diversion of the superior vena cava blood to the right pulmonary artery) remained almost constant with little modifications (bidirectional Glenn or hemifontan) if compared with the lower part of the circuit (diverting the blood from the inferior vena cava to pulmonary arteries) that had undergone a lot of modification (6,7). The most recent of which is the use extracardiac PTFE tube connecting the IVC to the pulmonary arteries in an attempt to avoid aortic cross clamping, cardiopulmonary bypass (CPB) and atrial arrhythmias (8).

In our study, we used a valved conduit trying to avoid further complications including liver dysfunction, chest tube drainage, ICU and hospital stay and, if possible, (in the future) the protein loosing enteropathy.

Although, the number of selected cases in this study was small (five cases) still important information was obtained. Before going into further details, it is important to talk about this valved conduit and its specifications.

Contegra bioprosthesis consists of heterologous bovine jugular vein having a totally integrated trileaflet venous valve with natural sinuses slightly larger in diameter than its lumen. It is preserved in buffered glutaraldehyde in a concentration low enough to preserve the flexibility of the leaflet material. It is available in both supported and unsupported models with wide range of sizes (12-22 mm), no thawing is required but rinsing, sufficient length is made available at both the inflow and out flow to facilitate surgical reconstruction, it easily bends, easy to cut and shape and the wall retains sutures that support the hemostatic suture lines (Fig. 1).

Liver function test showed trivial to mild dysfunction (mild elevation of liver enzymes) that might be either due to relatively low pulmonary artery pressure (PAP or protective function of the valve in case sudden rise of PAP has occurred for several reasons (crying, high pressure on the ventilator or during suctioning of the endotracheal tube while the patient is awake….etc), data
obtained from intraoperative pressure measurement above and below the valve showed that the valve holds some pressure (except patient number three) albeit small pressure difference while the patient under general anesthesia but it seems to be of help when the patient wakes up and gets extubated (Fig. 3).

Although, the mechanism behind chest tube drainage is still not well understood, but PAP plays an important role in its continuous production. All patients in the study had their azygous vein left patent and we believe that any time PAP rises, the blood finds its way through it (the azygous vein) to the thoracic venous plexus and thence to the portal system that is already protected by the valved conduit, this mechanism may take some pressure of the pulmonary artery and may explain the rapid drying out of the chest tubes in our study.

The average pump time were two hours and this is because three of our patients had previous surgeries that would make it more difficult to dissect during the 2nd procedure due to the adhesions around the heart. Chest tube drainage is usually prolonged among patients undergoing Fontan procedure but it dried out faster among our patients probably because they are selected. The ICU and hospital stay were dependent mainly on the patient’s chest tube drainage.

The conclusion is justified by the study since our aim was to see if a valved extracardiac conduit of help interim of liver function test and future protein losing enteropathy. The conclusion was based on five patients since Contegra is costly and not used in every case if not selected from the beginning.

**Fig. 1.** The trileaflet venous valve in the glutaraldehyde-preserved bovine jugular vein (the U shape on the shaft of the graft shows the direction of the flow).

**Fig. 2.** Intraoperative pressure measurements including the central venous pressure (CVP), graft pressure above and below the valve.
Fig. 3. The preoperative pulmonary artery pressure (PAP) measured in the catheterization Lab.

Fig. 4. The pattern of chest tube drainage in all patients over 16 days in the hospital

References


