
A NEW SURGICAL APPROACH: TOTAL CAVOPULMONARY ANASTOMOSIS IN SINGLE VENTRICLE

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The total cavopulmonary anastomosis has been advocated as a preferred method for Fontan type repair. In a patient with a single ventricle, wide rim ostium primum atrial septal defect, and a infundibular pulmonary stenosis, total cavopulmonary anastomosis was performed with a new surgical approach. Vena cava inferior was inlayed into the left atrium and the tunnel was formed using a pericardial patch, which ended at the interior orifice of the left atrial appendage. Left atrial appendage was then anastomosed to the main pulmonary artery. Then, vena cava superior was anastomosed to the right pulmonary artery. The patient is performing quite well with minimal medication and diet.

Key words: Total cavopulmonary anastomosis, single ventricle, Fontan procedure

Total cavopulmonary connection is an effective modification of the Fontan procedure that can be performed with relative technical ease. It can be used to treat a number of congenital heart defects characterized functionally by a single ventricle, and it is of particular use in patients with complex congenital anomalies, including pulmonary atresia, and intact ventricular septum with RV-coronary connections.

A CASE REPORT

A 16 year old male caucasian patient was admitted to the hospital because of exertional dyspnea, central cyanosis and digital clubbing. Physical examination revealed a regular pulse rate of 80 beats/min and an arterial blood pressure of 110/70 mmHg, with central cyanosis. Heart sounds were rhythmic, a 3/6° precordial systolic murmur was heard by auscultation. The ECG showed right axis deviation and right ventricular (RV) hypertrophy. A normal cardio thoracic index and a prominent pulmonary conus and situs inversus was seen on the chest radiograph. Combined two dimensional and Doppler echocardiography revealed a single ventricle, ostium primum atrial septal defect, a common atrioventricular valve, and a pulmonary infundibular stenosis



Figure 1: Preoperative echocardiography

(Figure 1) with a peak systolic gradient of 100 mmHg.

A right and left heart catheterization with ventricular cineangiography and oxygen saturation studies (Fig 2) revealed single ventricle, a wide ASD and infundibular pulmonary stenosis.

OPERATIVE TECHNIQUE

Standart bypass techniques were performed with a median sternotomy. Arterial cannulation was made from the ascending aorta. Double venous cannulation was made near the innominate vein and immediately above the diaphragm. The pulmonary artery and its branches were mobilized, superior vena cava was freed from its pericardial attachment up to its junction with the innominate vein. Moderate systemic hypothermia was applied to 26° Celsius. Myocardial arrest and protection was provided with ante-

grade cold crystalloid (St Thomas II) and intermittent blood cardioplegia. Reperfusion was obtained by cardioplegic warm blood infusion before declamping. The heart was entered with a right atrial incision. Inspection of the heart revealed a single ventricle, common A-V valve, a wide rim ASD, an infundibular pulmonary stenosis. There was right atrial juxtaposition. The inferior vena cava entered to the base of the left atrium. A tunnel was created using a glutaraldehyt treated pericardial patch between inferior caval entry into the left atrium and the left atrial appendage. The main pulmonary artery was transected and its proximal end was ligated. The distal end was anastomosed to the left atrial appendix. The superior vena cava was clamped 5-8 mm above the cavoatrial junction and the vessel was transected. The cephalad end of the superior vena cava was then anastomosed end to side to the superior aspect of the right pulmonary artery (Fig. 3). The right atrial incision was closed. The patient was weaned



Figure 2: Preoperative heart catheterization

from cardiopulmonary bypass in standart techniques. Total perfusion time lasted 166 minutes and aortic cross-clamp time period 125 minutes. Mild inotropic support was necessary before transferring the patient to the intensive care unit. Inotropic support was contiuned up to the 8 th. postoperative day.

Postoperative management and follow up

Bilateral serous pleural effusions that required tube drainage developed during the first postoperative month. Control X-ray revealed left pleural thickening at the left hemithorax(Figure 4). On auscultation respiratory sounds were slight over this area. There were no rhythm disturbances during the post operative period.

Postoperative control echocardiography, and right heart catheterization was performed on the third month (Figure 5,6). These studies revealed no obstruction of the cavopulmonary flow. The patient is performing pretty well, with minimal symptoms for 12 months. Minimal hepatomegaly and pretibial edema responds quite well to diuretics and a low salt diet.

DISCUSSION

Few surgical procedures have been more thoroughly investigated experimentally and clinically than the cavopulmonary anastomosis.¹ Most of the clinical data available relate to end to end superior vena cava-right pulmonary artery anastomosis.² Halle and colleagues³ studied the feasibility of anastomosing the superior vena cava end to side to the pulmonary artery, and thus diverting the superior vena caval blood into both lungs (bidirectional cavopulmonary anastomosis) This operation has been applied clinically as an isolated palliative procedure or in conjunction with the Fontan procedure.⁴⁻⁶ Experimental anostomosis of the inferior vena cava to the right pulmonary artery in dogs proved to be compatible with survival, although massive ascites was a major problem⁷. Several attempts experimentally to connect both the superior and inferior venae cavae to the pulmonary artery were made, but all failed^{7,8}. Succesful total cavopulmonary shunt operations were more recently reported in patients with azygos or hemiazygos continuation of the inferior vena cava.^{9,10}. Despite their "total cavo-

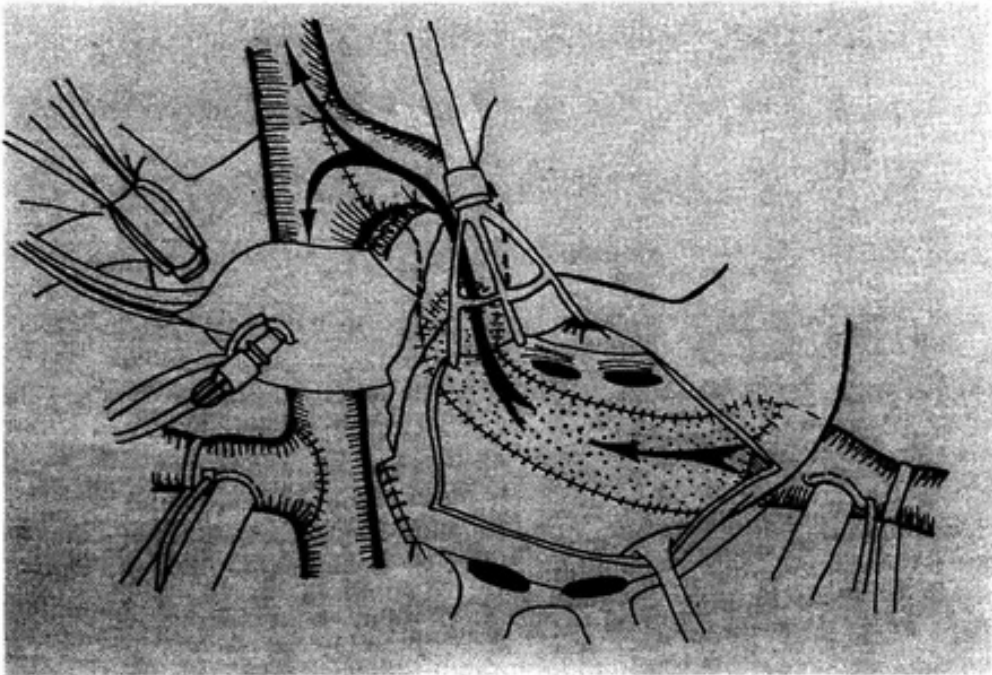
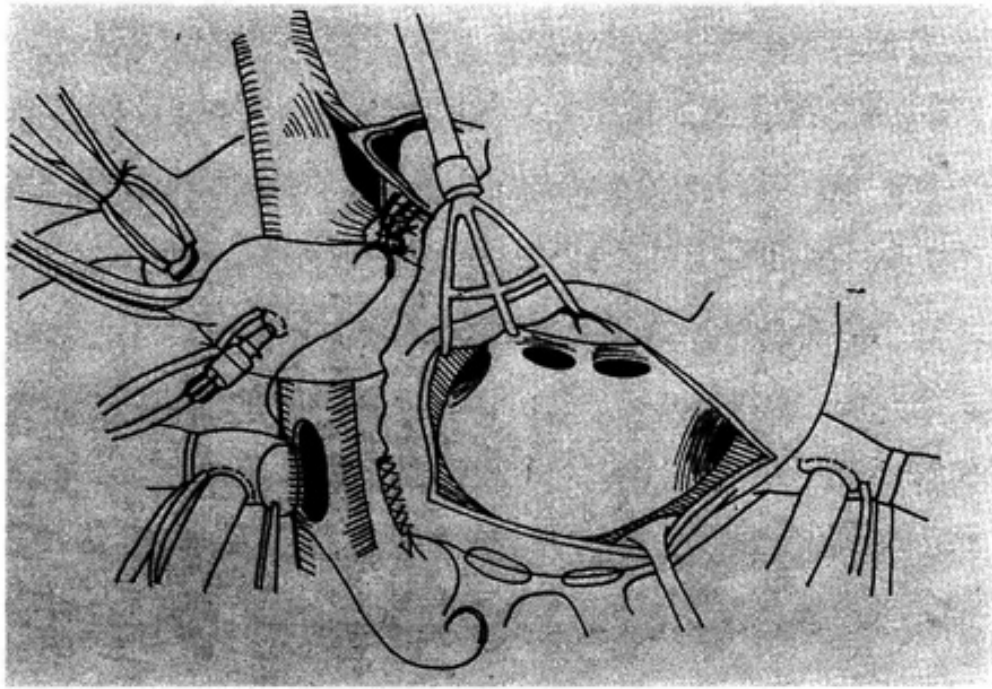


Figure 3 A, B: Surgical technique of total cavopulmonary anastomosis in a single ventricle.

pulmonary shunt", the total systemic venous return of these patients was not diverted to the lungs because of the recycling splanchnic venous¹¹. The Mayo Clinic group has reported on a series of patients with anomalies of pulmonary and systemic venous return, in whom channeling of inferior vena caval blood to the pulmo-

nary arteries was achieved by means of an intraatrial conduit.¹² For patients with left atrioventricular valve atresia or single atrioventricular valve, Puga, Chlavarelli, and Hagler¹³ described a technique of right atrial septation that does not interfere with the pulmonary venous drainage into the right or common atrio-

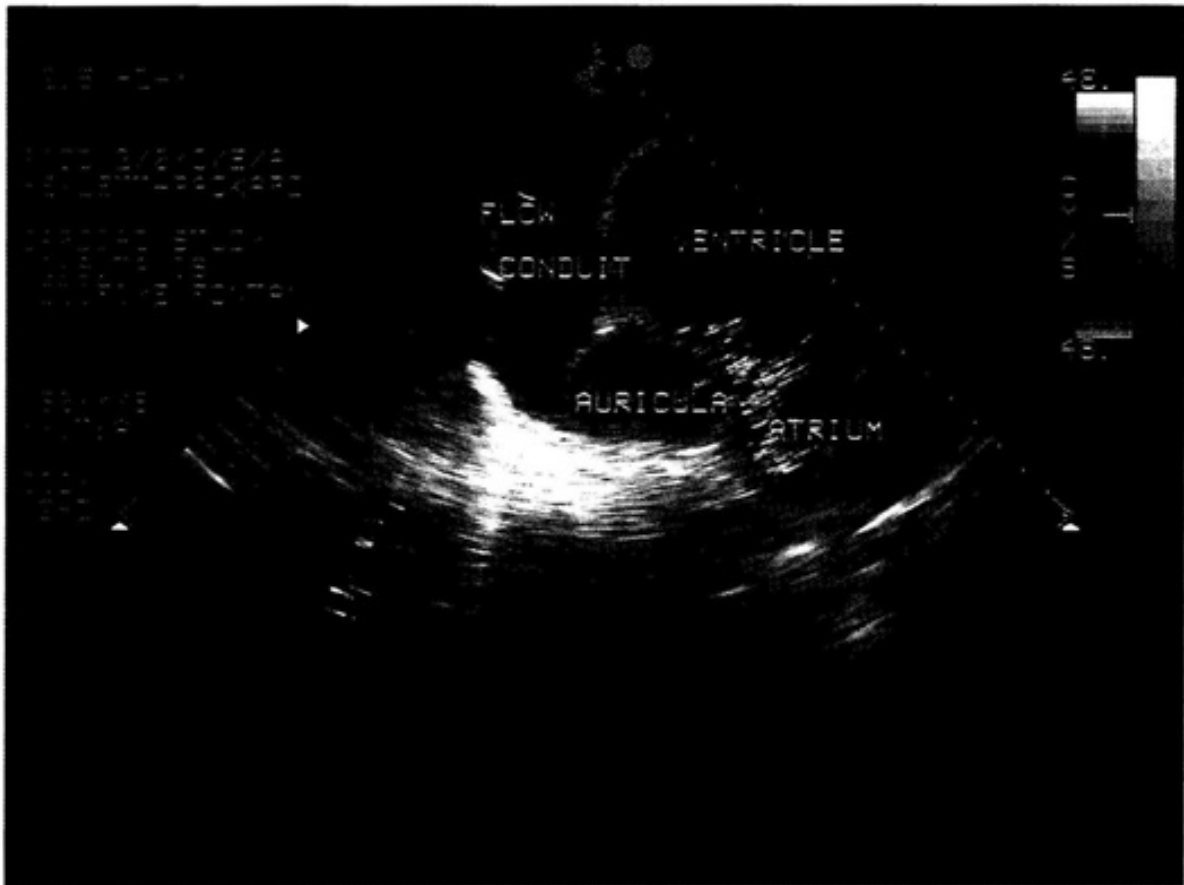


Figure 4: Postoperative control echocardiography

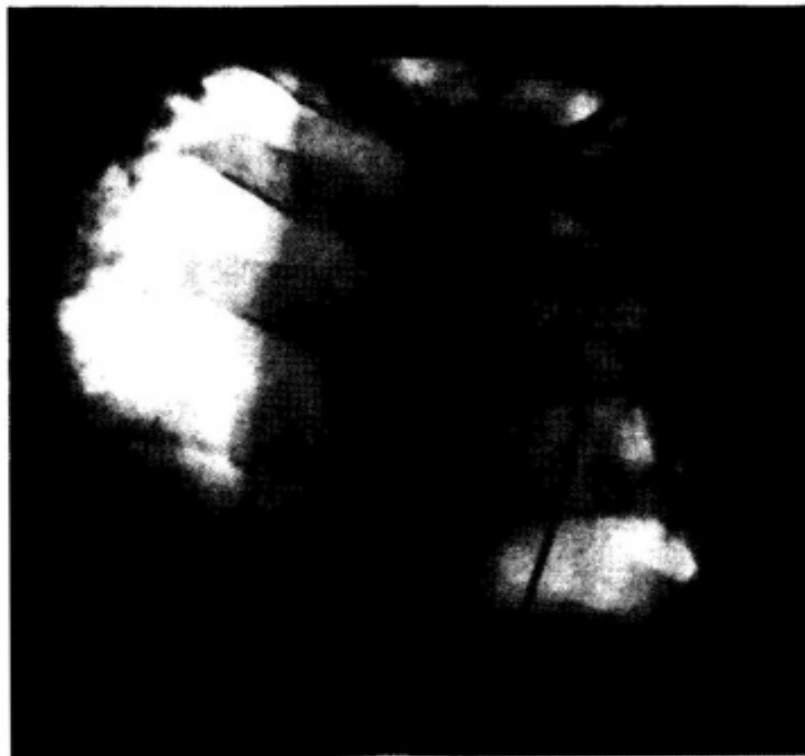


Figure 5: Postoperative pulmonary artery catheterization

ventricular valve. This technique also includes a bidirectional cavapulmonary anastomosis and an anastomosis of the cardiac end of the superior vena cava to the right pulmonary artery. Concurrent work by De Leval and associates¹⁴ demonstrated that the right atrial contraction was not necessary for pulmonary blood flow. Based on these experimental observations, De Leval and co-workers described the total cavapulmonary connection, lateral tunnel Fontan. Total cavapulmonary connections have the following advantages:

- 1) The procedure is technically simple and reproducible in any atrioventricular arrangement, and is away from the atrioventricular node;
- 2) Most of the right atrial chamber remains at low pressure, which reduce the risk of early or late arrhythmias;
- 3) Reduction of turbulence prevents energy losses and should minimize the risk of atrial thrombosis;
- 4) Postoperative cardiac catheterisation performs in these patients confirmed these favorable flow patterns with minimal gradients throughout the connection.

Pearl and et al¹⁵ compared results of total cavapulmonary anastomosis with conventional modified Fontan procedure. Patients undergoing a lateral tunnel Fontan operation have fewer late atrial arrhythmias, fewer late pacemaker placements, and a lower late mortality rate. Atrial arrhythmias are common late after Fontan operations.¹⁴⁻¹⁷

It has been experienced that a total cavapulmonary anastomosis using left atrial wall seems simpler, and carries less operative risk than the conventional modified Fontan procedure in treatment of complex heart diseases.

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