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Original Article

Surgical experience with the modified Blalock-Taussig shunt: what we might learn from mathematical and laboratory studies?

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Clinical experience in the treatment of patients with functionally univentricular hearts has shown the Fontan operation to be much less than a perfect therapy. Even in ideal patients,[1] acquired elevation of the venous pressures in the systemic circulation, especially in the regions drained by the inferior caval vein, is only a matter of time. For this reason the treatment of this complex form of congenital heart disease is still the object of active scientific debate, as well as considerable ongoing medical and basic research.

In this review, we describe our philosophy of treatment for patients having a functionally univentricular heart, with a particular insight in the use of the modified Blalock-Taussig shunt as the initial palliation. The surgical flow chart for the treatment of such patients includes three steps:

- Initial palliation, either by construction of the modified Blalock-Taussig shunt or by banding of the pulmonary trunk, or watchful waiting in those patients with balanced circulations.
- Intermediate palliation by construction of a bidirectional cavopulmonary anastomosis between 3 months and 1 year of age.
- Completion of the total cavopulmonary connection at the age of 2 to 3 years, or when dictated by the clinical evolution.

At the time of construction of the bidirectional cavopulmonary anastomosis, two choices are possible:

- Close all other sources providing flow of blood to the lungs.
- Leave an additional source, such as the modified Blalock-Taussig shunt, the banded pulmonary trunk, or the native pulmonary trunk protected by a stenotic valve.

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Initial palliation

When initial palliation is achieved by construction of a Blalock-Taussig shunt, we prefer to construct the shunt on the left side, between the left subclavian artery and the left pulmonary artery.

The advantages of this choice are:

- It leaves the right pulmonary artery anatomically intact for future incorporation in the bidirectional cavopulmonary anastomosis.
- The bidirectional cavopulmonary anastomosis will be performed through a previously undamaged sternum, usually utilizing simple venovenous bypass between the brachiocephalic vein and the right atrium, without the need to use cardiopulmonary bypass.

There are, of course, some special situations in which it is necessary to construct the shunt through a median sternotomy. Examples are unstable patients that do not even tolerate the thoracotomy position, babies with very low weight, below 2 kilograms, and patients needing associated procedures, such as correction of totally anomalous pulmonary venous connection, widening of a restrictive atrial septal defect, and so on.

The size of the modified Blalock-Taussig shunt

The other contributions to this supplement have emphasized the practical and theoretical importance

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of the size, length, and position of the shunt, along with its angle of implantation into the pulmonary arteries, in modifying the pathophysiology of the functionally univentricular circulation. In our clinical practice, we employ a 4-millimeter Gore-Tex tube in all neonates, except for those weighing less than 2.5 kilograms, in whom we insert a tube of 3.5 millimeters. The 4-millimeter tube is usually well adapted to the caliber of the vessels in the neonate, it does not increase the pulmonary arterial pressure and resistances, and maintains a good saturation of oxygen until the second step of palliation is performed at the age of 3 to 12 months.

Intermediate palliation

When constructing the bidirectional cavopulmonary anastomosis, our policy is to leave open an additional source of pulmonary flow, such as the modified Blalock-Taussig shunt.[2–5] The additional flow prolongs the efficacy of the bidirectional cavopulmonary anastomosis, thus postponing the indication for completion of the total cavopulmonary anastomosis. Furthermore, the additional source of flow maintains a passage for hepatic blood to reach the lungs, possibly inhibiting the formation of arteriovenous fistulas by supplying the presumed hepatic labile factor. The additional flow, when antegrade as in the setting of native pulmonary stenosis, can ameliorate the distribution of flow between the lungs. It also maintains pulsatility, thus providing a more physiologic circulation to the lungs.[4] The main drawback of the additional flow is the volume overload imposed on the functionally single ventricle, even if this is partly neutralized by construction of the bidirectional cavopulmonary anastomosis.

Completion of the Fontan circulation

As stated previously, the Fontan operation is less than a perfect solution for the definitive surgical treatment of patients with functionally univentricular hearts. The high inferior caval venous pressure, typical of the Fontan circulation, is responsible for the appearance of altered hepatic and intestinal function. In our practise, therefore, by offering the intermediate palliation of the bidirectional cavopulmonary anastomosis with an additional source of pulmonary supply, we try to provide satisfactory and long-term clinical stability with normal inferior caval venous pressure.[6,7] We delay completion of the Fontan circuit until dictated by the clinical evolution of the individual patient, assessed on the basis of saturations, ventricular function, and so on.

Conclusion

In the specific case of the patient with a functionally univentricular heart needing construction of a modified Blalock-Taussig shunt as initial palliation, we prefer, when possible, to perform a left-sided shunt, because it leaves the right pulmonary artery intact for use in the future bidirectional cavopulmonary anastomosis. The bidirectional anastomosis is constructed at 3 to 12 months of age, through a median sternotomy and without cardiopulmonary bypass, but with a simple temporary veno-venous bypass under systemic heparinization. At the time of the bidirectional cavopulmonary anastomosis, we leave in place an additional source of pulmonary supply, thus prolonging the clinical efficacy of intermediate surgical palliation. The extracardiac conduit used to complete the Fontan circuit is not uniformly presented as a staged procedure at 2 to 3 years of age in all patients, but is constructed according to the clinical evolution and saturation of the patient, thus hoping to delay the systemic venous hypertension responsible for renal, hepatic, and intestinal dysfunction.

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