

SURGERY FOR CONGENITAL HEART DISEASE

EDITORIAL: INTRACARDIAC THROMBUS AFTER THE FONTAN PROCEDURE

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In this edition of the *JOURNAL*, Rosenthal and associates¹ have highlighted the important problem of thrombus formation within the stump of the pulmonary artery after its distal ligation or division as part of a Fontan or Glenn operation. This report adds further evidence that numerous potential sources of thromboemboli are present after the Fontan operation and raises the question of the need for routine anticoagulation in such patients. The report also emphasizes potential technical modifications that may reduce the risk of thromboembolism after a Fontan operation.

In a study of cerebrovascular accidents after the Fontan operation, du Plessis and colleagues² described a 2.6% incidence of stroke among 645 patients who underwent the Fontan procedure at Children's Hospital, Boston, over the 15-year period between 1978 and 1993. Sixteen of the 17 affected patients underwent echocardiography at the time of the stroke. Seven patients were found to have intracardiac thrombus that in every case was in a position to generate emboli into the systemic circulation. Thrombus was located in the main pulmonary artery stump in three patients, on a fenestrated right atrial baffle or lateral tunnel in three patients, and on the anterior mitral leaflet in one patient. In two patients, intracardiac thrombus was evident in more than one location.

Factors that may predispose to the development of intracardiac thrombi include low cardiac output, particularly when the design of the operation has created areas within the heart that are prone to stasis, such as the stump of the main pulmonary artery or a large right atrium after a traditional atriopulmonary anastomosis. Atrial arrhythmias such as atrial flutter and fibrillation may further predispose to thrombus forma-

tion. Synthetic material such as a large polytetrafluoroethylene (PTFE) baffle may also be a nidus for thrombus formation. This is particularly true if inappropriate synthetic material* is used, which has an outer wrap on its adventitial surface. This wrap is not designed for blood contact and is probably thrombogenic. It is important that PTFE material that does not have this thrombogenic outer wrap be used for baffle construction. PTFE cardiovascular patch material, for example, is designed for blood contact on both surfaces.

The presence of a fenestration must be an additional risk factor for thromboembolism in the form of paradoxical embolus. Although this did not prove to be a significant risk factor in the study by du Plessis and colleagues, a clear trend in this direction was noted, with a 4.3% incidence of stroke in the patients with a fenestration versus a 0.95% incidence in the group without a fenestration ($p = 0.2$). However, it is important to remember that over the time frame reviewed, patients who underwent a fenestration procedure tended to have more risk factors than those who did not have a fenestration.

Rosenthal and coworkers have recommended patch closure of the pulmonary artery stump or primary closure at the level of the pulmonic valve rather than (or in addition to) ligation of the distal pulmonary artery. Since the report by du Plessis and associates of thrombus in the pulmonary artery stump, the practice at Children's Hospital, Boston, has been to combine excision of the pulmonary valve leaflets or oversewing of the pulmonary valve with division and oversewing of the pulmonary artery stump. Great care must be taken to avoid injury to the left main coronary artery if the pulmonary valve and the pulmonary artery stump are oversewn very proximally. Furthermore, there is serious concern that after the pulmonary valve is excised or eliminated in any other way, this valve may be needed at

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a later time if an important gradient should develop between the single ventricle and aorta related to a restrictive bulboventricular foramen or other cause of subaortic stenosis. Under such circumstances, a Damus-Kaye-Stansel anastomosis between the pulmonary artery stump and aorta might have solved this problem. This dilemma emphasizes the importance of early accurate prediction of subsequent subaortic stenosis or restrictive bulboventricular foramen in the setting of single ventricle.

The question of routine anticoagulation of all patients after a Fontan procedure needs to be clarified by a careful prospective study. Currently the empiric practice at Boston Children's Hospital is to prescribe anticoagulants for patients who are considered to be at higher risk, namely, those undergoing a prolonged hospitalization related to persistent pleural effusions (a rare occurrence in the current setting of routine fenestrated Fontan proce-

dures) or patients who exhibit evidence of chronically raised right atrial pressure or chronic borderline cardiac output. The report by Rosenthal and colleagues emphasizes that all patients require careful long-term follow-up after the Fontan procedure, with regular echocardiography to exclude development of intracardiac thrombus. Only in this way will the incidence of the potentially devastating complication of cerebrovascular accident after the Fontan procedure be minimized.

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