Interatrial septostomy under transesophageal echocardiography guidance: A novel approach

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Interatrial septectomy is performed as a palliative procedure to improve interatrial shunting and blood flow in patients with various congenital cardiac lesions, whenever an early definitive repair is not feasible. Interatrial shunting can be improved through interventional catheterization, either by balloon dilatation¹ of a patent foramen ovale (PFO) or by blade or biotome septectomy. These techniques have limitations such as problems with vascular access, requirement of a PFO, and variable success rates. The other alternative is a septectomy through a classic right atriotomy, which requires cardiac arrest and cardiopulmonary bypass (CPB). The use of CPB is associated with numerous adverse effects including myocardial, pulmonary, and renal dysfunction, neurologic injuries, coagulopathies, need for blood transfusions, and a generalized inflammatory response.

In the technique introduced here, we used transesophageal echocardiography (TEE) guidance to enable the surgical creation

of a septostomy by an aortic punch device (Scanlan International, Inc, St Paul, Minn) (Figure 1, A) that was introduced into the heart through the right atrium. The septostomy was performed without the need to arrest the heart, thus avoiding the complications of CPB.

Clinical Summary

Our patient was seen at 2 months of age with poor feeding, irritability, and cyanosis. She weighed 4 kg, had a heart rate of 115 to 160 beats/min, a blood pressure of 75-90/40-60 mm Hg, and a room air oxygen saturation of 60%. A grade 3/6 medium-pitched midsystolic murmur was auscultated best at the base of the heart. Initial workup showed D-transposition of the great arteries, 4 ventricular septal defects, an anomalous left superior vena cava, and a restrictive PFO with inadequate transatrial shunting. There was no patent ductus arteriosus.

Since definitive repair was not feasible, we decided to do an interventional septostomy in the catheterization laboratory. A variety of methods including a biotome, a balloon septostomy catheter, and a septectomy blade were used to enlarge the PFO. These methods only partly reduced the transatrial gradient, and the achieved improvement in shunting was short-lived and inadequate. Her arterial oxygen saturation dropped to preoperative levels the next day, and she was therefore taken to the operating room for a surgical septostomy and a pulmonary artery band.

After induction of general anesthesia, a pediatric biplane TEE probe (Acuson Corporation, Mountain View, Calif) was inserted. The initial TEE examination identified 2 separate atrial septal defects (ASDs) (Figure 1, B), both of which were small (2-3 mm) and had restrictive blood flow.

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Figure 1. A, The Scanlon aortic punch device. B, TEE examination showing 2 small separate ASDs. RV, Right ventricle.

Figure 2. A and B, Adequacy of interatrial shunting was confirmed by color flow and pulse wave Doppler sonography. RA, Right atrium; LA, left atrium; RV, right ventricle.

Through a median sternotomy, purse-string sutures were placed around the right atrial appendage. A 4-mm aortic punch device (Figure 1, *A* and *B*) was introduced toward the atrial septum through the atriotomy. Using the TEE guidance, the punch was positioned in the superior ASD and was used to excise tissue from the septum. This was repeated a few times until an adequate septal

defect (7.0 mm) was created and the oxygen saturations improved. Care was taken to avoid the annular structures and the back wall of the left atrium. Adequacy of interatrial shunting was confirmed immediately by color flow and pulse wave Doppler sonography (Figure 2, A and B). No surgical complications were noted on the TEE examination.

After the septostomy, the pulmonary artery, which had systemic pressures, was banded. Systemic arterial oxygen saturations were 88% with the patient breathing 100% inspired oxygen at the end of the procedure.

A postoperative transthoracic echocardiogram showed adequate transatrial left-to-right shunting, as did a follow-up catheterization at the age of 8 months.

Discussion

The initial method of creating ASDs to improve interatrial shunting (Blalock and Hanlon, 1950²) was performed without CPB. The major complications with this technique was arterial desaturation, hypotension, and hemorrhage into the right lung. The Rashkind-Miller balloon septectomy¹ described in 1966 has largely replaced the aforementioned procedure. A balloon-tipped catheter is introduced into the left atrium via the right atrium, the balloon is inflated, and the catheter is pulled back into the right atrium to enlarge an ASD. Other methods (see introduction) have also been used in the catheterization laboratory. However, in a significant number of patients, these techniques are not successful in creating an ASD large enough for maintaining adequate mixing. The other common approach is an open atrial septectomy through an atriotomy under CPB with cardioplegic arrest. The alternative to these conventional techniques is a septectomy in a beating heart without the use of CPB. Van Son and associates³ reported the use of an atriotomy knife to make a septectomy under TEE guidance. Simpson, Anderson, and Qureshi⁴ used a pediatric Brock punch and dilator to create an ASD in a 5-month-old infant in whom a prior blade septostomy had been complicated by tamponade.

For our procedure, however, we used an aortic punch device to resect septal tissue, under constant guidance of the TEE. This

device is commonly used to create aortotomies for coronary artery bypass grafting. Unlike a sharp surgical blade, the aortic punch device has a blunt tip and does not cut tissues until it is engaged. This may prevent any inadvertent damage to cardiac structures that may be caused by a misdirected surgical blade. The approach and the positioning of the blade or punch devices should be confirmed in both longitudinal and transverse views on the TEE. Our procedure was performed via median sternotomy mainly to facilitate the approach for pulmonary artery banding; otherwise, the septostomy procedure would have easily been possible through a right thoracotomy.

In summary, an adequate septostomy was created using an aortic punch device with the aid of TEE guidance. In patients in whom CPB may not be tolerated, this technique can be considered to create a palliative septostomy. As there is no direct surgical visualization, TEE is necessary to guide the resection, as well as to assess the results immediately. This procedure is short, well tolerated, and effective.

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