Transpulmonary Surgical Closure of Patent Ductus Arteriosus with Hypothermic Circulatory Arrest in an Adult Patient

Untreated patent ductus arteriosus carries a higher risk in adults than in children, especially when the defect is large (>4.0 mm in diameter), short, or friable. Therefore, various technical precautions have been suggested for application during surgical closure of a patent ductus arteriosus in an adult. We report the case of a 47-year-old woman with a patent ductus arteriosus who underwent transpulmonary surgical closure of the ductus under hypothermic total circulatory arrest. We discuss the technique in light of the current English-language medical literature. (Tex Heart Inst J 2005;32:88-90)

Surgical closure of untreated patent ductus arteriosus (PDA) carries a higher risk in adults than in children. The development of endocarditis, congestive heart failure, pulmonary hypertension with pulmonary vascular disease, aneurysm formation, and calcification may all complicate PDA in adults. In addition to simple ligation or division of the PDA through a left thoracotomy, various techniques have been suggested to improve safety during surgical closure of a PDA. We report the case of an adult in whom hypothermic total circulatory arrest (HTCA) was used during transpulmonary surgical closure of a PDA.

Case Report

In May 2000, a 47-year-old woman who had insulin-dependent diabetes mellitus was admitted with shortness of breath and a history of frequent upper-respiratory-tract infections. On auscultation, a continuous murmur was audible at the left upper border of the sternum. Transthoracic echocardiography revealed a PDA. Cardiac catheterization showed substantial blood flow into the pulmonary artery from the aorta (Fig. 1). The ratio of pulmonary blood flow-to-systemic flow...
Gross in 1938, various surgical techniques, including ligation and division technique, which can be performed safely and without recurrence in children, can be used. Open thoracotomy for the PDA usually leads to death. In 1968, Campbell reported that 20% of patients with untreated PDA died before they reached 30 years of age, and they had a 2.5% to 4% annual mortality rate between the 4th and 6th decades of life. Only 10% of patients with untreated PDAs lived beyond their 60s. In order to remedy this shortened life expectancy, surgical or interventional closure of the PDA should be considered except in cases of Eisenmenger syndrome.

Since the 1st successful surgical closure of a PDA by Gross in 1938, various surgical techniques, including ligation and division, simple ligation, and hemoclips application through a thoracotomy or even a sternotomy, have been used. Open thoracotomy for the PDA ligation and division technique, which can be performed safely and without recurrence in children, can be complicated in elderly patients by a fragile aortic wall due to atheromatous lesions, the presence of friable tissue at the surgical site, or calcification of the ductus. Therefore, surgical closure of PDAs in adults requires that certain technical precautions be taken, including the use of internal prosthetic shunts, CPB with transpulmonary Fogarty balloon occlusion of the ductus, or hypothermia with circulatory arrest.

More recently, preferred treatments have included video-assisted thoracoscopic surgery (VATS) and percutaneous transcatheter ductal closure (PTDC) devices. The VATS approach to PDA ligation was first introduced by Laborde and colleagues in 1993. Calculated ducts, severe pleural scarring, and short, wide, window-like ducts are considered contraindications to the VATS approach. Use of VATS for PDA closure also carries the risk of uncontrolled hemorrhage and recurrent nerve injury. On the other hand, with transcatheter PDA closure techniques, residual shunting and reopening after successful coil occlusion continue to be significant problems despite the use of new technologies. Large PDAs are more likely to have a residual shunt that causes hemolysis or endocarditis. The size and shape of the ductus appear to be important factors when deciding whether to use a PTDC device. A PDA “neck” is required for effective PTDC, and large PDAs may lack such a neck. Moreover, in large PDAs, which require multiple coils or bigger devices for closure, PTDC can lead to left pulmonary artery stenosis or aortic coarctation and embolization of the coils into the pulmonary circulation. Consequently, the PTDC and VATS techniques may not be safe for closing ducts that are more than 4 mm in diameter in adults. For our patient, direct closure of the ductus using the transpulmonary approach and CPB was our 1st choice, in part because the pulmonary end of the ductus is seldom calcified, and the pulmonary artery wall holds sutures well.

Methods that include the use of CPB are considered the safest for PDA closure in adults. One of the main difficulties arising from the use of CPB for PDA closure is backbleeding from the aorta into the pulmonary artery through the ductus. Hypothermic circulatory arrest and occlusion of the ductus with a Fogarty balloon catheter are 2 methods that have been suggested to overcome ductal backflow during PDA repair with use of CPB.

The unavailability of large series in adults evaluating various treatments of PDA makes it difficult to make a comparison between various PDA closure techniques in adults. Transpulmonary surgical closure of PDA with HTCA was chosen for the patient presented here, even though this method requires CPB and full heparinization. Despite the known risks and increased costs associated with use of the heart-lung machine, we found this standard method to be safe and easy. Since we had decided to apply CPB during this procedure, we cooled the patient further and attained perfect exposure of the pulmonary opening of the ductus with HTCA rather the using the transpulmonary...
tal balloon occlusion method. When CPB is used, further cooling of the patient and the application of circulatory arrest does not compound the risk; moreover, CPB with HTCA facilitates the exposure of the ductus through the pulmonary artery without any additional instruments to obscure the field.

Although 1 case does not provide sufficient experience to draw strong conclusions, we believe that the transpulmonary approach with hypothermic total circulatory arrest is the best method for closure of a large (>4.0 mm in diameter), short, or friable patent ductus arteriosus in an adult.

References