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Circulatory Arrest: A Surgical Option for Adult Window Ductus Closure

Vithalkumar Malleshi Betigeri[1], Anupama Vithalkumar Betigeri[2*], Vasudevan Armugum[3], Kasturi SatyaVenkataKumar SubbaRao[1]

[1]*Department of Cardiothoracic and Vascular surgery, JIPMER, Puducherry, India*
[2]*Department of Physiology, JIPMER, Puducherry, India*
[3]*Department of Anesthesia, JIPMER, Puducherry, India*

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ABSTRACT

The window ductus in adults is a rare, anatomical anomaly, successful closure of which is more challenging both to surgeons and interventional cardiologists. Eventhough various strategies are available, optimal method of repair of patent ductus arteriosus in adults remains controversial. We report the case of an adult female patient with window patent ductus arteriosus (2.5cmx0.5mm) with severe pulmonary artery hypertension, in whom circulatory arrest was used successfully as a surgical option for transpulmonary closure of the duct. Post operatively patient recovered well without any complications and is doing well in follow up.

►*Implication for health policy/practice/research/medical education:*
Our artcle is intended for the management of adult window ductus patients with severe pulmonary hypertension ,a challenging rare entity for both surgeons and interventional cardiologists, where optimal method of management is controversial.

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1. Introduction

The window ductus , an atypical type of patent ductus arteriosus(PDA) is a characteristically large in size(>2cm) with no recognizable length, characteristic continuation of main pulmonary artery with aortic arch and absence of internal ductal tissue. Surgical safety and effectiveness of its closure can be increased by using cardiopulmonary bypass (CPB) and hypothermic total circulatory arrest (HTCA) via median sternotomy.

2. Case Report

20- years- old female with diagnosis of PDA and severe pulmonary artery hypertension was referred for surgery. Clinical examination revealed hyperdynamic precordium, parasternal heave grade 3, a continuous murmur grade 5/6 at upper left sternal border. A Chest X-Ray (Fig.1) showed cardiomegaly with pulmonary plethora. An echocardiogram showed a large PDA (left to right shunt), severe pulmonary artery hypertension (PAH), mild to modearte mitral regurgitation, mild tricuspid regurgitation, mild Aortic regurgitation, mild to moderate pulmonary insufficiency,right ventricular systolic pressure (RVSP)-70mm Hg, and Pulmonary artery diastolic pressure(PADP)-40mmHg Cardiac catheterization (Fig. 2) revealed large Left to right shunt, pulmonary artery pressure - 80/60 mmHg, and aorta pressure -100/80 mmHg.

Patient was operated through the median sternotomy. There was a cardiomegaly, dilated and hypertrophied right ventricle, dilated left ventricle, dilated aorta, dilated and tense pulmonary artery (main and its branches), dilated

* *Corresponding author:* Vithalkumar. M. Betigeri. Associate professor, Department of CTVS, MAMC and G.B.Pant hospital, New Delhi, India. 110002. Fax:+ 91-01123234012, Tel: +91-9718598645.
e-mail: vithalkumarmb@gmail.com

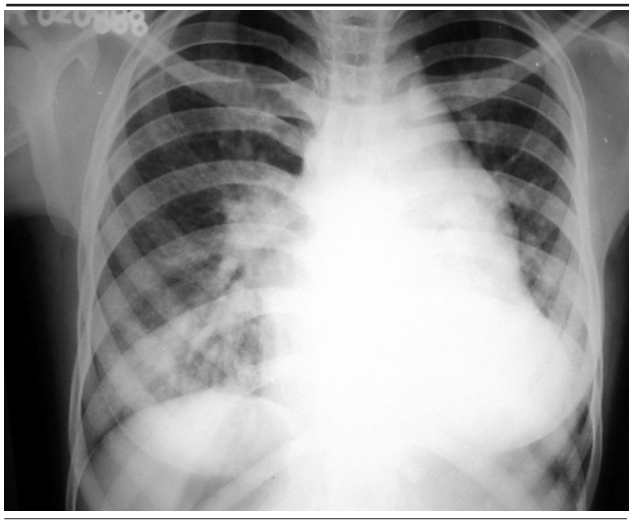

Figure 1. Chest X-rays showing Cardiomegaly and Dilated Pulmonary artery with plethoric lungs.

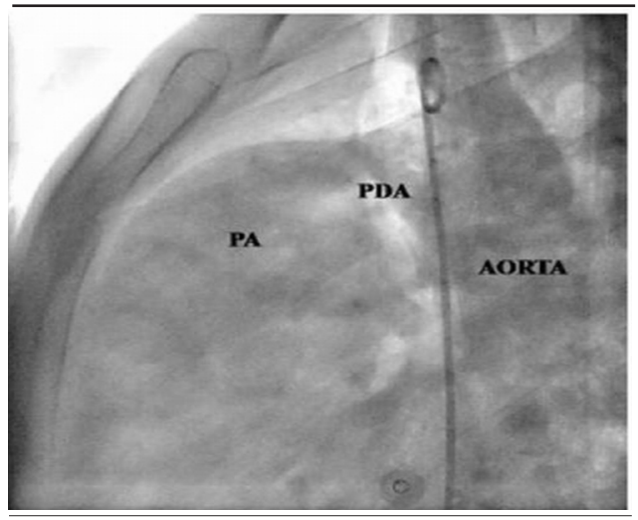

Figure2. Angiography. PDA-Window ductus , PA - Main Pulmonary artery

coronary arteries and prominent venous system. Isolation of PDA was difficult. Cardiopulmonary bypass (CPB) was instituted in the standard fashion by aortic and bi-caval cannulation. Because of unrecognizable length of ductus, dissection and exposure was difficult even at low flow bypass. With patient in Trendelenburg position and continuous cooling, fingertip occlusion of the pulmonary artery opening of the ductus was done by compressing wall of left pulmonary artery against it in order to prevent flooding of pulmonary vascular bed. When the patient's esophageal temperature was lowered to 24°C, aorta was cross clamped and cold blood cardioplegic solution was infused. After reducing the flow to 0.5L/min, finger pressure was removed and anterior pulmonary arteriotomy was made and occlusion of flow through pulmonary end was attempted with Foley's catheter several times but failed and hence proceeded with hypothermic circulatory arrest. The anatomy was then clear and obliquely oriented aortic opening was larger than the pulmonary opening of the ductus which measured 25 mm in diameter and almost facing pulmonary end (window like) (Fig 3).

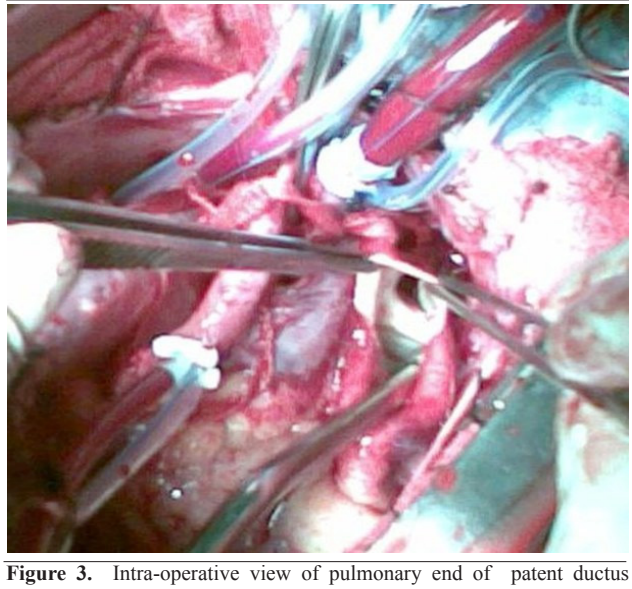

Figure 3. Intra-operative view of pulmonary end of patent ductus arteriosus, almost overlapped by aortic end.

With Gore Tex patch (W.L.Gore & Assoc. Flagstaff, AZ) transpulmonary closure of pulmonary end of the duct was done with 4-0 polypropylene sutures (Ethicon ,Somerville, NJ). Pulmonary arteriotomy was closed in two layers with 5-0 polypropylene. The HTCA time was 30 minutes and cross clamp time was 90 minutes. When nasopharyngeal temperature reached 36.6°C, after deairing she was weaned from CPB with support of isoprenaline 0.03µg/kg/min and transferred to ICU. During HTCA, dexamethasone 12mg, sodium thiopental 1g, mannitol (20%) infusion 100ml and ice-water packs around head were used for brain protection before total circulatory arrest in Trendelenburg position.

Patient recovered from the anesthesia and became fully conscious 6 hours after operation. After 24 hours of ventilation, patient was extubated with stable hemodynamics. Before discharge on 14th postoperative day, clinically patient was in sinus rhythm, silent precordium and without murmur. Transthoracic echocardiography revealed no residual PDA, with ejection fraction 52%, trivial mitral regurgitation, mild aortic regurgitation, pulmonary artery diastolic pressure (PADP) -14mmHg. At one year follow up, the patient was in good functional status and without any neurologic problem.

3. Discussion

Patent ductus arteriosus is rarely seen in adults as it is generaly closed in children. The cumulative death rate doubles to 1% by adulthood and increases to 2 to 4% by middle of life. As 42% of patients with untreated PDA die before 45 years of age ,the closure of the PDA is considered to remedy this shortened life expectancy, except in cases with severe pulmonary vascular disease(Eisenmenger syndrome) (1). The development of endocarditis, congestive heart failure, pulmonary hypertension with pulmonary vascular disease, aneurysm formation and calcification in untreated patent ductus arteriosus makes closure of duct in adults more challenging than in children both to surgeons and interventional cardiologists. Optimal method of repair of patent ductus arteriosus in adults remains controversial.

Among various modalities of treatment, more recently,

attractive and preferred treatments have included video-assisted thoracoscopic surgery (VATS) and percutaneous transcatheter ductal closure (PTDC) devices. Presence of calcification, scarred pleura and short, wide, fragile, window-like ducts are considered contraindications to the VATS approach (2) with associated risks of uncontrolled hemorrhage and recurrent nerve injury. For PTDC devices, size and length of the duct determine the effectiveness. Neckless, large window like PDA, similar to the one in our patient, prevents effective use of this new technology as residual shunting and reopening after successful coil occlusion pose problems.(2) This is more likely to cause hemolysis or endocarditis due to residual shunt. It may require multiple coils or bigger devices for closure with complications like migration of device resulting in pulmonary artery stenosis or embolization into the pulmonary circulation or aortic coarctation (2). In adults, PDA is usually large, short, thin and friable with concomitant pulmonary artery hypertension and calcification. Therefore its closure via VATS or transcatheter approach or even thoracotomy is unsafe and risky (3).

For our patient, in view of large size of the duct and severe pulmonary artery hypertension, we selected closure of the ductus using the transpulmonary approach under CPB. Utilizing CPB is safe in adult PDA closure (2). Surgical closure via transpulmonary route can be accomplished by using direct pledget suture, patch closure or purse string suture technique. While patient on CPB, flooding of pulmonary vasculature can be tackled using either finger occlusion or Fogarty/Foley's balloon catheter of appropriate size to occlude the duct or using hypothermic circulatory arrest. As mouth of the PDA at pulmonary end was large and back bleeding control with balloon was unsuccessful, we chose HTCA which was a safe and easy method as there was perfect exposure of the pulmonary opening of the ductus. As patient was already on CPB, further cooling of the patient and the application of circulatory arrest facilitated the exposure of the ductus through the pulmonary artery without obscuring operative field and thus surgical closure was accomplished without any risks. As there might be presence of air in aortic arch, deairing had to be done carefully. Use of CO2 and snaring of neck vessels are also recommended to prevent air embolism. Although the popular technique in PDA closure in adults is low flow CPB with systemic hypothermia, the safe application of HTCA have been reported (4, 5). Hypothermic total circulatory arrest (HTCA) provides a bloodless field for the surgeon to perform the procedure safely and effectively. In spite of 30 minutes of HTCA, our patient extubated without any neurological complications. In conclusion, in adult patients of window PDA with severe pulmonary artery hypertension, the use of CPB and HTCA can be regarded as a safe and appropriate technique.

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