Case Report

Trans catheter closure of large ductus arteriosus in patients with severe pulmonary hypertension: safety and efficacy of test occlusion

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Summary
Patent ductus arteriosus (PDA) is a serious congenital heart disease that can lead to irreversible pulmonary hypertension. Catheter closure has largely replaced surgical ligation and has the advantage of feasibility of test occlusion in patients with borderline operability. We present 3 cases of large PDA with severe pulmonary hypertension where test occlusion helped to verify operability and all cases had successful closure.

Keywords: Patent ductus arteriosus, cardiac catheterization, pulmonary hypertension

Introduction
Patent ductus arteriosus (PDA) accounts for approximately 10% of all congenital heart diseases, with an incidence of 2-4 per 1000 term births. Like many other congenital heart disease, PDA can lead to irreversible pulmonary hypertension (PHT) if left untreated\(^1\). Trans-catheter closure of PDA is well established with excellent short and long term results both in children as well as in adults\(^2\). In patients with severe PHT closing the PDA may lead to fatal complications and therefore critical peri-operative evaluation is needed by cardiac catheterization for the pulmonary artery pressure (PAP) and pulmonary vascular resistance (PVR). We report 3 sporadic patients (2 adults and 1 infant) with severe PHT who had successful PDA catheter closure, after test occlusion, using different devices.

Case Report
Patients were seen at the Sudan Heart Institute in 2010 and 2011. Clinical examination, chest X-ray and electrocardiograms were done. Complete 2-dimensional echocardiogram was done using Esaote (MyLab 50) machine. A standard right heart cardiac catheterization study was performed to measure PAP, left to right shunt (QP/QS) and PVR in room air then repeated after giving 100% oxygen for 10 minutes. The PDA was measured at the narrowest point from a lateral aortogram. In patient 1 (65 years old), a valvuloplasty balloon 10x20 mm was introduced through the femoral vein and inflated at the PDA; aortogram was repeated to ascertain complete PDA occlusion. In the other 2 patients (40 years old & 8 months old), test occlusion was done using the PDA device. The device was introduced using a long sheath through the femoral vein to pulmonary artery across the PDA to the descending aorta. In all patients test, occlusion was done for 10 minutes then the device was deployed.
During this time the patient’s vital signs and oxygen saturation were continuously monitored. The clinical and echocardiographic data of 3 patients who had PDA and PHT are shown in Table 1 and cardiac catheterization findings and outcome are shown in Table 2. Patient 1 had a coronary angiogram which revealed normal coronaries.

Table 1: Clinical and Echocardiographic Findings

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Clinical Features</th>
<th>ECG</th>
<th>CXR</th>
<th>Echocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65 years</td>
<td>Female</td>
<td>Heart failure, New York Heart Association (NYHA) class IV, Soft ejection systolic murmur</td>
<td>Atrial fibrillation</td>
<td>Pulmonary edema, left ventricle and atrial enlargement (Fig 1A)</td>
<td>PDA 11 mm with bidirectional shunt, dilated left ventricle and atrium.</td>
</tr>
<tr>
<td>2</td>
<td>40 years</td>
<td>Female</td>
<td>Exertional dyspnea, NYHA class II. Ejection systolic murmur</td>
<td>Left ventricle enlargement</td>
<td>Pulmonary edema. left ventricle and atrial enlargement</td>
<td>PDA 12 mm with bidirectional shunt. dilated left ventricle and atrium</td>
</tr>
</tbody>
</table>

Table 2: Cardiac Catheterization Findings and Outcome

<table>
<thead>
<tr>
<th>Patient</th>
<th>Oxygen saturation in room air/on oxygen</th>
<th>QP/QS in room air/on oxygen</th>
<th>PAP</th>
<th>PVR in room air/on oxygen (Woods Units)</th>
<th>Procedure and PDA Deive</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>92/98</td>
<td>0.7:1/1.5:1</td>
<td>99/47/5</td>
<td>15/13</td>
<td>Test occlusion using Numed Balloon 10/20 mm for 10 minutes. Blood pressure and oxygen saturation (O₂) were maintained then closed using 14/16 (Balimedic-China) PDA device.</td>
<td>Immediate improvement of symptoms (NYHA class improved from IV to I). Oxygen saturation remained 95%. Pulmonary edema Improved (Fig 1B). Normal PAP on follow-up at 12 months. Still in atrial fibrillation.</td>
</tr>
<tr>
<td>2</td>
<td>95/98</td>
<td>1.2:1/1.4:1</td>
<td>95/50/6</td>
<td>13/11</td>
<td>PDA was 14 mm from the angiogram. (Fig 2A) Test occlusion using an atrial septal defect occluder 16mm (Amplatzer-AGA-USA). Blood pressure and O₂ saturation were maintained. Device deployed in good position (Fig 2B).</td>
<td>Improvement of symptoms (NYHA improved from class II to I) and chest X-ray Normal PAP on follow-up at 6 months.</td>
</tr>
<tr>
<td>3</td>
<td>85/99</td>
<td>1.2:1/16:1</td>
<td>16/5</td>
<td></td>
<td>Test occlusion using PDA device 8/6mm (Starway-China). Blood pressure and O₂ saturation were maintained. Device deployed in a good position.</td>
<td>Immediate improvement of symptoms. (No signs of respiratory distress, normal O₂ saturation) Normal PAP on follow-up at 8 months</td>
</tr>
</tbody>
</table>

Table 1 and cardiac catheterization findings and outcome are shown in Table 2. Patient 1 had a coronary angiogram which revealed normal coronaries.
Fig 1A: Chest X-ray of a 65 year old lady with a large PDA showing left ventricle and atrial enlargement and pulmonary edema.

Fig 1B: Chest X-ray of the same patient 6 hours after PDA closure showing remarkable improvement in left side dilatation and pulmonary edema.

Fig 2A: Lateral aortogram showing the PDA.

Fig 2B: Lateral fluoroscopic view showing the catheter in the aorta and the occluding device well fitted into the PDA.

Discussion
The outlook for patients with untreated large PDA is poor with prompt development of severe irreversible PHT (Eisenmenger’s syndrome (ES) with advancing age; therefore, efforts should be to treat such patients as early as possible. The timing of development of ES is variable, patients with large congenital left to right shunts can develop irreversible PHT as early as 2 months of age\(^3\). On the other hand, we do encounter adults with large left to right shunts who still have reversible PHT late in their lives.
All patients with such shunts should be evaluated early and transcatheter/surgical closure should be considered. Catheter closure using coils or occluders has largely replaced surgical PDA ligation. In our experience as well as others, the short and long term outcomes are excellent\(^{(2,4)}\). The advantages of catheter closure include the avoidance of surgical scar, the short hospital admission (12 hours for catheter versus 3-5 days for surgical closure) and avoiding the complications of thoracotomy like vocal cord, phrenic nerve and lung injury. In fact, the morbidity in adult patients undergoing surgical PDA ligation is still significant with 32% complication rate and occasionally the need for cardiopulmonary bypass compared with a complication rate of 4.7% in large series of those undergoing PDA catheter closure\(^{(5,2)}\).

In patients with clinical, electrocardiographic and/or echocardiographic signs of shunt reversal, cardiac catheterization should be done to evaluate the PAP and PVR. Measuring PAP alone, a commonly encountered practice does not give enough information to assess operability; therefore PVR should always be calculated. PVR of less than 10 Woods Units after giving 100% oxygen (or nitric oxide inhalation) is usually taken as a cut-off point for operability. In those with borderline PVR careful evaluation of signs of left to right shunt clinically, by electrocardiograms and/or by echocardiography should be performed. These signs include the presence of left sided heart failure (as in patient 1), an oxygen saturation above 90% and signs of left side enlargement. Patients with such signs, (as in patients 1 & 2) benefit from the use of test occlusion to verify reversibility\(^{(6,7)}\). In patient 3, the PVR showed a favorable response to oxygen with drop of PVR to a safe level; however, we performed the test occlusion because of the extremely high PVR of 16 Woods Units in room air. Test occlusion is done by closing the PDA for 10-15 minutes using a balloon catheter or the PDA device itself and assessing the patient’s hemodynamics, if the patient remained stable, the device closure is undertaken. Assessment of the response to test occlusion by the arterial blood pressure and oxygen saturation allowed us to confidently proceed to device deployment with good results in the short term and on follow-up. Test occlusion has also been performed successfully in patients with atrial septal defect where reduction of the PAP by 25% relative to the basal level, without a fall in systemic pressure is taken as a favorable response\(^{(8)}\).

There are few reported cases of catheter closure of PDA at an advanced age (more than 60 years)\(^{(9)}\). PDA catheter closure using other devices like atrial septal and ventricular septal defect occluder has been occasionally reported\(^{(10)}\).

In conclusion, physicians should refer patients with congenital heart disease early in order to avoid the development of ES. Cardiologists need to carefully examine such patients and review investigations to decide operability. Transcatheter test occlusion is safe and effective for patients with borderline PHT.

**References**


