Amplatzer device closure of Patent Ductus Arteriosus (PDA) : A case report
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Abstract
Patent Ductus Arteriosus (PDA) is one of the common congenital cardiac anomalies found in neonate & children. Surgical closure of PDA has long been established but nonsurgical device closure of this defect is also emerged as the first choice in many centers through out the world. We selected a case of PDA of moderate size with mild pulmonary hypertension in a six years old young girl for device closure with Amplatzer Duct Occluder (ADO). Diagnosis & appropriate sizing of the PDA was determined with Echo-Color-Doppler study prior to the procedure. PDA size was pulmonary end 4.5 mm, aortic end 8 mm & length 12 mm. We selected an ADO device size of pulmonary end 6 mm, length 8 mm, aortic retention skirt 12 mm with a sheath size of 7 F. Angiocardiography was done to visualize the ductus & as well as for haemodynamic assessment by using Pigtail & NIH catheters. According to Krichenko A, et al (fig-1), PDA morphological class was A-2, found suitable for device closure. Right Judkin's catheter was used for guiding wire to pass through PDA into descending aorta. Then the device was deployed successfully at first attempt into PDA, which was occluded immediately as shown in subsequent checkup descending aortogram. No residual shunt, no migration, no LPA stenosis was seen in follow-up Echocardiography. The patient was discharged from the hospital one day after the procedure with follow-up advice.

Introduction
Patent Ductus Arteriosus (PDA) is a congenital cardiac malformation, which may be in an isolated form or in association with other cardiac anomalies. Other than in obligatory duct dependant pulmonary circulation, PDA should be closed either by surgery or with device 3.

PDA Classifications

<table>
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<th>PDAs have been classified into five types</th>
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<td>TYPE A- The most common (65% in one large series), a funnel-shaped ductus with a localized narrowing at the pulmonary artery junction.</td>
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<td>TYPE B- The next most common (18%), includes funnel-shaped PDAs with an aortic ampulla.</td>
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<td>TYPE C- Tubular shape.</td>
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<td>TYPE D- Oval shape with both aortic and pulmonary ampullae.</td>
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<td>TYPE E- Other bizarre forms.</td>
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The incidence of an isolated PDA is 1 in 2500 to 5000 live birth & 9-12 % of all congenital heart diseases. It is nearly two times more common in female than in male. Ductus originates from one of the 6th paired aortic arch. Physiological closure of the ductus occurs within few hours of birth but anatomical closure takes 2-3 days in effect & finally turns into a fibrous ligamentous arteriosus within one month. It may remain open in premature neonate but why it persists patent in term neonate, exact cause is not known. Hypoxia, acidosis & high prostaglandin level are the predisposing factors for the persistent of patent ductus arteriosus 7.

Surgical closure is the established method of treatment for PDA but device closure is emerging as an alternative attractive & effective mode of remedy for it avoiding surgical scar on the chest. Recently less invasive method of PDA closure using video assisted thoracoscopic surgery is also preferred.
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effective. It can be done in smaller infant\textsuperscript{10,11}. Tremendous research & modifications are occurring in devices for nonsurgical closure of congenital heart defects like isolated ASD, VSD & PDA. In 1967, Portsmann W, Wierny L, et al first reported percutaneous transfemoral closure of patent ductus arteriosus as an alternative to surgery. Since then, several modes were tried including Rashkind's double umbrella PDA occluder, various kinds of coils like Giantereco coils, Cook's detachable coils & finally cardioseal & Amplatz methods\textsuperscript{12-18}.

Generally smaller PDA (<2.5mm) is closed with coils; moderate to large PDA (>2.5 mm to 8 mm) should be closed with Amplatz Duct Occluder. Tiny PDA & very large PDA particularly Krinchenko type C, D & E should be sent for surgical closure\textsuperscript{19}. As the devices are not cost effective, in developing countries like Bangladesh, there are few cases found economically fit for device closure. In our country, Fatema NN et al have performed few cases of PDA device closure in last 2 years\textsuperscript{20}. This was the first case of Amplatz device closure of PDA at NICVD, which led to write this case reporting.

Case history
Luna, 6 yrs old, female child from Sylhet, admitted in pediatric cardiology unit of National Institute of Cardiovascular Disease (NICVD) Hospital, with the complaints of palpitation, exertional dyspnoea & repeated RTI with growth retardation. On examination, she was ill looking with below average body built, mildly pale, RR-20/m, HR-92/m, body weight- 12 kg, having thrill & continuous murmur in the pulmonary area. She was clinically diagnosed as a case of PDA. On investigations, CXR-Mild Cardiomegaly, ECG-Mild LVH. Echo-Doppler (Fig-2)-LA, LV & PA-Dilated, moderate PDA, Size-4.5 X 8 X 12 mm with PPG-65 mmHg & L-R shunt, Mild PAH (PASP-28 mmHg). We planned for Amplatz device (Fig-3) closure of her PDA

Figure 2: Echo-doppler & Figure 3: Amplatz device

with ADO size of pulmonary end 6 mm (1.5 mm more than PDA pulmonary end diameter) x aortic end size 8 mm & length 7 mm. Accordingly, She was admitted at NICVD in pediatric cardiology unit on 25th December, 2006 & was taken to Cath Lab on the following morning for the procedure.

Procedure
Patient was given sedation with injection diazepam & ketamine along with atropine. Proper sterilization of groin area was done along with draping. Femoral vein & artery access were achieved as routinely with 5F sheaths. Although, Echocardiography confirmed that there was no other shunt anomaly other than PDA, right & left heart catheterization was performed in routine fashion with NIH & Pigtail catheters along with pressure, oxymetry & haemodynamic study. PDA was visualized by a descending aortogram passing a pigtail catheter via femoral artery in lateral view (Fig-4). PDA shape

Figure 4: Aortogram showing PDA

corresponds to Krinchenko type A 2 that is funnel shaped. Measurements of PDA

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correspond to echocardiography measurements.

The Pigtail catheter was kept in situ. The selected size of the Amplatzer Duct Occluder was suitable for the patient. A J-tipped guide wire was introduced through the PDA into the descending aorta. Here we used right Judkin's as a guiding catheter. The delivery sheath was introduced onto the exchange wire up to descending aorta & wire removed. Position of the tip of the sheath was confirmed by a test injection of contrast medium. The delivery cable was passed through the loader & the device was mounted on to the tip of the cable and screwed in clockwise direction. Then the device was immersed into saline water & slowly pulled into the loader. Then the loader along with the device on the tip of the delivery cable within it was forwarded by pushing through the sheath without any rotation into the descending aorta. Only the retention skirt of the device was first deployed & pulled firmly against the aortic orifice of the PDA. It was seen in fluoroscopy as well as tugging sensation of aortic pulsation was clearly felt. Check descending aortogram was done using Pigtail catheter to see the well-seated position of the device into the aortic ampulae. The delivery sheath was then gradually withdrawn deploying the cylindrical portion of the device in the PDA while applying slight tension.

Again check descending aortogram was done & recorded on cine a power injection through the Pigtail catheter using 1 cc per kilogram of contrast at 12 ml per second at 400 psi in 35/35 degree LAO cranial view to visualize the length of the device whether it protruded into LPA. As there was no residual shunt & no migration into LPA, we deployed the device by screwing counter clockwise the plastic vise fixed with the cable, which along with sheath was slowly withdrawn. Another check aortogram with the help of pigtail catheter was performed after 10 minutes (Fig-5), but there was no trace of residual shunt due to 100% occlusion of the ductus & no aortic obstruction was seen (Fig-5), so the catheter & all the sheaths were removed with proper haemostasis.

Fluoroscopy time required was 15 minutes & the whole procedure time was 45 minutes. Injection Ceftriaxone (50 mg/kg) & tablet Aspirin (75mg/kg) were given. On the following day, Echo-Color-Doppler was done (Fig-6) & seen that there was no residual shunt & no LPA stenosis (PPG- 4.5 mm Hg, Peak Velocity-1.2 m/sec). The patient was discharged with oral aspirin & penicillin with follow up advice after 1, 3 & 6 months.

Discussion
Patent ductus arteriosus is a common congenital cardiac shunt anomaly, which must be closed either by surgery or with nonsurgical device procedure, because of its haemodynamic effects & the potential risk of infective endarteritis. Gross & Hubbard in 1938 performed first surgical ligation of PDA, since then it is the established method of treatment. But, there was reported 1-3.5% mortality in surgical closure of PDA & co-morbidity like, recurrent laryngeal nerve palsy with hoarseness of voice, recanalisation of PDA with residual shunt & ultimately an
ugly scar mark on the chest are not infrequent\textsuperscript{22}. So the pediatric cardiologists were trying to close PDA in cath. labs with various interventional methods since early age. Finally Rashkind W, Wierny L et al, after 30 years of first surgical procedure, successfully closed the PDA with device in 1967 & historically started the era of pediatric interventional procedure for congenital heart disease\textsuperscript{12}.

Now a days, device closure is the first choice for PDA treatment in many centers except very tiny & very large, bizarre PDA, which are sent for surgical closure\textsuperscript{8,9,23,24}. Different kinds of devices are in use with variable outcome & success rate but ideally, coils are suitable & cost effective for smaller PDA (pulmonary end diameter up to 2.5 mm), amplatzer duct occluder for moderate to large (pulmonary end diameter up to 10 mm) PDA. USFDA recommended Amplatzer method in May 14th, 2003 as a safe & alternative way to close PDA\textsuperscript{25}. As it is very costly in comparison to surgery, we are getting less number of patients suitable for device closure of PDA in our center, although it is the only tertiary level government cardiac hospital having both pediatric cardiology & pediatric cardiac surgery units. This was the first case we have done successful PDA device closure with Amplatzer. In multicentre case series (n = 435) study by Pass et al (2004) showed that angiographic immediate total occlusion was seen in 76% cases & after 24 hours 89% cases, along with one case of mortality due to device embolization\textsuperscript{26}.

In India, Shrivastava S, Marwah A, Radhakrisnan et al (2000) reported a series of PDA device closure with spring coils & amplatzer duct occluder. They had the experiences of 55% immediate closure, 89% delayed closure, 9.5% LPA stenosis due to inappropriate sizing of the device with migration in to LPA in amplatzer group. They had also 1% failure to deploy the amplatzer into the PDA\textsuperscript{9,21}. But in our case, there was immediate total occlusion after the deployment of the device without any residual shunt or any LPA stenosis. There were no single minor adverse effects in our case. The key to immediate success depends upon the accurate determination of size of the PDA by Echocardiography, specially viewing it in modified ductal cut window, in which PDA is well visualized\textsuperscript{27}. PDA with severe pulmonary hypertension can also be closed safely with ampltazer duct occluder in the same sitting after calculating PVR, if it is below 8 wood units\textsuperscript{28,29}.

Although it is an easy & safe procedure, there are few warnings & few contraindications. It should not be tried in-patient below 6 months of age & below 6 kg of body weight. Device should be removed if it extends > 3 mm into LPA (or LPA flow is > 3.0 m/s). MRI using magnetic field > 1.5 Telsa unit should be avoided after device closure. Endocarditic prophylaxis should be carried at least for 6 months.

**Conclusion**

Amplatzer device closure of moderate to large PDA is an alternative new mode of nonsurgical quite safe & effective interventional treatment. Device closures of congenital heart defects, particularly isolated PDA, ASD (secondum), and VSD (muscular) are now possible in our center. Although, these are costly procedures, but some of our peoples are affordable who used to buy them from other countries at the expense of our hard earned foreign currency, which we want save providing the services in most economic way at National Institute of Cardiovascular Disease (NICVD), Dhaka, Bangladesh.

**References**