INTRODUCTION

Patent Ductus Arteriosus (PDA) is a common cardiac anomaly (1 in 3000 births), nearly 15% of all adults with congenital heart disease. Structurally, it is a blood vessel which connects the proximal left pulmonary artery to the descending aorta just distal to the takeoff of the subclavian artery. During intrauterine life, it provides passage for systemic blood, providing up to 25% of aortic blood flow. The normal closure process begins within few hours after birth and unique pathological and histological findings have been noted in the ducts that are not destined to close. The natural history of PDA is one of shortened longevity but it largely depends on the size and magnitude of the shunt and the status of the pulmonary vasculature. The average age of death is in the third or early fourth decade of life with an expected annual mortality of 0.5% per year. However, despite having shortened lifespan, individuals do survive into later adulthood at which time they usually present with symptoms or complications. Heart failure and exercise intolerance are the most common symptoms in adults. Infective endarteritis, supraventricular tachyarrhythmias, angina and sudden death have all been reported. Moderate to large sized defects are associated with left sided cardiac volume overload and are at risk of congestive heart failure or irreversible pulmonary vascular disease. The Amplatzer duct occluder is a relatively new device with easy placement and higher rate of successful occlusion.

The objective of this study was to determine the outcome of using this device to occlude large sized (≥ 4 mm) PDAs, which traditionally were used to be closed surgically in the recent past.

METHODOLOGY

The study was carried out at Armed Forces Institute of Cardiology and National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi. All patients who underwent transcatheter closure of large-sized PDAs, using the ADO device, from January 2005 to December 2007, were included by convenient sampling technique. Large-sized PDA was defined as a PDA with narrowest diameter of >4.0 mm in lateral projection. A total of 100 patients underwent transcatheter closure of large-sized PDAs, using the ADO device, during the study period. Thirty seven patients were males and 63 were females. Mean age of the patients were 11.73 ± 10.31 years. All

ABSTRACT

Objective: To assess the results of anterograde transcatheter closure of a large sized patent ductus arteriosus using the Amplatzer Duct Occluder (ADO) device.

Study Design: A case series.

Place and Duration of Study: Department of Cardiology, Armed Forces Institute of Cardiology and National Institute of Heart Diseases, Rawalpindi, from January 2005 to December 2007.

Methodology: All patients who underwent transcatheter closure of large sized PDA (≥ 4.0 mm), using the Amplatzer Duct Occluder (ADO) device, from January 2005 to December 2007, were included by convenient sampling technique. After the procedure, repeat aortogram was performed to confirm the appropriate position of the ADO and to evaluate for residual shunts.

Results: A total of 100 patients had PDA diameter of ≥ 4.0 mm. Mean age was 11.73 ± 10.31 years and there were 37 males and 63 females. Mean PDA diameter was 6.011 ± 2.078 mm. Forty-nine patients had type 'A', 19 had type 'B', 19 patients had type 'C', 5 had type 'D' and 8 patients had type 'E' PDA. Complete closure was achieved in 70 patients, 26 had trace shunt and 4 patients had small residual shunt immediately after the procedure. However, no patient had residual shunt 24 hours after the procedure.

Conclusion: ADO is a highly efficient prosthesis that can be safely applied in most patients with PDA particularly in patients with large sized PDA.

Key words: Patent ductus arteriosus. Amplatzer duct occluder. Transcatheter closure.
patients were examined clinically in detail. PDA was confirmed on echocardiogram. ECG, CXR and other investigations were done whenever clinically indicated. A complete record of patient’s condition during the hospital stay was recorded. During cardiac catheterization, angiographic and hemodynamic data were obtained before and after transcatheter closure of PDA. Procedure was done according to standard technique, after getting informed consent from the parents or the patient. Biplane aortogram in anteroposterior and lateral projections were performed for size and type of PDA. Subsequently, a 4-6 Fr multi-purpose type catheter was advanced percutaneously from venous side into the PDA. This catheter was exchanged for delivery sheath (5-7 Fr) over a 260 cm, 0.035” guide wire and was advanced through PDA in the descending aorta. Then, the loader was introduced into the delivery sheath and without rotation, the device was advanced into the descending aorta. The sheath was retracted until the retention disk was opened into the proximal descending aorta using gentle tension on the delivery cable, the sheath was pulled back to deploy the rest of the device. With the device still attached to the cable, a descending aortogram was performed in the lateral projection to confirm device position and exclude left pulmonary or aortic obstruction. Once, the proper device position was confirmed, the device was released by turning the cable counter clockwise.

Angiographic type of the PDA was documented according to Krichenko classification. A repeat aortogram at the end of the procedure was performed to confirm appropriate position of the ADO and to evaluate for residual shunts. A residual shunt was classified as a trace shunt (only foaming is seen but no jet is present). “Small” shunt (left-to-right shunt present with a jet <2 mm in diameter), and “large” shunt (left-to-right shunt present with a jet >2 mm). Repeat non-invasive data was again obtained at 24 hours to document the presence or absence of residual shunt. SPSS 10 was used for statistical analysis.

RESULTS

During the study period, a total of 159 patients underwent PDA occlusion by transcatheter technique and 100 patients had large-sized PDA with diameter of ≥4.0 mm measured at their smallest angiographic diameter in the lateral projection. The mean PDA diameter was 6.011 ± 2.078 mm (ranging from 4.0 to 12.0). Using the classification adopted by Krichenko et al., 49 patients had type ‘A’, 19 patients had type ‘B’, 19 patients had type ‘C’, 05 patients had type ‘D’ and 08 patients had type ‘E’ PDA. The closure was achieved from the venous side and immediate success was achieved in 70 patients. Twenty six patients had trace angiographic residual shunt (foaming) through the device without contrast jet. Four patients had small angiographic residual shunt with jet <2 mm. However, no patient had residual jet 24 hours after the procedure measured on transthoracic echocardiogram.

In one patient, initially 12/10 ADO was deployed but it appeared quite oversized and partly obstructed the aorta. Repeat measurements were done and 10/8 ADO was deployed successfully. One patient developed atrial fibrillation during the procedure, which was settled spontaneously after the procedure. One patient underwent this procedure during pregnancy. One patient had associated bicuspid aortic valve and one patient had associated small perimembranous ventricular septal defect with pressure gradient of 68 mmHg.

No patient required blood transfusion. There was no femoral arterial or venous complications. All patients were discharged home one day after the closure (Figure A-D).

DISCUSSION

If PDA is an isolated lesion, it is almost uniformly undesirable and must be closed. Flow across the PDA is determined by the size of the defect and the compliance of the lung vasculature. PDA, if left uncorrected, can result in a number of long-term complications. Smaller lesions are not associated with hemodynamic abnormalities or left heart volume overload but these defects are at significant risk for endarteritis and for this reason, correction of these defects is recommended. Endarteritis of clinically silent PDA has also been reported. Moderate to large-sized defects are associated with left sided cardiac volume overload and can also develop pulmonary hypertension. In its severe form, PDA can also result in Eisenmenger physiology. Moreover, adult patients with PDA, associated with severe pulmonary arterial hypertension, transcatheter closure of PDA has the potential to differentiate from the reversibility of severe
pulmonary arterial hypertension and correct the hemodynamic defect.\textsuperscript{15} By convention, patients with pulmonary vascular resistance of >6 units, when breathing on 100% oxygen, are considered unsuitable candidates for repair of congenital heart defects, usually associated with left-to-right shunts,\textsuperscript{16} but in most cardiac catheterization, laboratories pulmonary vascular resistance is not routinely measured. However, surrogate markers for low resistance in PDA are large-sized left atrium and/or left ventricle, normal sized right ventricle with normal or raised pulmonary artery pressure.

Surgical management of the PDA has been the “Gold standard” since 1939, when Gross and Hubbard reported their first case of surgical ligation of PDA.\textsuperscript{17} Porstmann \textit{et al.} first demonstrated the feasibility of non-surgical closure of the PDA in 1967 by transcatheter technique with an Ivalon plug without thoracotomy.\textsuperscript{18} Since then, many occluding devices for PDA have been used and now the transcatheter interventional procedures for the treatment of congenital cardiovascular defects have evolved into an important therapeutic modality. Transcatheter occlusion of PDA, using various occluding devices like Ivalon plug, Rashkind double – umbrella occluder device, coil embolization Gritka bag devices, Sideris buttoned device and Botall occluder have been used with varying success.\textsuperscript{19-25} The major limitations of these devices are high incidence of residual shunt, especially when used in moderate to large-sized PDAs, complex delivery systems and their unsuitability for large-sized PDAs. The Amplatzer duct occlusion device was designed to overcome these problems, observed with other devices. This device is extremely beneficial in closing the moderate to large-sized PDAs without having any technical difficulty and it obviates the need for multiple coils or surgical intervention for these defects.\textsuperscript{7,8,26,27}

The holy grail of transcatheter PDA occlusion is 100% efficacy for all sizes of patients, all sizes of ducts and all types of duct morphology prior to leaving hospital that is not achieved with other devices.\textsuperscript{28} However, coil implantation is preferable in patients with small-sized PDA as well as small residual ductus after surgical ligation\textsuperscript{29} and for larger ducts, ADO from the venous route is the best available option.\textsuperscript{30} Although, some patients had trace shunt (foaming) at the end of the procedure but no patient had detectable shunt 24 hours after implantation, which indicates the advantage of the device for closing PDAs.

\textbf{CONCLUSION}

For large sized PDAs, ADO from the venous route was the best available option. The findings have demonstrated that the ADO can close large-sized PDAs with excellent results. With the introduction of this device, PDAs of any size can be closed safely and effectively using transcatheter techniques. Moreover, ADO is a highly efficient prosthesis that can be safely applied in most patients with PDA.

\textbf{REFERENCES}

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