Transcatheter Closure of Patent Ductus Arteriosus: The Penang Hospital's Experience

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SUMMARY

Transcatheter closure of small and moderate sizes of Patent Ductus Arteriosus (PDA) is a standard and well accepted form of treatment. The aim of this study is to describe the experience of transcatheter closure of PDA in Penang Hospital. All patients who underwent transcatheter closure of PDA at our institution between 20th January 2006 and 27th June 2008 were retrospectively identified and studied. There were a total of 66 patients who had undergone transcatheter closure of PDA during this period which comprised of 24 male and 42 female. The PDA was closed by Amplatzer Duct Occluder (ADO) in 31 patients, Gianturco coil in 29 patients and other types of devices in 6 patients. There were 4 patients (6%) who had developed acute complication during the procedure (3 of them developed coil embolization and 1 had bleeding from puncture site). The PDA was successfully close in 95.5% of the study population without any residual PDA shunting. All the patients were alive but 5 of them (4.5%) have some abnormalities (2 has mild left pulmonary stenosis, 3 has small residual). Comparison between ADO and Gianturco coil revealed no significant difference in the outcome. Transcatheter closure of PDA has proven to be safe and effective with good mid-term outcome. There was no significant difference between Amplatzer Ductal Occluder and Gianturco coil in term of the outcome.

KEY WORDS:
Patent ductus arteriousus, Amplatzer duct occluder, Gianturco coil

INTRODUCTION

Patent Ductus Arteriosus (PDA) is a common form of congenital heart disease. It has been estimated to occur about 1 in 2500-5000 live births. As an isolated lesion, it represents 9-12% of all congenital heart disease[1]. A significant PDA that is not closed may lead to sequelae such as heart failure, pulmonary hypertension, recurrent chest infection and an increased risk of infective endocarditis.

Gross *et al* (1939)[2] began the era of congenital heart surgery when he reported the first successful ligation of PDA. Subsequently Porstman *et al*[3] were the first to use a new method by which a PDA was closed successfully by Ivalon foam plug via transcatheter technique. Since than, many devices have been introduced as Rashkind device[4], buttoned device[5], Botallocclude[6] device, coil[7] and ADO[8].

Transcatheter closure of small to moderate PDA is now an established method of treatment for most patients with PDA[9]. We would like to share our experience of transcatheter closure of PDA in Penang Hospital.

MATERIALS AND METHODS

All patients who had undergone transcatheter closure of PDA between 20th January 2006 and 27th June 2008 in Penang Hospital were included in this retrospective study. The exclusion criteria included those who have been found to be not suitable for device closure after reviewing the descending aortogram.

The patients' clinical characteristics e.g. age, sex and weight were recorded. The cardiac catheterization data including pulmonary artery pressure, the size of the PDA measured by the narrowest diameter of the PDA from the descending aorta angiogram lateral view, type of PDA device used and fluoroscopy time during the procedure were identified. The complications that arise from the procedure were also recorded. Patients than had follow-up in Paediatric Cardiology Clinic at six weeks post procedure followed by six monthly thereafter. Patients were checked clinically for any evidence of cardiac murmur during each follow-up. The echocardiography was performed by using echocardiography machine either Philips IE33 or Acuson Sequoia C512. The Patients were assessed for residual PDA, left pulmonary artery stenosis and descending aorta stenosis during the echocardiography.

Univariate analyses were performed by using SPSS Statistics 17.0. There were two major devices used, which were Amplatzer Duct Occluder (ADO) or Gianturco coil and the patient's clinical characteristic and outcome were compared and analysed. Differences between categorical variables were determined using Chi-square and continuous variables were determined using non-parametric test, Mann-Whitney test. A p value < 0.05 was considered to be statistically significant.

RESULTS

A total of 66 patients underwent transcatheter closure of PDA between 20th January 2006 and 26th June 2008. It comprised of 42 females and 24 males. The clinical profiles of all the patients were shown as in Table I. There were a total of seven patients under 1 year old.

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Table I: Clinical profile of study population

Clinical profile	mean ± SD	range
Age (years)	6.35 ± 8.65	6 month - 51 years
Weight (kg)	17.8 ± 14.1	6 - 80
PDA size (mm)	3.14 ± 1.7	0.8 -8.1
Systolic PA pressure (mmHg)	37.9 ± 13.1	23 - 72
Diastolic PA pressure (mmHg)	17.8 ± 8.34	45 - 2
Duration follow-up (months)	13 ± 8.5	1 - 31
Fluoroscopy time (min)	15.0 ± 11.7	5 - 51

Table II: Type of the device

Type of device	Number of patient (%)
Amplatzer duct occluder (ADO)	31 (47)
Gianturco coil	29 (44)
PFM coil	3 (4.5)
Cocoon duct occluder	3 (4.5)

Table III: Comparison between Amplatzer duct occluder and Gianturco coil

Variables	ADO	Gianturco coil	*p value
PDA size (mm)			
Mean (+ SD)	4.20+ 1.59	1.57+ 0.57	<0.005
Range	2.34 – 8.10	0.8 – 2.7	
Age (years)			
Mean(+ SD)	8.77+ 11.52	4.36+4.14	0.36
Range	0 – 51	0 – 16	
Fluoroscopy time (min)			
Mean (+ SD)	14.94+ 13.90	15.85+ 8.40	0.13
Range	5 – 51	8 - 38	
Duration of follow-up (months)			
Mean (+ SD)	12.7+ 9.10	14.44+ 8.11	0.36
Range	1 – 31	1 – 30	

*Mann Whittney test

Table IV: Comparison between ADO and Gianturco coil

Variables	ADO n = 31	Gianturco coil n = 29	*p value
Sex: Male	11	9	
Female	20	20	0.71
Outcome:			
Alive and well	30	26	
Alive with condition	1	3	0.30

*Chi square test

Type of device

The types of device that was use in this study were shown in Table II. ADO was the most common device used in this study and then followed by Gianturco coil. The PFM coil and Cocoon Duct Occluder were also used in a small percentage of patients.

Complication

There were 4 patients (6%) experienced at least one complication during the procedure with coil embolization was the highest rate of complication. Three out of four patient developed coil embolization in which all were successfully retrieved back except for one patient with the coil in the right pulmonary artery and was unable to retrieve back. In two patients, ADO was used to close the PDA after the complication. One of the patients developed bleeding from the puncture site and received blood transfusion. The patient's weight was six kilograms with the age of six months and the PDA was closed with ADO size 10/8mm.

Outcome

All the patients that underwent in this study were alive. The PDA was closed without any residual shunt in 95.5% of the patient. Three of the patients (4.5%) have small residual PDA in which 2 of them used Gianturco coil and 1 from PFM coil. Mild left pulmonary stenosis was noted in two of them (one from ADO and another one from Gianturco coil). Both of the cases had a maximum velocity of less than 2.0m/s by Pulse Doppler Echocardiography. There was no reported case of descending aorta obstruction.

Comparison between ADO and Gianturco coil

A comparison between two most commonly used devices; ADO and Gianturco coil were shown in Table III and Table IV. There was statistically significant with p value < 0.005 in the size of the PDA between the two groups. However there were no statistically significant in other variables such as age, fluoroscopy time, duration of follow-up, sex and outcome. There was no significance difference between sex and type of devices used.

DISCUSSION

Transcatheter closure of PDA is an established method of treatment with no reported mortality and low morbidity. In this study, transcatheter closure was performed in 66 patients with the PDA size ranging from 0.8mm to 8.1mm. The youngest age group was 6 old months with 6kg in weight. There were minimal complications during the procedure. Only 6% of the study population developed complication, in which coil embolization developed in 3 patients and 1 had bleeding from the puncture site. Coil embolization is a well known complication for those who use coil as a device. This complication has been described in many series due to lack of controlled-release mechanism of the coil[10,11,12,13].

On the other hand, in this study ADO has no such complication. The advantage of ADO is that it can be easily retracted into the delivery sheath and redeployed several times. It is also agreed that ADO 's implantation is much simpler compared to Gianturco coil. However in our study the fluoroscopy time for ADO and Gianturco coil was not statistically significant. Coil is still the preferred device[11] in a small PDA (less than 2.5mm). The only significant difference between ADO and Gianturco coil group in our study was the size of the PDA.

The closure rate in our study population was 95.5%, in which 3 patients (4.5%) has a small residual shunt. Compared to other series this result was well accepted. Masura *et al*[13] has reported about similar percentage of patient who had small residual.

Mild left pulmonary stenosis occurred in 2 (3%) of our study population and still on our follow-up. This complication has been reported especially when using coil. In both of our patient there has been no evidence of progressive increase in flow velocity in the left pulmonary artery during follow-up evaluation. It has been postulated that with growth of the child, the pulmonary artery will enlarge and this type of partial obstruction will eventually diminish when the patient reach adolescent stage without clinical consequence. The progress or natural history of left pulmonary stenosis needs further evaluation.

There are many advantages of PDA device closure compared to surgical ligation which includes, less invasive, without surgical scar, short hospital course, low morbidity and comparable success rate. However, the surgical ligation is still necessary for large PDA especially in small children.

CONCLUSION

Our experience with transcatheter closure of small to moderate size PDA is effective and safe with good mid-term outcome, as reported by various interventional paediatric cardiology centres around the world.

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