

TRANSCATHETER DEVICE CLOSURE OF SECUNDUM ATRIAL SEPTAL DEFECT (ASD) IN YOUNG CHILDREN

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ABSTRACT

Objective: To analyze the safety and efficacy of device closure of secundum atrial septal defect in children ≤ 5 years of age.

Study Design: Quasi-experimental study.

Place and Duration of Study: The study was conducted at Armed Forces Institute of Cardiology / National Institute of Heart Diseases Rawalpindi, Pakistan from Dec 2010 - Dec 2012.

Patients and Method: Forty eight patients ≤ 5 years of age underwent transcatheter closure of secundum ASD during two years. All patients were evaluated with 2-D echocardiography before the procedure. The sizing balloon was used in 6% and general anaesthesia was given in 83% (n=40) of patients.

Results: Ninety seven point nine percent (47/48) had successful closure of ASD. The mean age was $4.1 \pm .68$ years (range 2.5-5 years) and 58.4% (28/48) were females. The defect size and occluders used were between 5-20 mm (mean 12 ± 3.5) and 8-22 mm (mean 15 ± 3.9) respectively, three patients had simultaneous procedures including pulmonary valvuloplasty in two and percutaneous transmitral commissurotomy (PTMC) in one. The major complications remained 2% (1/48) which included device embolization just after release of device while minor complication rate was 12.5%. The median procedure time was 30 min (15-100 min) and median fluoroscopic time was 6 min (1.50-45 min). There was no emergency surgical exploration or death during this period.

Conclusion: Transcatheter device closure of suitable secundum atrial septal defect is effective and safe in young children in skilled and professional hands.

Keywords: Atrial septal defect, Device closure, Percutaneous transmitral commissurotomy.

INTRODUCTION

The overall incidence of congenital heart disease (CHD) in general population is 6-9 per 1000 live births¹. ASD is one of the most common CHD and accounts for 8-10% of CHD, secundum or ASD is the most common form which accounts for 70% of all ASDs. It remains asymptomatic in most patients and picked up on clinical examination usually during respiratory illness². If remains undiagnosed it may result in a number of complications including arrhythmias, pulmonary hypertension, paradoxical thromboembolism, heart failure etc. In asymptomatic patients closure may be deferred to 2-4 years of age but in some situations may necessitate earlier closure^{3,4}. The surgical closure of septal defect remained a gold standard

treatment for secundum ASDs⁵ but with the advancement in technology and to avoid surgery related complications, transcatheter device closure of secundum ASD is an attractive alternative. The first transcatheter device closure was reported by King and Mills in 1976⁶.

In Pakistan few centers are providing facility for transcatheter device closure of secundum ASD. AFIC/NIHD is providing a broad range of transcatheter intervention for congenital heart defects in children and adults. At our centre first device closure of secundum ASD was done in 2001. Now with experience we are performing transcatheter closure of ASD in young children. The aim of this study was to find out the safety and effectiveness of transcatheter closure of ASD in young children.

MATERIAL AND METHODS

At our institution 227 patients underwent device closure of secundum ASD from Dec 2010

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to Dec 2012. Forty out of 227 were included in this study population and the age varied from 2.5 to 5 (\pm 68 SD) years and 58.4% (n=28) were females. All these patients were evaluated in

with standard protocol with Philips IE-33 for rims, total septal length and associated lesions. Eleven patients were having deficit aortic rim, two patients were having severe pulmonary

Table-1: Descriptive analysis of different variables included in the study population of secundum Atrial Septal Defect (ASD) for transthoracic device closure.

Variables	Minimum	Maximum	Mean	SD
Ht (cm)	86.00	110.00	98.4000	6.74007
Wt (kg)	9.50	19.00	13.8000	1.93781
Age (years)	2.5	5.0	4.170	.6810
Procedural time (mins)	15	100	34.98	14.891
ASD device size (mm)	8	22	15.04	3.903
Size of ASD (mm)	5.00	20.00	12.1000	3.59705
Fluoroscopic time (min)	1.50	45.00	8.5854	8.51639

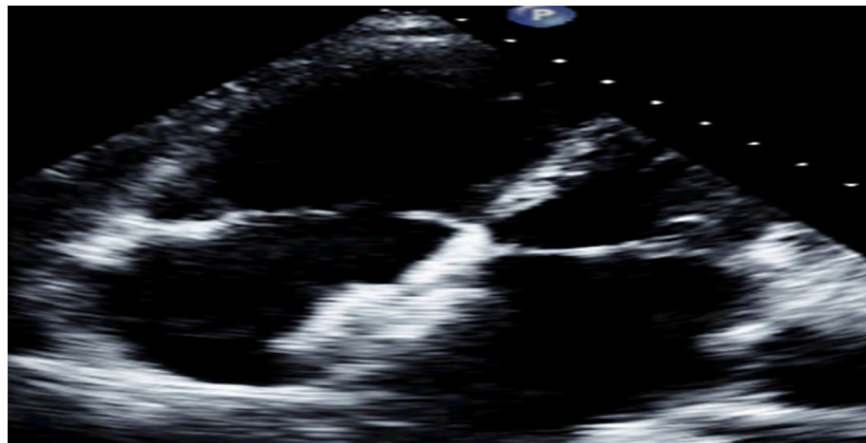


Figure-1: Transthoracic echocardiogram showing well placed Atrial Septal Defect (ASD) device.

patients with isolated secundum ASD were booked for device closure. The patients that were included comprised of elective closure n=29, with frequent respiratory infection n=4, social reasons and parents' anxiety n=12, pulmonary stenosis n=2 and mitral stenosis n=1.

The patients associated with other complex cardiac malformation, with partial anomalous pulmonary venous connection, too large defect, with deficient inferior vena caval/posterosuperior rim and multifenestrated ASD were not included in the study. A detailed 2-dimensional echocardiography was performed

stenosis, one was having kyphoscoliosis with severe mitral stenosis and two patients were having two defects, one larger than the other.

The occluder size (ASD \pm 3-5 mm) was decided on the basis of transthoracic echocardiography in OPD. In three patients we decided to use sizing balloon with stop flow technique for sizing the defect and the occluder size (defect size + 1-2 mm) as in these 3/48 patients the septal length seemed challenging for the device. A written informed consent was taken before the procedure. All the patients were recalled a day before the procedure for clinical

examination, blood complete picture, chest x-ray was done to rule out infection and admitted on the same day of procedure. Forty out of 48 (83%) had device closure under general anesthesia while conscious sedation was used in 8 patients. After venous access a catheter was passed through the defect to right upper pulmonary vein (RUPV) and a contrast injection was given in 4 chamber view to define the alignment of septum. A super stiff exchange wire was parked in RUPV and a recommended delivery sheath was passed and device loaded with delivery cable into the sheath. The left atrial disc of device was opened and under guidance of transthoracic echocardiography / fluoroscopy the device was then pulled along the septum and RA disc then deployed. The device was then unscrewed after confirming the position by transthoracic echocardiography as shown in figure-1.

A continuous monitoring was done with transthoracic echocardiography and fluoroscopy during the whole procedure. All patients received IV heparin 100u/kg and ceftriaxone 50mg/kg during the procedure followed by two more doses of antibiotics 12 hourly. Transthoracic echocardiography was performed after 24 hours at the time of discharge and advice to continue to take aspirin (3-5 mg/kg) for 6 months with follow up at 1, 3 and 6 months.

RESULTS

Forty seven out of 48 (97.9%) patients had successful closure of secundum atrial septal defect during the study period. The age varied from 2.5-5 (\pm 68 SD) years and weight between 9.5-19 kg (\pm 1.9 SD). Twenty eight (58.4%) patients were female and 40 (83%) had general anesthesia while in 8 patients the procedure was done with conscious sedation. The ASD size was 5-20 mm (\pm 3.5 mm) and occluder size was between 8-22 mm (\pm 3.9 mm). In 93.7% (n=45) patients transthoracic echocardiography was used for size/device estimation and guidance tool for device deployment. The sizing balloon with stop flow technique under transthoracic guidance with sizing plate was used in three

patients for sizing the defect. In 3/50 patients transesophageal echocardiography was used for defect size and for guidance of device deployment. The median procedure time was 30 min (15-100 min) and median fluoroscopic time was 6 min (1.50-45 min) as shown in table-1.

Three patients (3/48) had simultaneous procedure including two patients who had pulmonary valvuloplasty and the pressure gradient reduced from 60 mmHg to 16 mmHg and 80 mmHg to 25 mmHg respectively. The third patient, a 5 years old female child with kyphoscoliosis, who had severe mitral stenosis underwent successful mitral valve commissurotomy (mean pressure gradient reduced from 21 mmHg to 10 mmHg) without any mitral regurgitation along with device closure of ASD.

In two patients the two defects were closed with single device. There was difficulty in deployment of device in four patients requiring multiple attempts. In two patients the device could not be deployed even after multiple attempts then transesophageal echocardiography (TOE) was done which showed larger defect than the previous one (multiple attempts might have torn the septum) so larger size devices were then taken and deployed with satisfactory results and in one patient balloon assisted technique was used for deployment of device. In one patient IVC rim was attenuated so TOE was used as guidance for deployment but the device dislodged immediately after release into left atrium which was snared and retrieved successfully percutaneously and referred for surgical closure.

In two patients the device looked too large obstructing the AV valves (mitral regurgitation) so it was replaced with smaller device with good results. The overall minor complication rate was 12.5% including residual leak (n=1) which settled after 24 hrs, 4 had transient bradycardia and first degree heart block in one patient during the procedure. No death occurred during the study period.

DISCUSSION

The device closure of secundum ASD in young population remained successful and safe procedure with fewer complications in our study population. Although surgical closure of ASD has long history with excellent results, low complication rate and little or no mortality and also has good outcome even in young children⁷⁻⁹. The technique of device closure of ASD is progressing since 1976. This technique is a widely accepted mode of treatment in adolescent and adults with favorable outcome during long term follow up^{10,11}. It provides an effective and safe method of closure for secundum ASD as an alternative to surgical closure¹²⁻¹⁴. Butera et al has systematic review and meta-analysis of the available data and found percutaneous closure of ASD more safe with less complications compared to surgical closure¹². It has been extensively experienced in older patients^{12,15} but in very young children studies are lacking. Now with the availability of small sized catheters/devices and the expertise, it is possible even in small children^{16,17}. Lim DS reported device closure of secundum ASD in premature infant and there was significant improvement in respiratory problems¹⁸. Karim et al had experienced it in 15 infants with success in 14/15 and concluded that it is safe and alternative to surgery even in infants¹⁹. A number of factors including size/rims of defect, septal length and associated anomalies are important considerations for successful ASD closure. As in our study population meticulous analysis of all aspects was carried out in OPD by transthoracic echocardiography in most patients. Petit et al pointed out that the ASD size to weight ratio > 1.2 is associated with failure of percutaneous approach in infants and toddlers²⁰. Keeping in view this observation we did not attempt the procedure in two patients.

Butera et al had device closure in 48/553 young patients during 5 years period and reflected no major complication in young children for transcatheter device closure of ASD²¹. We had the same results but unfortunately one device dislodged with success

rate 97.9% (47/48). Similarly Cardenas et al reported closure of ASD in 52/278 children weighing ≤ 15 kg during 4.5 years and there was no major procedural complication except device embolization in two patients which were retrieved successfully with snare²². The minor complications ranged 10-16% which are comparable with our results as minor complication remained 12.5%.

A number of different tools including TOE, transthoracic echocardiography, intracardiac echocardiography and cardiac magnetic resonance imaging are available for measurements of atrial septal defect, estimation of device size and guidance for device deployment. We used transthoracic echocardiography as primary tool for measurement of defect / occluder size as well as guiding equipment during the deployment of device except in 3 cases (6%) where we switched from transthoracic echocardiography to transesophageal echocardiography.

On transthoracic echocardiography in two patients it was found that the occluder size was large and obstructing the mitral valve so we used smaller device with satisfactory results as supported by other studies²². The experience of Wang et al in 165 children under five years also supported our study with success rate of 98.8% and TTE was used for ASD/ occluder size estimation and deployment guidance while TOE was used in 5 cases (3%)²³.

During this study period we faced difficulty in venous access in some children which prolonged the procedure time as also pointed out by Kim et al about smaller sized vessels, larger sheath and relatively rigid delivery system with potential risk of damage to cardiac tissue²⁴. There was no tearing, perforation, avulsion, thrombus formation cardiac tamponade or death during our study period.

We have not compared our results with the surgical results in young children, as in this age group parents opt for percutaneous closure rather than having surgery.

CONCLUSION

Transcatheter device closure of ASD in young children is safe and effective in experienced hands with appropriate selection of cases.

REFERENCES

1. Van der Linde D, Konings EE, Slager MA. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. *J Am Coll Cardiol* 2011; 58: 2241-7.
2. Porter CJ, Edwards WD. Atrial septal defects. In: Allen HD, Driscoll DJ, Shaddy RE, Feltes TF. *Moss and Adams' Heart disease in infants, children, and adolescents: including the fetus and young adults*, 7th ed. Lippincott Williams & Wilkins 2008; pp. 632.
3. Park MK. *Pediatric cardiology for practitioners*. 5th ed. Philadelphia: Mosby Elsevier 2008; pp. 161-91.
4. Lammers A, Hager A, Eicken A, Lange R. Need for closure of secundum atrial septal defect in infancy. *J Thorac Cardiovasc Surg* 2005; 129: 1353-7.
5. Baskett RJ, Tancock E, Ross DB. The gold standard for atrial septal defect closure: current surgical results, with an emphasis on morbidity. *Pediatr Cardiol* 2003; 24: 444-7.
6. King TD, Thompson SL, Steiner L, Mills NL. Secundum atrial septal defect. nonoperative closure during cardiac catheterization. *JAMA* 235: 1976; 2506-9.
7. Murphy JG, Gersh BJ, Mc Goon MD, Mair DD, Porter CJ. Long-term outcome after surgical repair of isolated atrial septal defect: follow-up at 27 to 32 years. *N Engl J Med* 1990; 323: 1645-50.
8. Parvathy U, MCh, Komarakshi R Balakrishnan. Surgical closure of atrial septal defect in children under two years of age. *Asian Cardiovasc Thorac Ann* 2004; 12: 296-9.
9. Andrews R, Tulloh R, Magee A, Anderson D. Atrial septal defect with failure to thrive in infancy: hidden pulmonary vascular disease? *Pediatr Cardiol* 2002; 23: 528-30.
10. Fischer G, Stieh J, Uebing A, Hoffmann U. Experience with transcatheter closure of secundum atrial septal defects using the Amplatzer septal occluder: a single centre study in 236 consecutive patients. *Heart* 2003; 89: 199-204.
11. Knepp MD, Rocchini AP, Lloyd TR. Long-term follow up of secundum atrial septal defect closure with the amplatzer septal occluder. *Congenit Heart Dis* 2010; 5: 32-7.
12. Butera G, Biondi-Zoccai G, Sangiorgi G, Abella R. Percutaneous versus surgical closure of secundum atrial septal defects: a systematic review and meta-analysis of currently available clinical evidence. *EuroIntervention* 2011; 7: 377-85.
13. Bialkowski J, Karwot B, Szkutnik M. Closure of atrial septal defects in children. Surgery versus amplatzer device implantation. *Tex Heart Inst J* 2004; 31: 220-3.
14. Zhong-Dong DU, Hijazi ZM, Kleinman CS. Comparison between transcatheter and surgical closure of secundum atrial septal defect in children and adults. *J Am Coll Cardiol* 2002; (39): 1836-44.
15. Butera G, Romagnoli E, Carminati M, Chessa M. Treatment of isolated secundum atrial septal defects: impact of age and defect morphology in 1,013 consecutive patients. *Am Heart J* 2008; 156: 706-12.
16. Vogel M, Berger F, Dahnert I. Treatment of atrial septal defects in symptomatic children aged less than 2 years of age using the Amplatzer septal occluder. *Cardiol Young* 2001; 10: 534-7.
17. Choi JY, Kim NK, Park SJ. Feasibility and safety of transcatheter closure of atrial septal defect in small children weighing 10 kg or less. *Catheter Cardiovasc Interv* 2008; 1: S10.
18. Lim DS, Matherne GP. Percutaneous device closure of atrial septal defect in a premature infant with rapid improvement in pulmonary status. *Pediatrics* 2007; 119: 398-400.
19. Diab KA, Cao QL, Bacha EA, Hijazi ZM. Device closure of atrial septal defects with the Amplatzer septal occluder: safety and outcome in infants. *J Thorac Cardiovasc Surg* 2007; 134: 960-6.
20. Petit CJ, Justino H, Pignatelli RH, Crystal MA, Payne WA, Ing FF et al. Percutaneous atrial septal defect closure in infants and toddlers: Predictors of Success. *Pediatr Cardiol* 2013; 34: 220-5.
21. Butera G, De Rosa G, Rosti L. Transcatheter closure of atrial septal defect in young children. *J Am Coll Cardiol* 2003; 42: 241-5.
22. Cardenas L, Panzer J, Boshoff D, Malekzadeh-Milani S. Transcatheter closure of secundum atrial defect in small children. *Catheter Cardiovasc Interv* 2007; 69: 447-52.
23. Wang HS, Qian MY, Zhang ZW, Zeng SY. Applying interventional treatment for the atrial septal defect in 165 children under five years of age. *Zhonghua Er Ke Za Zhi* 2005; 43: 373-6.
24. Kim NK, Park SJ, Choi JY. Transcatheter closure of atrial septal defect: does age matter?. *Korean Circ J* 2011; 41: 633-8.