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Cardiac Catheterization And Interventions in CHD

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SINGLE OPERATOR EXPERIENCE OF CARDIAC CATHETERIZATION AND INTERVENTIONS IN CONGENITAL HEART DISEASES OVER TWO YEARS AT AFIC – CASE ASSORTMENT AND VASCULAR COMPLICATIONS

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ABSTRACT

Objective: This study elucidates single operator performed, contemporary experience of percutaneous cardiac interventions and diagnostic catheter studies in patients with CHD with focus on individual case selection, approach and vascular complications.

Study Design: Prospective study.

Place and Duration of Study: Department of Paediatric Cardiology, Armed Forces Institute of Cardiology and National Institute of Heart Diseases, (AFIC/NIHD) Rawalpindi, from Jul 2017 to Jun 2019.

Methodology: Total consecutive 574 patients, who were selected & underwent cardiac catheterization for various CHDs by single operator.

Results: The author performed total of 574 cardiac catheter procedures during study period including both diagnostic and interventions in various CHDs. Mean age was 8.8 years, mean weight 22 kg and mean height was 106.3 cms. 59% cases were done under general anesthesia and 51% of patient population was male. Diagnostic procedures constituted 51% of total cases with most common indication being the Tetralogy of Fallot. 284 interventional procedures done in 280 patients included Patent ductusarteriosus device closure (n=86), Atrial Septal defect device closure (n=52) and Pulmonary valve ballooning (n=39). In four patients, two interventions were done in same catheter procedure. Transient vascular complications occurred in 4.5% of the cases.

Conclusion: Cardiac catheterization in CHDs is generally efficacious and a safe procedure. Young infants are specifically at high risk of vascular complications.

Keywords: Cardiac catheterization, Congenital heart diseases, Device closure, Vascular complication.

INTRODUCTION

There is no doubt about the prominence of cardiac catheterization in diagnosis & treatment of various CHDs in all age groups and is being widely used all over the world[1]. In developed countries, the trend is now shifting from diagnostic cardiac catheter studies to interventions /hybrid procedures with cardiac Magnetic resonance imaging (MRI) generally replacing many simple diagnostic cardiac catheterizations[2-4]. Regardless of the image modality used, a complete diagnosis of congenital heart defects is fundamental for management and essential before any transcatheter or surgical intervention. CHDs are usually diagnosed on transthoracic echocardiogram with underlying anatomy and available resources determining the need for further imaging. Noninvasive options include transesophageal echocardiography, cardiac computed tomography (CT) Angio[5], 3 cardiac MRI while invasive option is generally cardiac catheterization or less commonly MRI guided cardiac catheterization procedures. The role of cardiac catheterization in diagnosis of CHDs especially in resource limited countries like ours is of paramount importance and its role is expanding with time due to advent of new procedures like percutaneous valve replacements[6]. Commonly performed procedures includes Patent ductusarteriosus (PDA) device closure[7], Atrial Septal defect (ASD) device closures[8], ventricular Septal defect (VSD) device closure[9,10], balloon valvuloplasty[11], balloon atrial septostomy[12], stenting of PDA[13]/ Right ventricle outflow tract (RVOT)[14]/Coarctation[15] & Branch pulmonary arteries, pacemakers and so forth.

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Centers around the world usually report their experience either as single center or involving multiple centers. However, an individual operator's experience can be fairly different from the overall center's experience in terms of selection of particular cases with special preferences or expertise/strengths in certain areas. The focus of this paper is to share my (author) experience of cardiac catheterization in various CHDs in two years at AFIC/NIHD, with special emphasis on indications, selection criteria, vascular complications and various individual techniques used during these procedures. All of the cases were seen on outpatient basis, worked up for catheter studies and accomplished catheterization procedures by the author.

METHODOLOGY

This prospective study analyzed the single operator performed cardiac catheter procedures for CHDs from July 2017 to June 2019. Consecutive 574 patients with CHDs were included, who underwent cardiac catheterization by single operator over the study period. All patients were assessed in detailand pre procedural assessment including a complete history & physical examination, 12 lead Electrocardiogram, a Chest X-ray, blood complete picture and atransthoracic or transesophageal echocardiography. Road map for cardiac catheter study was made before angiography. After taking written consent, patients were taken to the catheterization lab. After preparation/anesthesia, vascular access was established as per requirement. Vascular access was considered as one of the most important step in whole catheter study and smallest size sheath was chosen for arterial access at least to start with. Details of vascular access (table-IV). As commonly practiced, approach from right groin was preferred unless not required or not feasible. Radial artery was used in patients with coarctation of aorta undergoing stenting or if coronary angiography was also required. Axillary artery was used in one patient for PDA stenting. For arterial access, I preferred to start with cannula, (in study population arterial access was obtained with cannula in 87% of these cases), preferably puncturing only anterior wall in adults but in small children puncturing both walls and stabilizing the cannula followed by slow withdrawal without attaching syringe, waiting for blood jet and advancing the wire only if good flow was obtained so as to avoid intimal injury to arterial wall. For venous access, the standard Seldinger technique was used in most cases requiring either a cannula or short needle attached with 3ml syringe. However, I found obtaining venous access easier especially in very small infants/neonates to go for femoral vein with cannula, without attaching the syringe, pushing it just medial to femoral artery till it hit the bone, removing the needle and then very slowly withdrawing the cannula while waiting for a good flow.

In diagnostic catheter studies, focus remained on demonstrating the cardiac anatomy in full detail along with invasive/accurate blood pressure measurements in various chambers and vessels with complete hemodynamic studies. In intervention group, device closures, ballooning valvuloplasty or stenting procedures were performed as per protocols. One of PDA device closures and a case of aortic valve ballooning procedureis (fig-1 & 2). Balloon atrial septostomy was performed with minimal fluoroscopy under echocardiographic guidance. Meticulous care was taken to keep the procedure risk free, avoiding unnecessary fluoroscopy and keeping sheath in anesthesia time to a minimum possible. Critical cases were usually shifted to high dependency units or Paediatric intensive care units. Post procedural care included two doses of antibiotics, vital signs monitoring, examination & echocardiography after 4 hours and discharge echocardiography on the next morning. Vascular complications were recorded and pulse loss managed according to institutional protocol. Data was entered in SPSS-23 and descriptive analysis done; student's t or Chi-square tests were used as applicable.

RESULTS

The author did total of 574 cardiac catheter procedures during study period including both diagnostic and interventional in various con-

genital heart diseases from July 2017 to June 2019. Basic descriptive data is presented (table-I). Mean age was 8.8 ± 10.8 years, mean weight was 22 ± 18.9 kgs and mean height was 106.3 ± 36 cms. 59% cases were done under general anesthesia and 51% of patient population was male. Diagnostic procedures constituted just over 51% (table-II). The two most common indications for device closure (n=86), ASD device closure (n=52), Pulmonary valve ballooning (n=39), balloon atrial septostomy (n=26) and Coiling of major Aorto pulmonary collaterals (MAPCAs) (n=19). In four patients, two interventions were performed through a single catheter i.e. ASD device closure & pulmonary valve ballooning in three cases and PDA Stenting and balloon atrial septostomy in

Table-I: Descriptive dataof study population.

Variables	Total No.	Mean & SD	Min.	Max.
Age in years	574	8.8 ± 10.8	01 day	70
Weight in KGs	574	21.9 ± 18.9	02	85
Height in cms	574	106.3 ± 36	48	177
Procedural time in minutes	574	36.7 ± 16.2	15	125
Fluoroscopy time in minutes	574	8.9 ± 8.7	00	75
Amount of contrast used in ml	574	30.5 ± 25.6	00	150
ASD size in mm (ASD device closure group)	52	20.1 ± 8	06	35
PDA size in mm (PDA device closure group)	86	5.5 ± 3	1.5	12

Table-II: Breakdown of diagnostic cardiac catheterization.

Disease / procedure	Male patients	Female patients	Total
Tetralogy of Fallot including Pulmonary Atresia	55	47	102
Septal defects + pulmonary hypertension	45	50	95
Complex Single ventricle physiology	29	20	49
Pre – Fontan Cath study	08	03	11
Others	18	19	37
Total	155	139	294

Table-III: Break down of interventional procedures.

Procedure	Male patients	Female patients	Total
PDA device closure	24	62	86
ASD device closure	22	30	52
VSD device closure	05	10	15
Pulmonary valve ballooning	23	16	39
Aortic valve ballooning	08	03	11
Coarctation balloon / Stenting	05	02	07
MAPCA coiling	14	05	19
PDA Stenting	07	02	09
Balloon atrial septostomy	19	07	26
Percutaneous permanent Pacemaker	04	01	05
Others	08	07	15
Total	139	145	284

diagnostic catheter studies were either Tetralogy of Fallot (TOF) like anatomy in 102 patients or physiological/operability evaluation in left to right shunt group in 95 patients.

The author performed 284 interventional procedures in 280 patients (details in table 3) of which the five most common cases were PDA one neonate. Total of 52 ASD device closures were accomplished during the study period. As per our practice, 47 of them were done under trans-thoracic echocardiographic and angiographic guidance and only one of ASD device was embolized which was retrieved with a snare. A right pulmonary venous approach was preferred

and was found successful in over 90% of patients. The most common intervention was PDA device closure in 86 patients; 80% were type A Krichenko ducts, 40% were large size and 31% moderate size. 35% of PDA device closures were done without an arterial line under transthoracic echocardiographic guidance and all were successful. Only one PDA device embolized but was snared from right pulmonary artery which was replaced by a bigger device in the same procedure without any complications. Being conservative, only 15 VSDs were closed using a device (VSD is to be closed only if it is hemodynamically significant, chances for spontaneous closure are remote and if it's easily achievable). Most common procedure in neonate was balloon atrial septostomy (27 patients) resulting in base line oxygen saturation improvement from a mean of 58% ± 12 to 81% ± 6 (p-value <0.005) in air and increment in the size of patent foramen Ovale from 1.3mm ± 0.5 to 5.3mm ± 0.5. Mean age in these neonates was 17 days so all but two were done using femoral venous approach; in two cases umbilical vein was used. Among the group of pulmonary/ aortic/ coarctation ballooning, the pre-procedural peak to peak pressure gradient was 71.7 ± 23.9 mmHg (range: 33-150mmHg) which was reduced to 23.3 ± 18.2 mmHg after the procedure.

Table-IV: Vascular access used in study population.

Vessel used for cath / Angio	Numbers	Complications
Right or left femoral artery	285	13 (4.5%) – transient pulse loss
Right Radial artery	14	Nil
Left Axillary artery	01	Nil
Right or left femoral vein	515	Nil
Right or left internal Jugular vein	16	Nil
Left internal Jugular vein	02	Nil
Left subclavian vein	05	Nil
Right Subclavian vein	02	Nil
Umbilical vein	02	Nil

Details of vascular access (table-IV). In 49.6% of cases, only venous line was obtained, in 42% both arterial & venous lines were used and in 8.4% cases only access required was arterial. As commonly practiced, preferred approach was from the right groin unless not required. Radial artery was used in patients with coarctation of aorta undergoing stenting or if coronary angiography was also required. Axillary artery was used in one patient for PDA stenting. In context tovascular/arterial complications, 96% patients did not suffer any complications, 13 patients (including 11 infants) required intravenous heparin for mean of 04 hours and one of them addition-

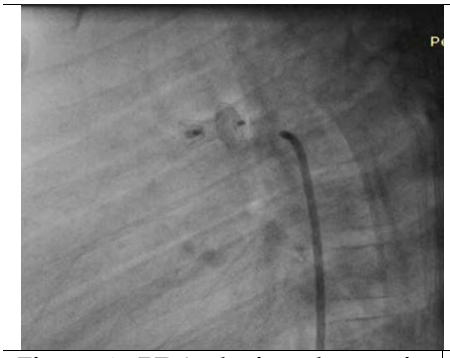

Figure-1: PDA device closure in young girl with small sized PDA, closed with 8/6 ductal occluder.

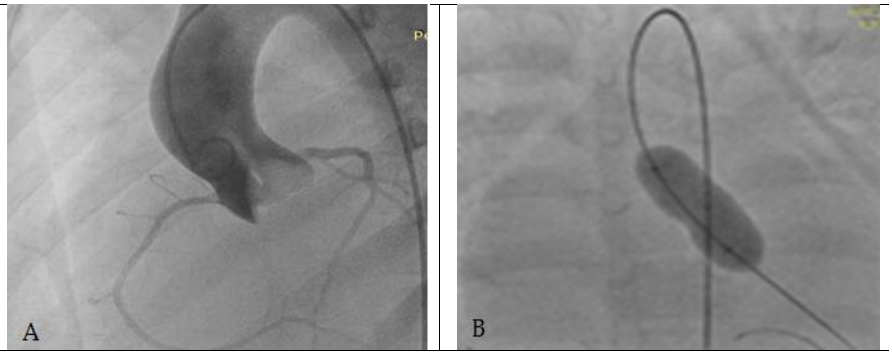

Figure-2: Aortic valve ballooning in a young girl with severe aortic valve stenosis, a): a pre-procedural aortogram showed very narrow aortic valve with central opening, b) balloon with waist positioned at aortic valve.

ally required one hour infusion of streptokinase for pulse loss. However, all of them recovered without complications.

DISCUSSION

Cardiac catheterization is widely used to diagnose as well as to treat various types of CHDs all over the world in all age groups. Nevertheless, thetrend is now shifting from diagnostic catheter studies to interventions as cardiac MRI is generally replacing many simple diagnostic catheterizations especially in developed countries[2]. At our institution (AFIC), we have been performing cardiac catheterization studies for almost three decades with increasing frequency in last fifteen years. We have published our data in number of journals as overall center experience but this paper is first of its kind where an experience of only one pediatric cardiologist (author) is looked at over the last two years. I am therefore presenting my experience of 574 cardiac catheter studies in CHDs with age ranging from a 01 day old neonate to a 70 years old (70-year-old lady with large ASD secundum who underwent successful device closure using 39 mm Septal occlude). Diagnostic group can either CHDs with decreased pulmonary flow or with pulmonary hypertension and were nearly equally comprised in my study population similar to a documen-tation from Egypt[16].

The way the cases are selected and approached in catheter laboratory can be dissimilar for different operators and it is fascinating to look at individual approach in comparison to institutional approach. There is a wide range of application of catheter studies in CHDs in all age groups both for diagnostic and for interventional purposes. Every operator is customized to his own case selection & approach and interesting variances could be established, for example, anideal age & weight of the patient for a particular procedure. For instance, for a small to moderate sized PDA, the ideal timing for device closure can be at any time once patient's weight is around 06 KGs. Some operators prefer one year olds (I prefer the same!) and some are routinely doing it at 09 months in a similar set of patients. Although PDA device closure in now increasingly being reported in very young premature infants 6 but it is technically challenging and only attempted if there is no other option. I offered device closure to 86 patients with isolated PDA, mean age was 5.2 ± 6.3 years, mean weight was 15.6 kg and only 11 cases were younger than one year of age as compared to 28 who were between 1-2 years of age. Likewise, I chose a very conservative approach while going for transcatheter VSD Device closure and only offered device closure to 15 patients with hemody namically significant VSDs in whom chances for improvement or spontaneous closure were very remote and only if it was easily doable with transcatheter technique. In ASD device group, out of 52 cases, only one device was embolized to main pulmonary artery and was successfully snared and retrieved. Similar statistics are being reported in a recent article from Lebanon[18].

Regarding vascular access, every operator is different with minor alterations & modifications. Every effort was made to avoid the arterial access especially in smaller infants with TOF or other cyanotic CHDs during routine diagnostic cardiac catheterization and to obtain all the necessary information from venous approach. These cyanotic children generally have polycythemia/procoagulant tendencies and are at higher risk for arterial thrombosis especially if arterial line is insitute for a prolonged time. Hence, it's best to avoid the arterial access altogether or if necessary, to keep the catheter in for the shortest possible time. In my experience, about 4.5% of cases (more than 80% of them were young infants) had transient limb pulse loss requiring brief intravenous infusion of heparin; similar statistics are documented worldwide[19-21]. As documented in literature, arterial complications are usually encountered in small low weight infants, needing multiple attempts to obtain an arterial access, damaging intima with guide wire, pro-longed in sheath time, large caliber arterial sheaths, multiple changes of catheters and failure to give heparin. One of the recent studies from

Egypt has reported 12 vascular complications in their retrospective analysis of 262 children with CHDs[1].

Cardiac catheterization is not risk free and potential complications can be life threatening. If risk is too high then alternative imaging option should be considered like cardiac MRI/CT Angio or TOE. There is definitely a learning curve involved and is widely documented in literature that with experience, appropriate case selection and good peri op management, the rate of complication can be reduced[1,8].

CONCLUSION

Cardiac catheterization in CHDs is generally a safe procedure in hands of experienced & well-trained pediatric cardiologists but is certainly not risk free. The younger age, lower body weight and prolonged procedure times can lead to complication especially the vascular ones.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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