

## ANESTHETIC CONCERNS IN PAEDS CARDIAC CATHETERIZATION AT ARMED FORCES INSTITUTE OF CARDIOLOGY/NATIONAL INSTITUTE OF HEART DISEASES

Amna, Naila Niaz, Zainab Farid, Umair Younas, Rehana Javaid

Armed Forces Institute of Cardiology/National Institute of Heart Disease (AFIC/NIHD)/National University of Medical Sciences (NUMS) Rawalpindi Pakistan

### ABSTRACT

**Objective:** To examine the types of procedures and analyze the frequency of anesthesia-related complications during pediatric cardiac catheterization.

**Study Design:** A prospective observational study.

**Place and Duration of Study:** Pediatric Cardiac Catheterization Lab at AFIC/NIHD Rawalpindi, from July 2019 to Nov 2019.

**Methodology:** Total 180 consecutive patients undergoing cardiac catheterization fulfilling inclusion criteria were studied. Demographic variables, diseases, type of procedure, variables and anesthesia-related complications were noted. All the data was analyzed using SPSS-23.

**Results:** The study included 180 patients where 96 (53.3%) were male and 84 (46.7%) were female. Most of the patients in our study were between ages 1 to 3 years (85). 99 (55.0%) patients had diagnostic cardiac catheterization (CC), while 81 (45%) patients underwent interventional procedures. The overall complication rate noted as 18.9%, including arrhythmia in 11.1% followed by hypotension 4.4%, laryngospasm 3.9% and inotropic support requirement 3.3%, Mortality was 0.6%. Most of the patients presenting to the pediatric cardiac catheterization lab were for PDA device closure (16.6%). Age of child was found to be significant risk factor for cardiac catheterization associated complications with a *p*-value of 0.022.

**Conclusion:** Congenital and structural heart disease catheterization procedures are progressively increasing, especially due to the medical advances and complex interventional therapeutic procedures. A thorough pre-anesthesia assessment should be carried out to optimize before cardiac catheterization.

**Keywords:** Cardiac Catheterization, Anesthesia-related complications, Congenital heart disease.

---

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

---

### INTRODUCTION

Cardiac Catheterization (CC) is required in patients with congenital heart disease where the anatomy of the heart cannot be well defined by non-invasive means. Specific details about the hemodynamic features and anatomy of complex heart lesions require cardiac catheterization<sup>2</sup>.

Because of newer techniques and devices, pediatric cardiac catheterization is rapidly expanding. A variety of interventional procedures are being performed, which include the device closure of ventricular septal defect, atrial septal defect and patent ductus arteriosus PDA, the creation of holes such as septostomy, valvuloplasty, the placement of stents to open up narrowed vessels

such as coarctation of aorta, ductal narrowing in duct dependent circulation for example stenting of PDA in duct dependent circulation which is very high risk procedure, the embolization of vessels such as collateral vessels in Tetralogy of Fallot<sup>3-5</sup>.

Various adverse events can occur throughout the CC procedure. It can be during premedication for sedation, vascular access, diagnostic CC and therapeutic interventions. Some of the most common complications include exposure to radiation; risk of general anesthesia (aspiration, laryngospasm and bronchospasm, hypoxia); hypothermia, aggravation of hypoxemia; arrhythmias, vascular injuries, perforation or tears. Other complications include cardiac perforation, cardiac valve injury, thromboembolism, renal insuffi-

---

**Correspondence:** Dr Amna, Adult Cardiac Anesthesia Department, AFIC/NIHD Rawalpindi Pakistan

ciency, pulmonary hypertensive crises, blood loss that requires transfusions, allergic reaction (to contrast agents, drugs or anesthetics), Severe hypotension, stroke and death<sup>6</sup>. Studies showed the risk of severe complication is (1.91-9.3%) and the mortality rate is (0.14-0.29%) in diagnostic and interventional procedures<sup>7-9</sup>.

Pediatric Cardiac Catheterization is well developed at the Armed Forces Institute of Cardiology. Various Diagnostic and Interventional procedures are carried out.

### **METHODOLOGY**

It was a prospective observational study. Duration of the study was from July to Nov 2019 in Pediatricscardiac catheterization Lab, Armed Forces Institute of Cardiology, Rawalpindi, inclusion criteria consist of the patients with age 0 days to 16 years and Patients scheduled for elective cardiac catheterization under general anesthesia/sedation.

After Approval by the research board of our institute, prospective data were collected from the Paeds cardiac catheterization Lab. Consecutive patients undergoing cardiac catheterization fulfilling inclusion criteria were studied. Patients demographics profile including age, gender and weight were noted, age of the children were further divided into six groups i.e. group 1: age less than 6 months, group 2: age 6 months to less than 1 year, group 3: 1 year to 3 years, group 4: age >3 years to 6 years, group 5: >6 to 10 years, group 6: age >10 years. Disease, type of procedure, anesthesia-related complications like arrhythmias, hypotension, hypoxemia, bronchospasm, cardiac arrest and mortality were noted. The catheterization procedures were divided into two categories i.e. interventional and diagnostic. Diagnostic studies were performed to evaluate the anatomic structures and hemodynamic status. Interventional studies included all procedures where an attempted therapy was performed, including balloon pulmonary valvuloplasty (BPV), balloon dilatation of coarctation or stenting, balloon aortic valvuloplasty (BAV), balloon atrial septostomy (BAS), peripheral pulmonary tree balloon

dilatation or stenting, patent ductus arteriosus (PDA), closure of Secundum atrial septal defect (ASD), or ventricular septal defects (VSD), balloon mitral valvuloplasty (BMV) and other miscellaneous procedures. Three methods of oxygenation and airway during sedation and general anesthesia were performed (face mask, laryngeal mask airway (LMA) and endotracheal tube (ETT)). The procedure was done according to standard protocols. Anesthetic techniques and catheterization procedures were performed by the consultant cardiac anesthetist and pediatric cardiologists respectively. Standard monitoring was done.

Data were analyzed using SPSS version 23. The frequency was calculated for age groups, diagnostic procedures, interventional procedures, airway management groups, and anesthesia-related complications. Mean, Median, minimum and maximum values were determined for age and weight. Comparison between risks of different anesthesia-related complications was noted with reference to procedure groups and age groups, and *p*-value was observed using Chi-square charts.

### **RESULTS**

The study included a total of 180 patients. Ninety six (53.3%) were male and 84 (46.7%) were female. Mean and Standard Deviation for age and weight of children was  $3.27 \pm 3.0$  years and  $12.0 \pm 6.49$  kg (Mean  $\pm$  SD) respectively. Minimum age of patients presented in CC lab was 0.01 years and minimum weight was 2.0kg. The distribution of patients in the age groups were as follows:- group 1: age less than 6 months were 15 (8.3%), group 2: age 6 months to less than 1 year were 19 (10.6%), group 3: 1 year to 3 years were 85 (47.2%), group 4: age >3 years to 6 years were 36 (20.0%) , group 5: >6 to 10 years were 16 (0.9%) , group 6: age >10 years were 9 (5.0%). Most of the patients in our study were between ages 1 to 3 years. 99 (55.0%) patients had diagnostic cardiac catheterization (CC), while 81 (45%) patients underwent interventional procedures. For general anesthesia, 73 patients procedure was done using

face mask, 89 patients required LMA and in 18 patients, ETT was placed. Different anesthesia-related complications are given in the table.

Among the 180 cases, 34 (18.9%) patients developed anesthesia-related complications which were more common in interventional procedures

**Table-I: Anesthesia-related complications during cardiac catheterization and its percentage.**

Anesthesia-Related Complications	Yes	No	Percentages
Laryngospasm	7	173	3.9%, 96.1%
Hypotension	8	172	4.4%, 95.6%
Arrhythmias	20	160	11.1%, 88.9%
Inotropic requirement	6	174	3.3%, 96.7%
Cardiac Arrest	1	179	0.6%, 99.3%
Mortality	1	179	0.6%, 99.3%

**Table-II: Types of diagnostic and interventional procedures and its percentage.**

Diagnostic Procedures (n=99)	n (%)
Tetralogy of Fallot	29 (32.2)
Ventricular Septal Defect	20 (20.2)
Tricuspid Atresia	11 (11.1)
Complete and Partial Atrio Ventricular Defects	5,3 (8.0)
Double Outlet Right Ventricle	7 (7.1)
Pulmonary Atresia	4 (4.0)
Partial Anomalous Pulmonary Venous Drainage	3 (3.0)
Other Complex Congenital Heart Diseases	17 (17.2)
Interventional Procedures (n=81)	
PDA Device Closure	30 (37.0)
Ventricular Septal Device Closure	11 (13.6)
Atrial Septal Defect Closure	9 (11.1)
Pulmonary Valve Ballooning	8 (9.9)
Aortic Valve Ballooning	5 (6.2)
Coarctation of Aorta Ballooning	2 (2.5)
Right Ventricle Outlet Stenting	3 (3.7)
Pulmonary Artery Stenting	2 (2.5)
PDA Stenting	1 (1.2)
Major Arterio Pulmonary Collaterals Coiling	3 (3.7)
Septostomy	1 (2.5)

(29.6%) as compared to diagnostic procedures (14%). Among the complications Arrhythmias was most common with percentage of 11.1% followed by hypotension occurring in 8 patients.

While incidence of inotropic support requirement was 3.3%, laryngospasm (3.9%), cardiac arrest (0.6%), and mortality (0.6%).

Types of diagnosis for patients presenting to CC were as follows (n=180). Most of the patients presenting to the paediatric catheterization lab were for PDA device closure 30 out of 180 patients (16.6%), followed by tetralogy of fallot (16%) for diagnostic cath and for ventricular septal defect closure (11.1%).

The risk factor association between type of procedure and different airway techniques related to different complications was done using chi square. Age of child was found to be significant

**Table-III: Different complications occurring in different groups of procedures.**

Complications	Diagnostic Group	Interventional Group
Arrhythmias	8	12
Hypotension	3	5
Ionotropes Requirement	3	3
Laryngospasm	3	4

risk factor for cardiac catheterization associated complications with a *p*-value of 0.022. Similarly, arrhythmia was strongly associated with hypotension and inotropic requirements with *p*-values of 0.000 and 0.001, respectively.

Complications were more related to interventional procedure as compared to diagnostic that was 29.6% and 14.0% respectively. The table below shows different complications occurring in two groups of procedures.

## DISCUSSION

Over the past two decades, cardiac catheterization for congenital heart disease has shifted from primarily diagnostic to therapeutic procedures. Now well-established diagnostic and interventional procedures are being done along with novel techniques. However, this approach of treatment is still burdened with the risk of complications.

Previously, there had been a lot of work done on pediatric cardiac catheterization compli-

cations in Pakistan<sup>10,11</sup>, but the focus of our study was the complications that arise and managed during anesthesia. In our study, we analyzed diagnostic and interventional procedures in the cardiac catheterization lab to identify the type and frequency of anesthesia-related complications and determine the associated risk factors.

Complication rates, which are reported in previous studies, range from 8.8% to 24% and mortality rates ranging from 0.14% to 2.7%<sup>12-17</sup>. In our present study the complication rate was 18.9% which was comparable to previous studies. The arrhythmia was most commonly found in our study and leading to hypotension and inotropic requirement. Only one patient in our study group died, giving an overall mortality of 0.6%, which is slightly higher than the mortality quoted in the 1990s of 0.14 to 0.38%<sup>18-19</sup>, but this can be attributed to small sample size and majority of population being n=85 of age from 1-3 also differences in our methodologies and prolonged cardiac cath procedures account for this. Kamel *et al*, Corroborates with our finding that younger children experienced more anesthetic events during cardiac catheterization agrees with other reports<sup>9</sup>, in our study, the data collection included only deaths occurring in the Cardiac Catheterization lab and post cath ward.

In 2006 West investigated complications for diagnostic cardiac catheterization for which 41 cardiac centers contributed, and 7582 pediatric procedures were registered. Arrhythmias were found to be the leading type of complication (35%) followed by vascular complications (22%)<sup>17</sup>. In our study, arrhythmia occurred in 20 patients (11.1%) out of 180 patients. While vascular thrombosis (11.4%-64.5%) was the most common complication in some of the previous studies<sup>20-23</sup>. Our study revealed that inotropic support requirement (3.3%) while hypotension was seen in (14.4%), laryngospasm (3.9%). Mehta reported that respiratory complications were very rare in a population 11073 patients where procedures were mainly performed under general anesthesia<sup>14</sup>, comparable to our study the result show incidence of respiratory complication of laryngospasm

in 3.9% patients out of 180. In Prospective multicentre experience by Lin *et al*<sup>25</sup>, in 2015, 0.6% of the patients had serious events related to airway management.

Pediatric cardiac and structural heart catheterization has deviated from being a diagnostic tool to a therapeutic one mainly. Several studies have supported the evidence concerning our study, which has shown that the rate of complications is higher in interventional therapeutic procedures than in the diagnostic ones<sup>7,22,24</sup>.

## CONCLUSIONS

Congenital and structural heart disease catheterization procedures are progressively increasing, especially due to the medical advances and complex interventional therapeutic procedures. It is important for anesthetist to know the pathophysiology of disease and effect of anesthetist and interventions have on patients hemodynamic to provide a safe course. Where ever required additional monitoring like invasive blood pressure, central venous pressure, arterial blood gases and temperature monitoring should be considered to enhance safety. Good clinical care, constant vigilance and effective communication within team is essential. It was the aim of our article to review challenges we as anesthetist face in cardiac catheterization suite.

## CONFLICT OF INTEREST

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

## REFERENCES

1. Zuechner A, Mhada T, Majani NG, Sharau GG, Mahalu W, Freund MW. Spectrum of heart diseases in children presenting to a paediatric cardiac echocardiography clinic in the Lake Zone of Tanzania: a 7 years overview. *BMC Cardiovasc Dis* 2019; 19(1): 291.
2. Bonnet C, Greffier A. Paediatric cardiac catheterization: an information sheet. *Arch Cardiovasc Dis* 2013;106(4):228-37.
3. Fattouh A, Sobhy R, Abo-Seif M, Abd-El Aziz F. Egyptian Pediatric Association Gazette. 2017. [Internet] <https://scholar.google.com/citations?user=6k30VbYAAAAJ&hl=en>.
4. Ovaert C, Kammache I, Bonello B, Habib G, Fraisse A. Transcatheter closure of intracardiac shunts. *Arch Cardiovasc Dis* 2012; 1(1): 154-62.
5. Pinte L, Pinte F, Nița D, Mocanu I, Murgu V. Interventional procedures. *Right Heart Pathol* 2018; 1(1): p.697-24.
6. Fiadjoe JE, Litman RS, Serber JF, Stricker PA, Coté CJ. The pediatric airway. A practice of anesthesia for infants and children:

- Elsevier 2019; p. 297-39. e21.[Internet] <https://www.science-direct.com/book/9780323429740/a-practice-of-anesthesia-for-infants-and-children>.
7. Lee KE, Seo YJ, Kim GB, An HS, Song YH, Kwon BS, et al. Complications of cardiac catheterization in structural heart disease. *Korean Circulation J* 2016; 46(2): 246-55.
  8. Bergersen L, Marshall A, Gauvreau K, Beekman R, Hirsch R, Foerster S, et al. Adverse event rates in congenital cardiac catheterization - A multi center experience. *Cathet Cardiovasc Interven* 2010; 75(3): 389-00.
  9. Kamel H, Nour A, Shams K, Roushdy A. pediatric cardiac catheterization outcome-a single center experience. *J Cardiovasc Dis Diagn* 2019; 7(4): 1-8.
  10. Ali F. Impact of the congenital cardiac catheterization project on outcomes-quality improvement (C3PO-QI) in low and middle income countries (LMICs): A single center experience in Pakistan. *Am Acad Pediatrics*; 2019. [https://pediatrics.aappublications.org/content/144/2\\_meetingabstract/552](https://pediatrics.aappublications.org/content/144/2_meetingabstract/552).
  11. Ullah M, Sadiq N, Shah SA, Mehmood A, Sultan M, Akbar H. Practicing Paediatric Cardiology In Resource Limited Country Like Pakistan. *Pak Heart J* 2018; 50(4): 230-34.
  12. Co-burn JP, Gillette PC, Mullins CE, McNamara DG. Cardiac catheterization in the neonate: A comparison of three techniques. *J Pediat* 1978; 93(1): 97-01.
  13. Mori Y, Nakazawa M, Yagihara T. Complications of pediatric cardiac catheterization and system of catheterization laboratories minimizing complications-a Japanese multicenter survey. *J Cardiol* 2010; 56(2): 183-88.
  14. Mehta R, Lee KJ, Chaturvedi R, Benson L. Complications of pediatric cardiac catheterization: a review in the current era. *Cathet Cardiovasc Interven* 2008; 72(2): 278-85.
  15. Booth P, Redington A, Shinebourne E, Rigby M. Early complications of interventional balloon catheterisation in infants and children. *Heart* 1991; 65(2): 109-12.
  16. Rhodes JF, Asnes JD, Blaufox AD, Sommer RJ. Impact of low body weight on frequency of pediatric cardiac catheterization complications. *Am J Cardiol* 2000; 86(11): 1275-78.
  17. West R, Ellis G, Brooks N. Complications of diagnostic cardiac catheterisation: results from a confidential inquiry into cardiac catheter complications. *Heart* 2006; 92(6): 810-14.
  18. Vitiello R, McCrindle BW, Nykanen D, Freedom RM, Benson LN. Complications associated with pediatric cardiac catheterization. *J Am College Cardiol* 1998; 32(5): 1433-40.
  19. Cassidy SC, Schmidt KG, Van Hare GF, Stanger P, Teitel DF. Complications of pediatric cardiac catheterization: a 3-year study. *J Am College Cardiol* 1992; 19(6): 1285-93.
  20. Brotschi B, Hug MI, Kretschmar O, Rizzi M, Albisetti M. Incidence and predictors of cardiac catheterisation-related arterial thrombosis in children. *Heart* 2015; 101(12): 948-53.
  21. Krasemann T. Complications of cardiac catheterisation in children. *BMJ Publishing Group Ltd and British Cardiovascular Society*; 2015. <https://heart.bmj.com/content/101/12/915>.
  22. Luceri MJ, Tala JA, Weismann CG, Silva CT, Faustino EVS. Prevalence of post thrombotic syndrome after cardiac catheterization. *Pediatric Blood & Cancer* 2015; 62(7): 1222-27.
  23. Zhang DZ, Tan TH, Wong KPL, Sundaraghavan S, Choo JTL. Reperfusion injury with compartment syndrome following systemic thrombolysis for cardiac catheterization-related arterial thrombosis in an infant. *J Pediat Int Care* 2020; 9(01): 74-76.
  24. Mullins CE. 35 Complications of diagnostic and therapeutic cardiac catheterizations. *Charles E Mullins, MD* 2006; 895.
  25. Lin, CH, Desai S, Nicolas R. et al. Sedation and Anesthesia in pediatric and congenital cardiac catheterization: a prospective multicenter experience. *Pediatr Cardiol* 2015; 36(7): 1363-75.