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Original Research Article

Profile of cardiac catheterization in children with congenital heart disease in eastern Indonesia

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Abstract

Background: Congenital heart disease (CHD) remains one of the most common congenital defects in pediatrics, affecting 8 to 10 of 1000 live births. Early detection of CHDs is essential, however, data regarding CHDs and their interventions are limited, particularly in Eastern Indonesia.
Aims and Objectives: This study aimed to evaluate the profile of children with CHDs who underwent transcatheter closure procedures at Prof. Dr. R. D. Kandou Manado Hospital.
Materials and Methods: We conducted the retrospective study at Prof. Dr. R. D. Kandou Manado Hospital from January 2020 through June 2022. Medical records were reviewed to obtain baseline characteristics including age, gender, nutritional status, economic status, and type of CHDs and the interventions, which were further categorized by each characteristic.
Results: We included a total of 50 children with CHDs with a history of transcatheter closure at Prof. Dr. R. D. Kandou Manado Hospital from January 2020 to June 2022. The baseline characteristics showed a higher number of females compared to males (56% vs 44%) with the age under 5 years old as the predominant age group. We found that transcatheter closure for atrial septal defect (ASD), ventricular septal defect (VSD), and patent ductus arteriosus (PDA) were the most common interventions, and no complications were noted.
Conclusion: The majority of pediatric patients in Eastern Indonesia had acyanotic CHDs, with ASD being the most frequent. No immediate complications after interventions were noted, with ASD closure as the most prevalent procedure conducted.

Keywords: Children, Congenital heart defects, Congenital heart disease, Transcatheter closure, Trans catheterization closure.

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1. Introduction

Congenital heart diseases (CHDs) represent the most prevalent congenital anomalies among children, characterized by considerable morbidity and mortality rates. Pediatric patients with CHDs are at an increased risk of facing restrictions in their daily activities, which may include extended or frequently disrupted feeding sessions, decreased physical stamina, susceptibility to respiratory infections, and subsequently, malnutrition and developmental delays. Children with CHDs frequently require ongoing medical oversight and monitoring, which further restricts their capacity for social interaction and daily tasks. Furthermore, certain forms of CHDs may be linked with certain congenital anomalies. Post-surgical or therapeutic interventions may leave children vulnerable to varying degrees of disability and potential complications. Although mortality rates are contingent on the specific type of CHD, the overall reported mortality for CHDs ranges from 11.6% to 13.4%.[1-4]

Congenital heart defects arise from atypical embryonic development of the heart.[1] Clinically, CHDs are categorized into cyanotic and acyanotic types, with the distinction made according to the concentration of deoxygenated hemoglobin. The most common acyanotic CHDs include ventricular septal defect (VSD), atrial septal defects (ASD), and patent ductus arteriosus (PDA). Conversely, transposition of the great vessels (TGV) and tetralogy of Fallot (TOF) represent the majority of cases within cyanotic CHDs.[2]

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The incidence of CHDs exhibits considerable variation on a global scale, with an estimate of 8 cases per 1000 live births.[1] Within Asia, CHDs continue to be the predominant form of congenital anomalies, with prevalence rates fluctuating between 6 to 10 per 1000 live births.[3-4] Despite the scarcity of recent epidemiological data of CHDs among children in Indonesia, it is estimated that approximately 50,000 infants annually are born with CHDs. In 2016, Soetomo General Hospital in Surabaya reported 247 pediatric patients diagnosed with CHDs. In comparison, Dr. M. Djamil Hospital in Padang documented 98 patients with CHDs between the years 2008 and 2011.[3] Data from the neonatal intensive care unit (NICU) at Prof. Dr. R. D Manado Hospital indicated 27 CHD cases from 2013 to 2017. Nonetheless, recent statistics regarding the prevalence of CHDs among the overall pediatric population in Eastern Indonesia have not yet been established.

Cardiac catheterization has been an important tool in the diagnosis and management of CHDs since the 1950s. With the advancement of technology, the safety of this intervention has provided us with an indispensable therapeutic alternative for CHDs. Cardiac catheterization has now been developed for defect closure (transcatheter closure), valvuloplasty, stenting, or as a palliative measure. The success has been reported in several cases of CHDs such as ASD, PDA, pulmonary stenosis (PS), mitral stenosis (MS), and VSD. Although most of CHDs cases are still treated with conventional surgery, transcatheter closure is deemed potential due to its less invasive, less expensive, and potentially more rapid healing.[2]

Approximately 600 to 900 transcatheter procedures were conducted annually at referral institutions in Jakarta.[6] However, information regarding pediatric patients with congenital heart diseases (CHDs) in Eastern Indonesia has been limited. Consequently, the objective of the current study is to characterize the profiles of pediatric patients who received transcatheter closure at Prof. Dr. dr. R. D. Kandou Manado Hospital, serving as a referral center in Eastern Indonesia. According to our knowledge, this study is the first to report on transcatheter closure procedures in children with CHDs in Eastern Indonesia.

2. Materials and Methods

We performed a retrospective observational study involving pediatric patients who had undergone transcatheter closure at Prof. Dr. R. D. Kandou Manado Hospital, a referral hospital for Eastern Indonesia, from January 2020 to June 2022. Throughout the study duration, all pediatric inpatients and outpatients who presented with congenital heart diseases (CHDs) at Prof. Dr. R. D. Kandou Manado Hospital were included. We gathered their anthropometric measurements and baseline characteristics, including age, gender, and socioeconomic status. The nutritional status was assessed using WHO Growth Chart for children under 5 years old, and CDC growth chart for children beyond 5 years old, in according to the national protocol. A pediatric cardiologist examined the patient and further identified the types of CHDs, based on the physical examinations and echocardiography findings. Other clinical characteristics were obtained from the medical records. The demographic and clinical characteristics of the patients were represented using means, medians, or proportions as appropriate. This research received approval from the Medical Research Ethics Committee of Prof. Dr. R. D. Kandou Manado Hospital subsequent to obtaining informed consent from participants and complied with the Declaration of Helsinki.

3. Results

We identified a total of 50 patients diagnosed with congenital heart defects (CHDs) who underwent transcatheter closure at Prof. Dr. R. D Kandou Manado Hospital from January 2020 to June 2022. The patient group's characteristics are presented in **Table 1**, with the majority of them being female. In terms of age distribution, most patients were under the age of 10 years old. Despite 38% of children being malnourished, most patients were classified as having normal nutritional status before the cardiac catheterization. Almost all patients presented with acyanotic CHDs. Among the eight patients with multiple defects, the combinations of the defects were VSD and PDA (n=2), VSD and pulmonary stenosis (n=1), VSD and tricuspid regurgitation (TR) (n=1), ASD and PDA (n=2), PDA and patent foramen ovale (PFO) (n=1), as well as VSD and ASD (n=1). In socioeconomic, a little over half of the patients belonged to a low economic status group.

The types of CHDs observed in our patient cohort are illustrated in **Figure 1**. The three most prevalent CHDs were ASD (36%), PDA (26%), and VSD (22%). The cyanotic types of CHDs identified in the study included tetralogy of Fallot (TOF), transposition of great arteries (TGA), and tricuspid atresia (TA), with the latter also associated with additional defects (dextrocardia, VSD, and underdeveloped right ventricle).

Table 1: Baseline characteristics of pediatric patients who underwent transcatheter closure at Prof Dr. R.D Kandou Manado Hospital in 2020-2022.

Variables	N = 50 (n, %)
Gender	
Male	22 (44)
Female	28 (56)
Age group (years)	
< 5	21 (42)
6 – 10	17 (34)
11 – 15	8 (16)
> 15	4 (8)
Nutritional status	
Overweight	2 (4)
Normoweight	31 (62)
Wasted	16 (32)
Severely wasted	1 (2)

Economical status	
Moderate	22 (44)
Low	28 (56)
CHDs type	
Cyanotic	4 (8)
Acyanotic	46 (92)
CHDs complexity	
Single defect	
Multiple defects	42 (84)
	8 (16)

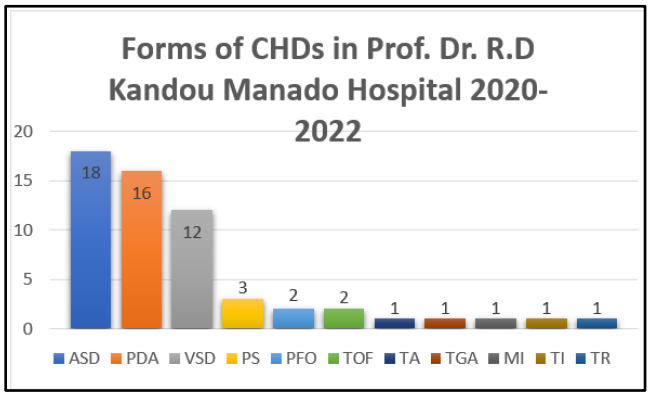

Figure 1: CHDs in pediatric patients who underwent transcatheter closure at Prof Dr. R.D Kandou Manado Hospital in 2020-2022

During the study period, all 50 patients did not have complications following the interventions. Forty-two out of 50 transcatheter closure procedures were performed for ASD, PDA, and VSD, in comparison with another four for TOF, TA, and PDA. (**Table 2**). Transesophageal echocardiography (TEE) was used to assist in the catheterization of 20 interventions.

Table 2: Number of transcatheter closure in each CHD in pediatric patients at Prof Dr. R.D Kandou Manado Hospital in 2020-2022.

Interventions	**N = 50 (n, %)**
ASD closure	18
PDA closure	13*
VSD closure	11
Percutaneous Catheter Baloon Valvuloplasty	3
Baloon Atrial Septostomy (BAS)	1
TOF catheterization	2
TA catheterization	1
PDA stenting	1

*1 PDA closure was performed for PFO

4. Discussion

The current study outlined the profile of CHD cases observed at Prof. Dr. R. D Kandou Manado Hospital in Eastern Indonesia. Our focus was on the CHDs requiring interventions, particularly cardiac catheterization. Baseline characteristics, including age, gender, nutritional status, types of CHDs and interventions, as well as complications, were recorded. We included 50 children who underwent transcatheter closure without complications.

Congenital heart defects (CHDs) represent the most common congenital anomaly in children, with a global prevalence of 8-10 per 1,000 live births. Asia reports the highest incidence, with 9.3 per 1,000 live births. In Indonesia, the estimated incidence of CHDs is approximately 15,000 newborns or around 9 per 1,000 live births.[2-4] Ventricular septal defect (VSD) is the most prevalent type of CHD, followed by atrial septal defect (ASD), accounting for 20-30% of all CHDs.[7] In the current study, ASD was identified as the most common type, succeeded by patent ductus arteriosus (PDA) and ASD. This observation aligns with previous findings from Prof. Dr. R. D. Kandou Manado Hospital regarding CHD prevalence from 2013 to 2017, as well as similar trends noted in other studies.[3-5]

We observed female predominance among our pediatric patients with CHDs, which agrees with previous studies.6[6-8] While the rates of mortality and morbidity associated with CHDs vary among different genders,[4-5] the prevalence of these disorders tends to be higher in females from childhood to adulthood.[6-8] The underlying mechanisms remain unclear; however, genetic susceptibility and biological variations in blood vessel structure may contribute. Additionally, it has been reported that males exhibit a greater tendency for spontaneous closure compared to females.[10]

Congenital heart defects cause not only dysfunction in the cardiovascular system but also other complications, such as malnutrition due to increased energy expenditure, chronic hypoxemia, and concurrent infection. The risk escalates when the timing of interventions for CHDs is delayed.[9-11] However, diagnosing newborns with CHDs, particularly the acyanotic type, presents significant challenges. A comprehensive evaluation comprising medical history, physical examination, and screening echocardiography facilitates early detection of CHDs within the first year of life.[9-12] The global report encompassing 195 countries in 2020 indicated that the highest prevalence was observed among children aged 1 to 4 years. Likewise, a meta-analysis examining global trends over a 40-year period revealed an increasing prevalence of CHD among school-aged children, particularly in low- to middle-income countries across Asia and Africa.[14] The larger proportion of well-nourished patients in the current study may be attributed to the high incidence of patients under 5 years old, suggesting early diagnosis in the study and allowing for better nutritional status at the time of diagnosis.

Atrial septal defect (ASD) closure was the most frequently performed intervention in this study. The primary indication for this procedure is the presence of a significant left-to-right shunt, commonly associated with large ASD defects. Elective ASD closure is also considered for children older than 3 years who are unlikely to experience spontaneous closure.[15-20] Almost all patients over the age of

4 in this study had a secundum type of ASD, which accounts for the higher rate of ASD transcatheter closures observed. Patent ductus arteriosus (PDA) and ventricular septal defect (VSD) were the second and third most common interventions, respectively.

Cardiac catheterization plays a significant role in the management of cyanotic congenital heart defects (CHDs). In cases of Tetralogy of Fallot (TOF), cardiac catheterization can be utilized as a palliative measure to enhance pulmonary blood flow, improve oxygen saturation, and stabilize the patient prior to corrective surgery. For Transposition of the Great Arteries (TGA), balloon atrial septostomy (BAS) is performed early to facilitate adequate blood mixing and potentially normalize right-sided pressures.[9,21] In our research setting, four palliative cardiac catheterizations were performed for TOF, TGA, and Tricuspid Atresia (TA).

Percutaneous transcatheter balloon valvuloplasty is one treatment option for valve stenosis, particularly for pulmonary stenosis, aortic stenosis, and mitral stenosis. Cardiac catheterization assesses the severity of stenosis by measuring the pressure gradient. In certain clinical scenarios, surgical valvulotomy remains the preferred corrective intervention to mitigate the risk of recurrent stenosis and complications such as valve insufficiencies associated with catheterization. However, the demand for transcatheter approaches is increasing due to their less invasive nature, shorter hospital stays, lower costs, and reduced complication rates compared to traditional surgeries.[22-24] In this study, interventions were performed in three cases of stenosis, with no immediate complications observed.

5. Conclusion

To the best of our knowledge, this study is the first to describe transcatheter interventions among children with congenital heart diseases (CHDs) in Eastern Indonesia. Despite a number of successful interventions for CHDs, the prevalence of these conditions in this region is lower compared to others.[2-5,13-14] Factors such as limited facilities and the number of trained interventional pediatric cardiologists may contribute to this disparity. Given that early detection is crucial in preventing complications associated with CHDs, our study may serve as baseline data to enhance awareness among healthcare institutions and professionals regarding pediatric cardiac health in Eastern Indonesia. As our data were obtained from a single referral hospital and based on medical records, we believe further research is necessary to explore the characteristics and risk factors of CHDs, as well as the complications related to trans catheter closure in this region.

6. Source of Funding

The authors received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

7. Conflict of Interest

The authors have no competing interests to declare.

8. Authors' Contributions

Miske Marsogi was involved in the methodology, software, formal analysis, preparing the original draft, and reviewing and editing. David S. Waworuntu contributed in the conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, original draft preparation, reviewing and editing, visualization, supervision, project administration, as well as funding acquisition. E. David Kaunang participated in validation, investigation, resources, data curation, reviewing and editing, and supervision.

9. Source of Funding

None.

10. Conflict of Interest

None.

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