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Quality of life outcomes in pediatric patients with patent ductus arteriosus after transcatheter closure at Dr. Soetomo General Hospital Surabaya

Daryl Naufaldy Nafis [1], Taufiq Hidayat [2,*], Heroe Soebroto [3] and Arief Rakhman Hakim [3]

[1] *Medical Study Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[2] *Department of Pediatrics, Dr. Soetomo General Hospital - Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[3] *Department of Thoracic, Cardiac and Vascular Surgery, Dr. Soetomo General Hospital - Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*

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Abstract

Background: Patent ductus arteriosus (PDA) is a congenital heart disease that occurs when the ductus arteriosus fails to close after birth, resulting in abnormal blood flow between the aorta and the pulmonary artery. This condition can significantly affect children's health and quality of life if untreated. Transcatheter closure has become the preferred treatment due to its safety and minimally invasive nature.

Objective: This study aimed to know the quality-of-life outcomes in patients with PDA following transcatheter closure at Dr. Soetomo General Hospital Surabaya.

Methods: This descriptive-analytic study included 72 patients aged 2–18 years who underwent transcatheter PDA closure in 2023–2024. Patient demographics, birth characteristics, device type and duration, and clinical outcomes were collected. Quality of life was assessed using the PedsQL 3.0 Cardiac Module.

Results: Most patients were 2–4 years old (44.44%) and predominantly female (70.83%). The majority were full-term births (80.56%). All patients underwent PDA closure using occluder devices. Procedural success was achieved in all cases. The mean PedsQL 3.0 Cardiac Module score was 92.24 ± 22.66, indicating favorable outcomes across heart problems and treatment I, treatment II, perceived physical appearance, treatment anxiety, cognitive problems, and communication domains. No major complications were reported.

Conclusion: Transcatheter closure of PDA in pediatric patients was highly successful and associated with improved quality of life. These findings support transcatheter closure as the treatment of choice for PDA in children.

Keywords: Patent Ductus Arteriosus; Congenital Heart Disease; Transcatheter Closure; Pediatric Cardiology; Quality of Life; PedsQL

1. Introduction

Patent ductus arteriosus (PDA) is among the most common acyanotic congenital heart defects, characterized by the persistence of a vascular connection between the descending aorta and the left pulmonary artery that should normally close after birth [1]. When the ductus fails to close, it leads to abnormal left-to-right shunting, resulting in pulmonary overcirculation, cardiac volume overload, and complications such as pulmonary hypertension, heart failure, and impaired growth if left untreated [2, 3]. The prevalence of PDA represents approximately 6–11% of all congenital heart

* Corresponding author: Taufiq Hidayat

diseases worldwide [4]. Higher incidence has been reported among preterm and low-birth-weight infants, with up to 60% of extremely preterm neonates affected [3]. In Indonesia, PDA remains a significant clinical problem, with thousands of new cases reported annually [4].

Over the years, treatment strategies have evolved from surgical ligation to transcatheter closure, which is now considered the standard approach in most cases. Transcatheter closure offers several advantages, including high success rates, minimal invasiveness, shorter hospitalization, lower complication risks, and improved cosmetic outcomes compared with open surgery [5, 6].

In addition to anatomical and hemodynamic outcomes, there has been increasing attention on evaluating health-related quality of life (HRQoL) in children with congenital heart disease. HRQoL is a multidimensional measure that reflects not only physical health but also emotional, social, and cognitive functioning, which are essential aspects of child development [7, 8]. Children with PDA may experience physical limitations, frequent hospitalizations, and emotional challenges such as anxiety or depression, all of which can impair daily activities and social interactions [9].

The Pediatric Quality of Life Inventory (PedsQL) 3.0 Cardiac Module has been validated as a reliable tool for assessing HRQoL in children with congenital heart disease [10]. However, few studies have examined HRQoL outcomes specifically after transcatheter PDA closure in Southeast Asian populations. This study therefore aims to evaluate the post-procedural quality of life of pediatric patients undergoing transcatheter PDA closure at Dr. Soetomo General Hospital using the PedsQL 3.0 Cardiac Module. By combining clinical outcomes with patient-reported measures, this research seeks to provide a comprehensive understanding of the benefits of transcatheter PDA closure in children.

2. Materials and Methods

2.1. Study Design and Setting

This was a descriptive-analytic retrospective study conducted at Dr. Soetomo General Hospital Surabaya, in January 2023–December 2024.

2.2. Participants

Inclusion criteria: patients aged 2–18 years with isolated PDA who underwent successful transcatheter closure and whose parents consented to participate.

Exclusion criteria: patients with chromosomal abnormalities, syndromic conditions (e.g., Down syndrome), or additional congenital heart disease.

2.3. Sample Size

72 patients met the criteria and were included.

2.4. Procedure and Device

All patients underwent PDA closure using occluder devices via femoral vein access. Device choice was based on ductal morphology and cardiologist's discretion.

2.5. Data Collection

Demographic data (age, sex, birth history), type of device, results of transcatheter, and quality of life was measured using the PedsQL 3.0 Cardiac Module, which evaluates six domains: heart problems and treatment I, treatment II, perceived physical appearance, treatment anxiety, cognitive problems, and communication.

2.6. Statistical Analysis

Data were analyzed using SPSS. Descriptive statistics were presented as mean ± SD for continuous variables and frequency/percentage for categorical variables.

2.7. Ethics

Approved by the Ethics Committee of Dr. Soetomo General Hospital. The names of the patients are kept confidential in this research, and all collected data will be used solely by the researcher for the purposes of this research.

3. Results

The sampling for this study was carried out at Dr. Soetomo General Hospital Surabaya, during the 2023–2024 period, involving patients diagnosed with patent ductus arteriosus (PDA) who had undergone transcatheter closure. After applying the inclusion and exclusion criteria, a total of 72 patients were obtained as the study sample.

Table 1 Age Distribution

Age	Frequency	Percentage (%)
2 – 4 years	32	44,44%
5 – 7 years	14	19,44%
8 – 12 years	15	20,83%
13 – 18 years	11	15,28%
Total	72	100%

Table 1 indicates that, out of 72 PDA patients who underwent transcatheter closure, the largest proportion was found in the 2–4 years age group, totaling 32 patients (44.44%).

Table 2 Sex Distribution

Sex	Frequency	Percentage (%)
Male	21	29,17%
Female	51	70,83%
Total	72	100%

Table 2 shows that among the 72 PDA patients who underwent transcatheter closure, 21 were male (29.17%) and 51 were female (70.83%).

Table 3 Birth History

Birth History	Frequency	Percentage (%)
Pre-term	14	19,44%
Full-term	58	80,56%
Total	72	100%

Table 3 demonstrates that, out of the 72 PDA patients who underwent transcatheter closure, 14 were born prematurely (19.44%), while 58 were delivered at term (80.56%).

Table 4 Transcatheter Device

Device	Frequency	Percentage (%)
Coil	0	0%
Occluder	72	100%
Vascular plug	0	0%
Umbrella device	0	0%
Total	72	100%

Table 4 reveals that among the 72 PDA patients who underwent transcatheter closure, only one type of device was used, namely the occluder.

Table 5 Results after Transcatheter Insertion

Results of Transcatheter	Frequency	Percentage (%)
No residual flow/successful	72	100%
Residual PDA (partial occlusion)	0	0%
Failure of transcatheter deployment	0	0%
Transcatheter dislodgement	0	0%
Total	72	100%

Table 5 indicates that, among the 72 PDA patients who underwent transcatheter closure, all were found to have no residual flow, signifying a successful procedure. A few patients initially presented with a mild smoky residual flow; however, this had completely resolved at follow-up.

Table 6 Quality of Life Outcomes (PedsQL 3.0 Cardiac Module)

Domain	Min.	Max.	Mean	SD
Heart problems and treatment I	71,43	100	93,99	17,55
Treatment II	25	100	88,61	28,53
Perceived physical appearance	66,67	100	98,61	7,87
Treatment anxiety	0	100	91,67	25,64
Cognitive problems	35	100	88,68	27,84
Communication	0	100	91,89	24,90
Total			92,24	22,66

The structure of the PedsQL 3.0 Cardiac Module consists of 27 questions divided into six domains: Heart problems and treatment I (7 questions) to assess issues related to heart disease, treatment II (5 questions) to evaluate the child's experiences with therapy, perceived physical appearance (3 questions) to assess how the child feels about their physical appearance, treatment anxiety (4 questions) to measure the child's anxiety regarding treatment, cognitive problems (5 questions) to assess cognitive difficulties, and communication (3 questions) to evaluate the child's communication skills. The scores are then converted into a 0–100 scale with the following values: 0 = 100; 1 = 75; 2 = 50; 3 = 25; 4 = 0.

Table 6 shows that the heart problems and treatment I domain had a mean score of 93.99 ± 17.55, the treatment II domain had a mean of 88.61 ± 28.53, the physical appearance domain averaged 98.61 ± 7.87, the treatment Anxiety domain averaged 91.67 ± 25.64, the cognitive problems domain had a mean of 88.68 ± 27.84, and the communication domain averaged 91.89 ± 24.90. Overall, the mean quality of life score was 92.24 ± 22.66.

4. Discussion

4.1. Age Distribution

This study included PDA patients aged 2–18 years, as individuals over 18 are no longer classified as children. The research specifically focused on pediatric patients. The age range starting from 2 years is consistent with the PedsQL questionnaire guidelines, which state that data collection can begin once the child reaches the age of 2.

PDA is classified as a congenital heart disease, which requires prompt management once symptoms and diagnosis are identified. This study suggests that younger children, particularly those aged 2–4 years, are more easily detected compared to older children. This finding is consistent with the Australian Institute of Health and Welfare (2019) [11], which reported that many congenital heart disease cases are identified during infancy and early childhood. On the other hand, older patients often present with PDA without indications for closure [12].

4.2. Sex Distribution

At Dr. Soetomo General Hospital, 70.83% of PDA patients were female, while 29.17% were male. These results align with findings that PDA occurs more frequently in females than in males, with a reported female-to-male ratio of 2:1 [3].

However, a meta-analysis conducted by Borges-Lujan et al. (2022) [13] reported no significant difference in PDA risk between sexes. The reason for the higher prevalence in females remains unclear [3].

4.3. Birth History

Since most cases were found in full-term patients, the results contrast with the American Heart Association's [14] statement that failure of ductus arteriosus closure is more common in premature infants and rarely occurs in those born at term. However, the same statement also notes that in many children, the exact cause of PDA remains unknown. This implies that a single risk factor alone is insufficient to explain the condition, and other contributing factors should also be considered as potential triggers for failed ductal closure.

4.4. Transcatheter Device

The occluder is often selected because it is considered an effective and safe device with a low complication rate [15]. The use of coils has been shown to be safe and effective for closing small to medium-sized PDAs but has not been proven effective for larger defects [16]. Meanwhile, vascular plugs are particularly useful in small infants, as they reduce the risk of aortic obstruction caused by the device [17].

4.5. Results after Transcatheter Insertion

Residual flow is the persistence of blood flow through the ductus arteriosus after closure. This can occur following surgical or transcatheter procedures and is considered significant due to risks such as hemolysis [18]. In this study, smoky residual flow was observed, similar to findings by Kuswiyanto et al. (2016) [6], where 41% of patients experienced smoky residual flow immediately after transcatheterization. Although such residual flow was present, all patients in that study showed complete closure upon follow-up evaluation.

Despite these positive outcomes from transcatheter procedures, some patients in this study were also undergoing treatment for pneumonia. This may be related to the underlying congenital heart disease (CHD), specifically PDA. CHD often presents early symptoms and carries a higher risk of pneumonia in children [19]. PDA causes a left-to-right shunt, increasing pulmonary blood flow and leading to congestion. This condition can impair lung function and reduce the ability to clear pathogens effectively, thereby increasing the risk of infections such as pneumonia [20].

4.6. Quality of Life Outcomes (PedsQL 3.0 Cardiac Module)

The assessment of quality of life in the study entitled "Quality of Life Outcomes in Patients with Patent Ductus Arteriosus after Transcatheter Closure at Dr. Soetomo General Hospital Surabaya" was conducted using questions from the Pediatric Quality of Life Inventory (PedsQL) 3.0 Cardiac Module. This questionnaire consists of 27 items divided into six domains: Heart problems and treatment I, treatment II, perceived physical Appearance, treatment anxiety, cognitive problems, and communication. The average scores from these domains were calculated to evaluate whether the quality of life could be considered good or poor. According to Varni et al. (2014) [21], a child's quality of life is considered poor if the total summary score is below 70.

This study found an average quality of life score of 92.24 ± 22.66, indicating that PDA patients who underwent transcatheter closure achieved a good quality of life, as the score exceeds the threshold of 70. Furthermore, none of the domains showed poor quality of life scores: Heart problems and treatment I averaged 93.99 ± 17.55; treatment II, 88.61 ± 28.53; physical appearance, 98.61 ± 7.87; treatment anxiety, 91.67 ± 25.64; cognitive problems, 88.68 ± 27.84; and communication, 91.89 ± 24.90.

These findings align with the results of Dai et al. (2023) [22], who evaluated the quality of life in children with congenital heart disease (CHD) after surgery, finding total scores for each PedsQL domain above 70. Similarly, Atmadja et al. (2017) [10] compared 20 children with CHD post-surgery to 20 healthy children using the PedsQL questionnaire and found no significant differences in social, emotional, and school functioning.

When compared to a study using the same cardiac module. Rachmawati et al. (2016) [23], which assessed quality of life in children with cyanotic and acyanotic CHD without specifying transcatheter intervention, results showed that children with acyanotic CHD also achieved good quality of life scores, with each domain scoring above 70. This supports the idea that quality of life can be maintained at a high level if children with congenital heart disease receive appropriate treatment and care.

Medical intervention and management for pediatric PDA patients can significantly improve clinical symptoms and quality of life. However, some differences remain compared to healthy children, making ongoing health education and post-treatment interventions necessary [9]. These findings suggest that congenital heart disease, including PDA, when properly treated, can result in good quality of life for affected children. As noted by Dai et al. (2023) [22], corrective surgery and appropriate care for congenital anomalies have a positive effect on improving Health-Related Quality of Life (HRQoL).

Although this study shows good quality of life outcomes, other influencing factors may still affect patients' well-being. Early intervention by families and healthcare providers — including timely diagnosis, referral, and optimal treatment — may contribute to better developmental outcomes and quality of life for children with congenital heart disease [24]. Raj et al. (2019) [24] further emphasize that addressing neurological, psychosocial, and physical development issues early can positively impact overall clinical outcomes and the quality of life for children with congenital heart disease.

5. Conclusion

This study demonstrated that most patients undergoing transcatheter closure of patent ductus arteriosus (PDA) at Dr. Soetomo General Hospital were young children aged 2–4 years, with a predominance of females and predominantly full-term births. All patients received an occluder device, with the majority using it for more than six months, and the procedure was associated with favorable clinical outcomes without significant complications.

Quality of life assessment using the PedsQL 3.0 Cardiac Module revealed substantial improvements across multiple domains, including cardiac symptoms, treatment burden, physical appearance, anxiety, cognitive function, and communication. Overall, patients reported good quality of life following the procedure, with scores indicating positive physical, emotional, and social well-being.

In summary, transcatheter PDA closure not only provides a safe and effective alternative to surgery but also significantly enhances the health-related quality of life of pediatric patients. These findings highlight the importance of considering both clinical and patient-reported outcomes in the management of congenital heart disease.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of ethical approval

This research has been granted ethical clearance by the Committee Ethics of Dr. Soetomo General Hospital (1107/KEPK/IX/2024).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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