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Intermediate Term Evaluation Of Nutritional Status Of Children Undergoing Catheter Interventions For Congenital Heart Disease : An Ambispective Study

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Abstract

Objective:
To evaluate intermediate-term (1-year) nutritional outcomes in children undergoing transcatheter device closure for congenital heart disease (CHD) and to assess associations between nutritional recovery and clinical outcomes.

Methods:
This ambispective study included children aged 6 months to 16 years who underwent device closure of atrial septal defect (ASD), ventricular septal defect (VSD), or patent ductus arteriosus (PDA) between January 2021 and December 2024 at a tertiary-care center in Navi Mumbai, India. Baseline demographic and anthropometric data were recorded. Follow-up evaluations were conducted at 1 month, 6 months, and 1 year. The primary outcome was change in weight-for-age Z-score at 1 year. Secondary outcomes included height-for-age Z-scores, lesion-specific growth trends, and procedural success.

Results:
A total of 144 children (ASD 52, VSD 20, PDA 72) were enrolled. Mean baseline weight was 15.30 ± 7.98 kg and mean height was 106.14 ± 26.19 cm, with a mean weight-for-height Z-score of −2.1, indicating prevalent malnutrition. At 1-year follow-up (n = 50), mean weight increased to 17.38 ± 7.77 kg ($p = 0.02$) and mean height to 109.0 ± 3.0 cm ($p < 0.001$). Weight gain was greatest in children with PDA, followed by ASD, while those with VSD demonstrated minimal improvement. Procedural success was 100%, with no major complications.

Conclusions:
Transcatheter closure of simple CHD lesions is associated with significant improvement in intermediate-term nutritional status, particularly in children with PDA. Persistent malnutrition in some patients underscores the need for routine nutritional assessment and continued follow-up.

Keywords: congenital heart disease; catheter intervention; nutrition; growth; pediatric cardiology; device closure

Introduction

Congenital heart disease (CHD) is the most common congenital anomaly worldwide, affecting approximately 8 per 1,000 live births. Malnutrition is highly prevalent in children with CHD and is associated with impaired growth, increased infection risk, adverse neurodevelopment, and poorer clinical outcomes [3,20]. Children with unoperated congenital heart disease demonstrate high rates of underweight and stunting [10]. Studies have consistently demonstrated a high burden of undernutrition across

both cyanotic and acyanotic lesions [4,5], and contemporary cohort studies continue to report significant malnutrition across diverse populations [11]. Recent meta-analyses report malnutrition in up to half of affected children globally [14,18]. Nutritional deficits have also been independently associated with adverse clinical outcomes in children with CHD [19]. Despite this burden, nutritional assessment and structured support remain inconsistently implemented in routine CHD care [9].

Growth failure in CHD is multifactorial, resulting from increased metabolic demand, feeding difficulties, chronic heart failure, recurrent infections, and impaired nutrient utilization. Poor nutritional status adversely affects postoperative recovery and long-term outcomes [8,21]. Baseline malnutrition has also been shown to negatively influence early postoperative outcomes [13]. Although catch-up growth after surgical correction is well described [6,15], data on nutritional recovery following transcatheter interventions remain limited [1,2].

ASD, VSD, and PDA differ in hemodynamic burden and metabolic impact; therefore, nutritional response following closure may vary. Hemodynamically significant PDA contributes to increased metabolic demand and impaired growth [25]. Lesions with significant left-to-right shunting may demonstrate greater catch-up growth after correction [22–24]. This study evaluates intermediate-term nutritional outcomes following transcatheter closure of ASD, VSD, and PDA, with emphasis on lesion-specific growth pattern

Methods

This ambispective study was conducted at a tertiary-care teaching hospital in Navi Mumbai, India, between January 2021 and December 2024. Children aged 6 months to 16 years undergoing device closure for isolated ASD, VSD, or PDA were included. Patients with syndromic conditions, multisystem disease, multiple cardiac defects, residual lesions requiring further intervention, acquired heart disease, or irreversible pulmonary hypertension were excluded.

Baseline demographic and anthropometric data were recorded prior to intervention. Weight and height were measured using standardized techniques, and Z-scores were calculated according to WHO growth standards. Procedural details and complications were documented. Follow-up was performed at 1 month, 6 months, and 1 year.

Statistical Analysis

Continuous variables are expressed as mean ± SD and categorical variables as frequencies and percentages. Paired t-test was used to compare baseline and 1-year anthropometric parameters. Subgroup analysis was performed by lesion type. A p-value <0.05 was considered statistically significant.

Results

A total of 144 children underwent transcatheter closure. The mean age was 71.55 ± 48.60 months, and 56% were female. Baseline characteristics are summarized in **Table 1**.

Table 1. Baseline demographics and clinical characteristics of study participants (n = 144).

Values are presented as mean ± standard deviation or n (%). ASD: atrial septal defect; VSD: ventricular septal defect; PDA: patent ductus arteriosus

Variable	Mean ± SD / n (%)
Age (months)	71.55 ± 48.60
Sex	
— Male	64 (44.4%)
— Female	80 (55.6%)
Weight (kg)	15.30 ± 7.98
Height (cm)	106.14 ± 26.19
Age Group	
— Below 7 years	90 (62.5%)
— Above 7 years	54 (37.5%)

Note: P-value for sex distribution = 0.211;

P-value for age-group distribution = 0.001.

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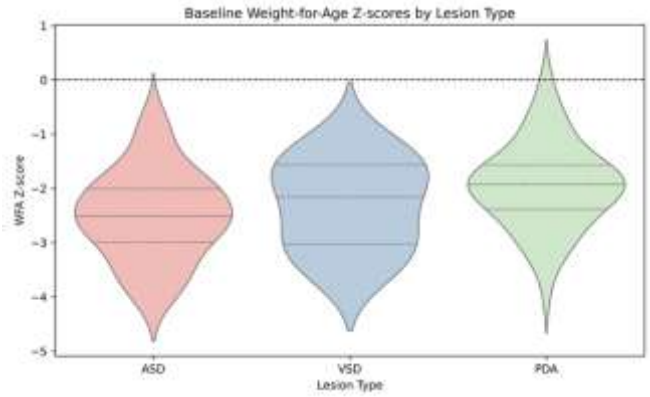
Baseline anthropometry revealed significant undernutrition, with a mean weight-for-height Z-score of −2.1. Weight-for-age Z-scores were lowest in children with VSD and relatively higher in those with PDA (**Fig. 1**).

Figure 1. Baseline weight-for-age Z-scores by lesion type.



Violin plots showing the distribution of baseline weight-for-age Z-scores (WFA-Z) among children with atrial septal defect (ASD), ventricular septal defect (VSD), and patent ductus arteriosus (PDA). The dashed horizontal line indicates the WHO reference median (Z = 0). PDA children demonstrated slightly higher baseline Z-scores, whereas VSD children showed the lowest scores, reflecting more severe undernutrition.

Procedural success was 100%, with no major complications. At 1-year follow-up (n=50), mean weight increased from 14.78 ± 7.16 kg to 17.38 ± 7.77 kg (p=0.02), and mean height increased from 103.66 ± 3.05 cm to 109.00 ± 3.00 cm (p<0.001). Anthropometric changes are detailed in **Table 2**.

Table 2. Anthropometric changes at 1-year follow-up (n = 50).

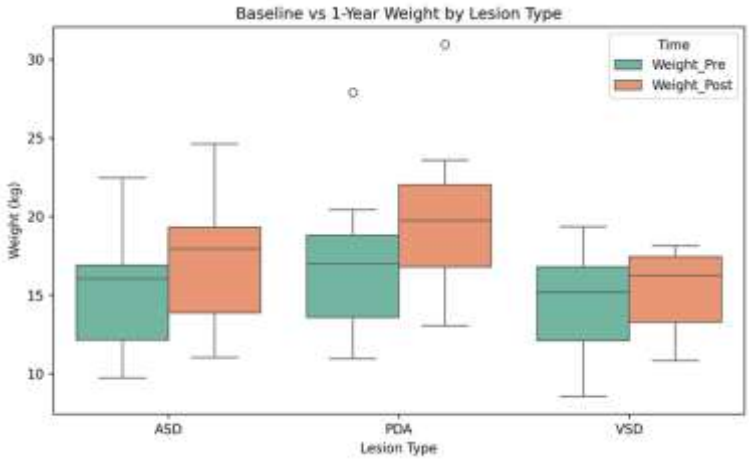
Comparison of weight and height from baseline to 1 year post-device closure. p-values calculated using paired t-tes

Measure	Baseline	1 Year	p-value
Weight (kg)	14.78 ± 7.16	17.38 ± 7.77	0.02
Height (cm)	103.66 ± 3.05	109 ± 3.0	<0.001

Lesion-specific analysis demonstrated greatest weight gain among PDA patients, followed by ASD, with minimal change in VSD (**Fig. 2**).

No late complications were observed.

Figure 2. Lesion-specific weight distribution at baseline and 1-year follow-up.



Box-and-whisker plots illustrating median weight changes by lesion type. PDA shows the greatest increase; VSD shows minimal change.

Discussion

This study demonstrates significant improvement in weight and height at 1 year following transcatheter closure of simple CHD lesions. These findings reinforce the relationship between hemodynamic correction and growth recovery [6,15].

The greatest improvement was observed in children with PDA, likely due to substantial reduction in volume overload after closure [22–24]. More modest gains in ASD and limited improvement in VSD may reflect differences in baseline hemodynamic burden and chronicity of heart failure.

Despite overall improvement, some children remained undernourished at 1 year [14,18]. This highlights that hemodynamic correction alone may not fully reverse longstanding nutritional deficits. Early enteral nutritional strategies may improve recovery,

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particularly in infants with CHD [12]. Structured nutritional monitoring and intervention should therefore be integrated into routine CHD care. Postoperative nutritional optimization has been associated with improved recovery and shorter hospital stay [17].

Conclusion

Transcatheter closure of ASD, VSD, and PDA is associated with significant intermediate-term improvement in growth parameters, particularly among children with PDA. Lesion-specific follow-up and continued nutritional support are essential to optimize outcomes.

What This Study Adds

Demonstrates 1-year catch-up growth following transcatheter CHD closure. Highlights lesion-specific variation in nutritional recovery.

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