Clinical profile and effects of ductal size on anthropometry of children with Patent ductus arteriosus (PDA)

Abstract

Background

It is not known at which size of PDA do severe malnutrition ensue in children, neither is it known, the effect of ductal size on anthropometry of children with PDA.

Objectives

This study was aimed to determine if ductal size had any effect on anthropometry of children with PDA and at which size do severe malnutrition ensues in children with PDA.

Methods

This is an observational cross-sectional study on children who presented with PDA over a five-year period in three tertiary institutions.

Results

Although there was a negative correlation between the size of PDA and the weight of patients, the correlation was not significant (Pearson correlation coefficient = -0.1, p = 0.7). There was a negative correlation between the size of PDA and patient's height/length, but the correlation was still not significant (correlation coefficient = -0.1, p = 0.5).

The association of size of PDA with the severity of malnutrition, showed greater proportion 35.3% (6/17) of wasting and stunting in patients who had large PDA compared with fewer proportion, 26.1% (6/23) in those whose PDA sizes were 3- 6mm and 33.3% (10/30) among those with tiny PDA <3mm ($\chi 2 = 10.21$, p = 0.8). Although there is a positive correlation between ductal size and nutritional status of patients, severe malnutrition ensues from ductal size of 3.2mm.

The majority of children with PDA presents with severe forms of malnutrition (wasting and stunting). Severe malnutrition ensues when ductal size is 3.2mm. The size of PDA has no effect on weight and height of children with PDA.

Keywords: children; PDA; ductal size; anthropometry

Key Messages

1. Majority of children with PDA present with severe forms of malnutrition.
2. Symptoms of severe malnutrition ensues when the ductal size is 3.2mm.
3. There is no gender difference in the severity of malnutrition among children with PDA

Introduction

Patent ductus arteriosus (PDA), occurs when there is a persistent communication between the descending aorta and the left pulmonary artery. [1] This is usually due to the failure of the closure of the ductus arteriosus. [1]

PDA could also coexist with other congenital heart anomalies anomaly or could even occur as a ductal dependent lesion lesson as in TGA with an intact septum and critical pulmonary stenosis. [2,3]

The reported prevalence of PDA in term neonates is 1 in 2,000 births, accounting for 5%–10% of all congenital heart disease. [4] These prevalence rates are higher in preterm neonates with values ranging from 20%–60%. [5] The increased prevalence in the preterm infant is probably due to the lack of normal closure mechanisms from immaturity. [5]

Previous documentation revealed malnutrition as a very common issue in congenital heart disease and even worse in PDA. [6-9] No known study in this locality ha considered any link between anthropometry and the size of PDA among children. Studies abound on the

nutritional status of children with congenital heart disease, but very few focused on assessing the effects of anthropometry on the size of PDA. This study is therefore aimed to determine if the size of PDA has any effect on anthropometry (weight, height, z scores). It also determines at which size of PDA does severity of malnutrition begins to ensue.

Methods

Study design

This study was an observational cross-sectional study conducted in three institutions from the year 2016 to 2020. During the study period, echocardiography was done on children with various forms of cardiac disease.

Study Area and Study Population

Children aged 1 day to 18 years with a congenital heart defects who fulfilled the diagnostic criteria for patent ductus arteriosus from 2016 to 2020 at the University of Nigeria Teaching Hospital were recruited in the study. We defined patent ductus arteriosus (PDA) as a defect seen between the descending aorta and the left pulmonary artery and with a left to right shunt. Relevant clinical features were also elicited by a thorough history taking and sociodemographic variables were also enumerated.

Anthropometric measurements included height in centimetre for age more than 2 years and supine length in centimetres for age below two. Weight was measured by standardized methods and recorded in kilograms. *Z* scores for weight for age (WAZ), weight for height (WHZ), and height for age (HAZ) were also calculated using the WHO Anthro software. The clinical features were was also elicited.

Echocardiographic Measurement of Patent Ductus Ateriousus

Though PDA can be seen from many windows, left-sided parasternal otherwise called the ductal view is the best option used in this study to obtain a clear image . The ductal size was ascertained and measured at the narrowest diameter, which is at the pulmonary end. [10]

Assessment of size of Patent ductus arteriosus

Size of patent ductus arteriosus of 1-3mm is taken as a small size PDA in this study. Moderate size PDA were those PDAs with a diameter of 4-6mm while the ductal diameter of equal to and more than 7mm is classified as large PDA.

Data analysis

The data were analysed with the IBM SPSS statistics for windows, version 20 (IBM Corp, Chicago). Differences in proportions were compared using the chi-square test. The weight and height z-scores were calculated using WHO Anthro and Anthro Plus software. The nutritional status was based on the WHO classification of weight for age (WAZ), weight for height (WHZ), and height for age (HAZ). P-value < 0.05 was regarded as significant.

Results

There was a total of 758 children with heart anomalies examined within the study period, of which 70 children had confirmed diagnosis of PDA. The patients with PDA were made up of 45.7% males and 54.3% females. The age distribution of the patients is as in table 1, with a predominance of infants. Their mean age was 30.0±39.2 months.

The patients' mean weight and height were 11.8±10.5kg and 84 .6± 29.2cm respectively. The mean weight for males, 11.3±8.3kg was comparable to that for females, 12.2±12.5kg ($t = -0.29$, $p = 0.8$). Also, the mean height/length for males, 84.7±27.3cm was comparable to that

for females, 81.1±35.2cm (t = 0.41, p = 0.7). Out of 48 children assessed for nutritional status, 29.2 % were well-nourished, 45.8% (22/48) were both wasted and stunted, 14.6% wasted, 8.3% stunted while 2.1% were obese.

Table I: age distribution of the patients

Age group	Frequency	%
Infants	35	50.0
preschool	24	34.3
school age	7	10.0
adolescents	4	5.7
Total	70	100.0

infants; 1-12 months, preschool; > 12 months to 5 years, school age; > 5 years to 10 years, adolescents; >10 to 18 years

Table 2: Nutritional status among the males and females

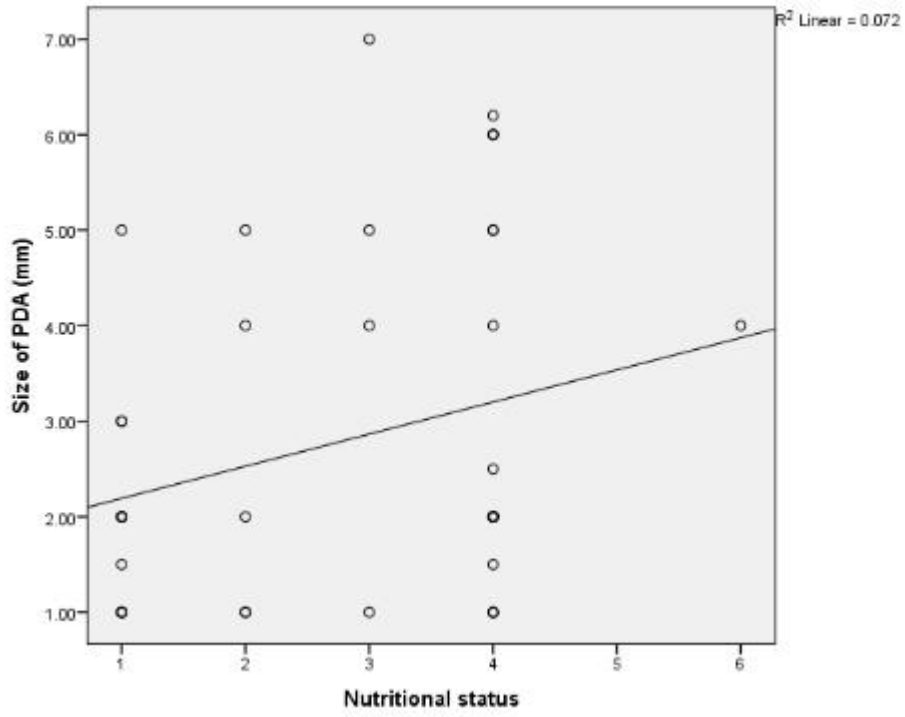
		Nutritional status					Total
		Normal (%)	Wasted (%)	Stunted (%)	wasted and stunted (%)	Obese (%)	
Sex	male	5 (20.8)	2 (8.3)	3 (12.5)	13 (54.2)	1 (4.2)	24
	female	9 (37.5)	5 (20.8)	1 (4.2)	9 (37.5)	0 (0)	24
Total		14 (29.2)	7 (14.6)	4 (8.3)	22 (45.8)	1 (2.1)	48

Chi-square = 5.2, p = 0.3. Wasted = Z-score weight-for-age or weight-for-height <2SD, stunted = height/length-for-age <2SD, obese = BMI for age ≥2SD. The calculation was made using WHO "anthro" and "anthroPlus" software.

There was no significant difference in the nutritional status between the males and females as illustrated in table 2.

Figure 1: Graph of PDA size and nutritional status

Although there is a positive correlation between ductal size and nutritional status of patients, the effect size was small as shown in the figure 1, with ETA square of 0.072



1, well nourished; 2, wasted; 3, stunted; 4, wasted and stunted; 5, overweight; 6, obese

The graph shows that severe malnutrition ensues when ductal size is 3.2mm.

The frequency of some clinical features varied among these patients with PDA as illustrated in table 3. The commonest feature was fast breathing, observed in 68.9% of the patients assessed for the clinical feature, followed by pulmonary hypertension in 51.4%.

Table 3: Frequency of different clinical features among patients with PDA

Clinical feature	Frequency (n/N)	% (n/N) X 100
Cough	0/39	0.0
Fast breathing	40/58	68.9
Failure to gain weight	22/46	47.8
Easy fatigability	30/67	44.8
Pulmonary hypertension	36/70	51.4

N = number of patients with complete data for the assessed feature, n = actual number of patients with the symptoms.

The majority of the patients (42.9%) had tiny PDA while 32.8% and 24.3% had small and large PDA respectively. Analysis of the size of PDA with nutritional status indicates that 35.3% (6/17) of patients with large PDA are wasted and stunted compared with 26.1 (6/23) and 33.3% (10/30) of those with small and tiny PDA respectively ($\chi 2 = 10.21$, $p = 0.8$).

Although there was a negative correlation between weight and the size of PDA, the correlation was not significant (Pearson correlation coefficient = -0.1, p = 0.7). There was a negative correlation between the height/length and size of PDA, but the correlation was still not significant (correlation coefficient = -0.1, p = 0.5).

Discussion

This study was aimed to determine if size of PDA had any effect on anthropometry. The study showed no effect of size of PDA on weight and height of on the children with PDA. We noted that severe malnutrition begins in children whose PDA size is 3.2mm and above. Increased metabolic stress from cardiac failure, high fat-free mass to fat mass ratio, prolonged hypoxia, metabolic acidosis, and worsening sympathetic system activity could explain this finding. [11-17] Another Other reason for children with large size PDA presenting with wasting and stunting could be due to elevated pulmonary artery pressure in children with large PDA. The pulmonary pressure is caused by pulmonary over-circulation and pulmonary vascular disease, either in combination or alone could create a nidus for chest infections. [15] This could further worsen malnutrition. Accentuated pulmonary hypertension, poor intake due to anorexia, easy fatigability, uncoordinated breast sucking, neurological dysfunction, easy satiety, and fast breathing all get accentuated in children with large size PDA. [16]

The commonest symptom seen in this study were fast breathing and this was seen mostly in children with large PDA. This could be caused by pulmonary hypertension which is seen in over 50% of the children. Some studies have also documented PDA-associated symptoms as been triggered by mesenteric, cerebral hypo-perfusion, renal, and pulmonary oedema secondary to pulmonary hypertension seen in over 50% of those with persistent PDA. [18-21] Abhijeet et al [22] also noted breathlessness and history of recurrent respiratory tract

infections as the commonest symptoms in their his series and noted that these symptoms are seen in majority of children who had large PDA

The prevalence of severe malnutrition in children with Patent Ductus Arteriosus noted in this study is high, this is seen mostly among the under-fives. This prevalence is higher compared with prevalence values seen in children without any congenital heart disease. Chinawa et al have documented that children with congenital heart disease who are less than five years old are prone to malnutrition when compared to those who had no congenital heart disease. This could be explained by increase metabolic demands seen at this age, late surgical intervention, progressive hypoxemia and progressive pulmonary hypertension which is usually seen in children less than five years old who had congenital heart disease and who had no intervention. [23-29]

Other forms of malnutrition seen in this study included stunting, wasting, or both. Mechanisms for malnutrition are multifaceted. These include associated chromosomal anomalies or genetic syndromes, feeding difficulties, poor absorption from congestive cardiac failure (CCF). Besides, increased caloric demand, altered respiratory, and neuro-humoral dysfunction with attendant chronic hypoxia with impaired cellular metabolism have all been implicated in malnutrition in children with PDA. [30] Malnutrition in children with PDA is a known cause of frequent hospitalization, pulmonary hypertension, and death. [31,32]

Limitations

It is known that the echocardiography has many limitations in the measurement of the size of the duct. In older children and young adults, the lung limits the visualization of the duct and hence difficulty in measuring the size.

Conclusion

The majority of children with PDA presents with severe forms of malnutrition (wasting and stunting). Severe malnutrition ensues when ductal size is 3.2mm. The size of PDA has no effect on weight and height of children with PDA.

Declaration

Ethics approval and consent to participate: Ethical approval was obtained from the Ethics and Research committee of the University of Nigeria Teaching hospital, Enugu

Verbal informed consent was obtained from parents or guardians (care-givers) of the subjects and controls .

.**Consent for publication:**

Not applicable

Availability of data and materials: data supporting the findings of this study are available from the corresponding author (JMC) on request.

Competing Interest: We declare that we have no competing interests.

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Author contributions statement

JMC was involved in the conception and design of the article BFC was involved in the analysis and interpretation of the data. JMC was involved in the drafting of the paper, while COD, ATC and ACA were involved in critical revision of the article for intellectual content; and the final approval of the version to be published. All authors agree to be accountable for all aspects of the work.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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