

Clinical Characteristics and Spectrum of Cyanotic Congenital Heart Diseases Diagnosed in Pediatric Age Group

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Abstract

Background: It is necessary as early as possible to diagnose and treat cyanotic congenital heart defects (CCHDs) because survival of them is highly related to the time of diagnosis. But not all serious congenital heart diseases (CHDs) clinically appear with cyanosis during the first few days of life. There are several types of CCHD, some of them are more common like tetralogy of fallot (TOF), transposition of great arteries (TGA), and tricuspid atresia. **Aim:** This study was conducted to determine various types of cyanotic CHDs and clinical presentations of cyanotic CHDs and different procedures were done for them in children at Erbil. **Materials and Methods:** This was prospective, cross-sectional study, carried out in Pediatric Cardiac Department of Hawler Surgical Specialty Hospital-Cardiac Centre. All patients aged 0-18 years were included in the study. **Results:** During the study period, 124 cases were diagnosed with cyanotic CHDs. The common CHD type was TOF (46.8%), followed by D-TGA (12.1%), DORV (10.5%), tricuspid atresia (9.7%), and single ventricle (8.9%). Interventional management was done in 44.4% of studied children with CCHDs, total surgical repair was main procedure (14.5%). The common symptoms of cyanotic CHDs were commonly murmur (90.3%), shortness of breath (85.5%), cyanosis (76.6%), and fatigue (76.5%). **Conclusion:** TOF was the most common CCHD noted in our study. Ebstein anomaly, truncus arteriosus, and PPH were the least prevalence CCHD. Heart murmur was the most common presenting sign while shortness of breath and central cyanosis were the most common presenting symptoms.

Keywords: Clinical characteristics, congenital heart disease, cyanosis

INTRODUCTION

Scrutiny of frequency of congenital heart diseases (CHDs) allows us to have a better understanding of clinical aspects of congenital cardiac malformations, and it has major inferences of their clinical management.^[1] It is necessary as early as possible to diagnose and treat cyanotic congenital heart defects (CCHDs) and other critical congenital heart defects because survival of them is highly related to the time of diagnosis. But we should know that not all serious CHDs clinically appear with cyanosis during the first few days of life, especially during the short stay in the nursery.^[2] Th cyanosis is when the skin and mucous membranes turn a bluish color, and there will be cyanosis if hemoglobin is not adequately saturated with oxygen. Cyanosis can be seen when the amount of unsaturated hemoglobin is more than 4–5 g/dL of blood.^[3] Cyanosis is generally categorized into central and

peripheral cyanosis. Central cyanosis, which is manifested by blue discoloration of tongue and oral mucosa, is highly linked to true arterial desaturation and is usually caused by cardiac or respiratory conditions. Peripheral cyanosis which is usually expressed as acrocyanosis in the pediatric age group can be regarded as normal. Under anemic conditions, cyanosis needs more desaturation to be apparent because of low hemoglobin; it is difficult to get >5 g/dL of desaturated hemoglobin. There are two types of cyanosis in CHD patients: the first one is constant and the second one is episodic. Constant cyanosis occurs when there is intracardiac shunt or decreased pulmonary blood

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flow, whereas episodic cyanosis occurs in hypercyanotic spells due to tetralogy of Fallot (TOF) or in patients with single ventricle associated with subpulmonary stenosis.^[4] About 2% of all live births have congenital defects, and 50% of them are composed of congenital heart diseases.^[5] Cyanotic CHDs comprise about 33% of all CHDs.^[6]

One of the characteristics of cyanotic CHD is right-to-right shunt; this means that deoxygenated blood from the right side of the heart mixes with oxygenated blood from the left side of the heart, and heart pumps poorly oxygenated blood to the body. Generally, cyanotic congenital heart diseases are categorized into two groups, according to pulmonary blood flow. The first group is characterized by decreasing pulmonary blood flow, which indicates that less blood goes to the lung to get oxygenation, such as tetralogy of Fallot (TOF), pulmonary arteria, and right-sided hypoplastic heart. Despite decreasing pulmonary blood flow, there is other pathology which is intracardiac shunt, in which there is mixing of poorly oxygenated blood of the right side with rich oxygenated blood of the left heart. The second group is characterized by normal or increased pulmonary blood flow, but there is abnormal mixing of oxygenated blood from pulmonary venous return with deoxygenated systemic venous return.^[5] Substantial cardiac shunts that result in pulmonary blood overflow can induce variable and significant physiologic and histologic changes in the pulmonary vascular tree, resulting in pulmonary hypertension (PHT).^[7]

There are several types of CCHDs; some of them are more common like TOF, transposition of great arteries (TGA), tricuspid atresia, total anomalous pulmonary venous return (TAPVR), and truncus arteriosus.^[8]

Complications

- Patients with CCHDs may develop complications; these are the popular complications recognized in patients with CCHD^[2,4]:
 - Infective endocarditis
 - Heart failure
 - Hypoxic spell
 - Brain abscess and vascular stroke
 - Hematological disorder
 - Scoliosis
 - Clubbing
 - Hyperuricemia and gout

Aim of the study

The aim of this study was to determine:

- Various types of cyanotic CHDs in children who attended Pediatric Cardiology Department at Hawler Surgical Specialty Hospital-Cardiac Center.
- Clinical presentation of cyanotic CHDs and different procedures were done for them.

Objectives of the project

- To determine various categories of cyanotic CHDs by using echocardiography and Doppler examinations that will be completed according to the recommendation of the American Society of Echocardiography (ASE).
- To assess characteristics of cyanotic CHD with several clinical variables including age, sex, gender, definitive diagnosis, cyanosis, shortness of breath (SOB), feeding difficulties, murmur, fatigability, clubbing, and fever.
- To determine various palliative and corrective procedures that were done for them.
- To assess the impact of cyanotic congenital heart on growth and nutrition of affected children.
- To assess the most common complication that may occur in the study group.
- To compare the results of all variables in Erbil center with those of other centers.

MATERIALS AND METHODS

- This was a prospective, cross-sectional study;
- *Place of the study*: Hawler Surgical Specialty Hospital-Cardiac Center;
- *Duration of the study*: about 1 year, from June 1, 2021 to June 30, 2022.

All children from birth to 18 years attending Pediatric Cardiac Department of Hawler Surgical Specialty Hospital-Cardiac Center was included in the study. The cases were referred from either outpatient clinics or various hospitals inside or outside Hawler province, depending on clinical examination like presence of murmur or abnormal heart sound, cyanosis, dimorphic features (like Down syndrome, Noonan syndrome, and others), or history like shortness of breath, difficult feeding, recurrent chest infection, and failure to thrive which were not explained by other causes, suggesting that they may have CHDs. Also, cases that already been diagnosed of having CHD were regularly visiting the pediatric cardiac clinic and were included. Informed consent was obtained from parents and older aged children.

Information obtained from their parents or older age children included age, gender, consanguinity, sibling with CHD, and age of the child at the time of diagnosis of cyanotic CHD if previously diagnosed.

Then the cases were re-evaluated by history and clinically by looking for cyanosis, nutritional status, scar of previous operation, dysmorphic features, rapid respiration, intercostals and subcostal recession, and others, then palpating the chest for apex beat, heave, or thrill, and checking the pulses of upper limbs and then femoral pulses. Auscultation of chest was also done to detect any murmur or abnormal heart sounds as well as to be sure that chest is clear, to exclude respiratory causes of cyanosis. Pulse oximeter or cardiac monitor was used

to assess oxygen saturation and heart rate, and this was an easy way to know the hypoxia state and severity as well as rapidly gives us heart rate; 12-lead electrocardiography (ECG) was used selectively for those patients presented with bradycardia, tachycardia, or abnormal heart rhythm.

All patients underwent anthropometric measurements, including weight and height or length (for those less than 2 years). Height is measured in centimeters using an infantometer below the age of 2 years and a stadiometer above the age of 2 years and weight in kilograms using an infant weighing scale and adult weighing scale. It is a rapid and inexpensive way of determining short- and long-term nutritional status. Then height (length) and weight had been plotted on WHO and CDC standard growth charts. Children below 2 years were plotted on WHO growth charts and children older than 2 years were plotted on CDC growth chart standards. Moderate underweight is defined as weight for age ≤ 2 SD, and severe underweight is ≤ 3 SD of z -score. Stunting is defined as ≤ 2 z -score SD, whereas severe stunting as ≤ 3 z -score SD.^[9] Two-dimensional echocardiography and color Doppler echocardiography with different probes like neonatal, children, and adult transducers were done for all cases. Echocardiography and Doppler examinations were completed according to the recommendation of the ASE.^[10] Cardiac catheterization and computed tomography scan (CT scan) were used for cases for which diagnoses by echocardiography are not clear.

Inclusion criteria

Patients from birth to 18 years, who were confirmed to have cyanotic CHDs in the center during the period of data collection of the study, were included.

Exclusion criteria

- Patients older than 18 years;
- Any patients presented with acquired cyanosis in non-cyanotic CHDs like Eisenmenger syndrome;
- Common atrioventricular canal associated with right ventricular outflow tract stenosis or obstruction;
- Pulmonary arteriovenous connection.

Ethical approval

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with patients' verbal and analytical approval before the sample was taken. The study protocol and the subject information and consent form were reviewed and approved by a local Ethics Committee according to the meeting code 8, paper code 1 at June 27, 2022 to get this approval.

RESULTS

This study included 124 children with cyanotic CHDs presented with a mean age of 3.3 years; 6.5% of the

children were in the age group 1–30 days, 29% of them were in the age group 1–11 months, 49.2% of them were in the age group 1–6 years, 11.3% of them were in the age group 7–11 years, and 4% of them were in the age group of 12–18 years. Male children with cyanotic CHDs were more than females (54.8% vs. 45.2%) [Table 1].

The common CHD type was TOF (46.8%), followed by D-TGA (12.1%), double outlet right ventricle (DORV) (10.5%), tricuspid atresia (9.7%), single ventricle (8.9%), and so on. The isomerism was absent in 93.5% of the children with cyanotic CHDs, whereas right isomerism was present in 4% of them and left isomerism was present in 2.4% of them. Dextrocardia was detected in 3.2% of the children with cyanotic CHDs [Table 2].

Table 1: Demographic characteristics of children with cyanotic CHDs

Variable	No.	%
Age		
1–30 days	8	6.5
1–11 months	36	29.0
1–6 years	61	49.2
7–11 years	14	11.3
12–18 years	5	4.0
Gender		
Male	68	54.8
Female	56	45.2
Total	124	100.0

Table 2: Cyanotic congenital heart disease types and characteristics

Variable	No.	%
Congenital heart disease types		
TOF	58	46.8
D-TGA	15	12.1
L-TGA	2	1.6
DORV	13	10.5
Tricuspid atresia	12	9.7
Pulmonary atresia	3	2.4
Single ventricle	11	8.9
TAPVC	3	2.4
Ebstein anomaly	2	1.6
Truncus arteriosus	1	0.8
PPH (primary pulmonary hypertension)	1	0.8
Hypoplastic left heart syndrome	1	0.8
Critical neonatal PS	2	1.6
Isomerism		
No	116	93.5
Right isomerism	5	4.0
Left isomerism	3	2.4
Dextrocardia		
Yes	4	3.2
No	120	96.8
Total	124	100.0

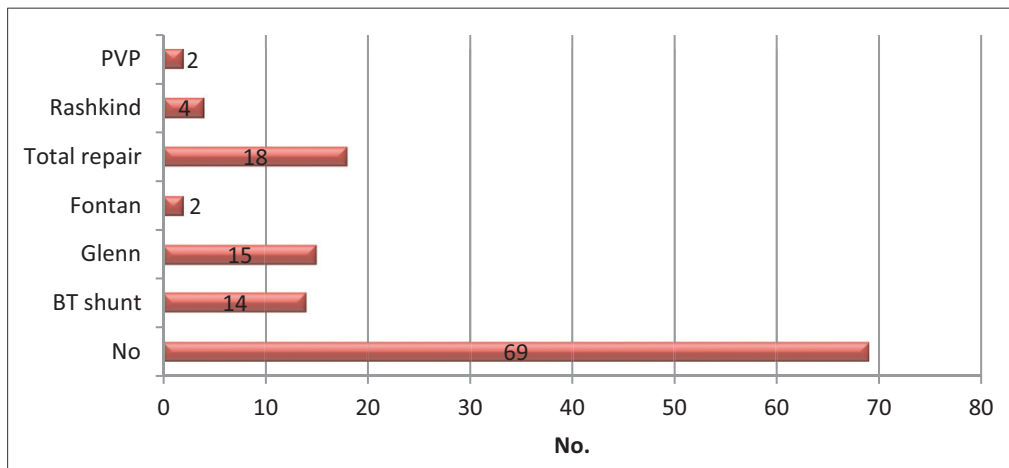


Figure 1: Management procedures of cyanotic CHDs

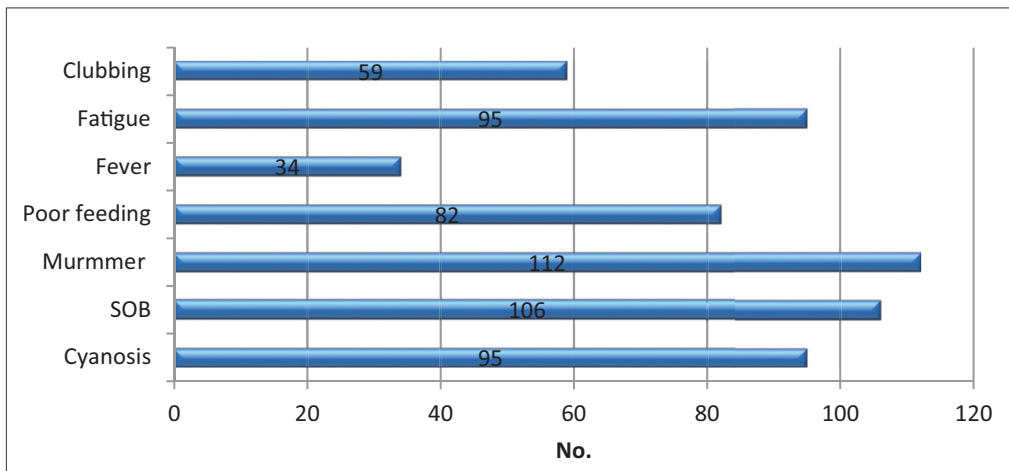


Figure 2: Symptoms of cyanotic CHDs

The interventional management was not done in 55.6% of the studied children with cyanotic CHDs, whereas management procedures were mainly total repair (14.5%), Glenn (12.1%), BT shunt (11.3%), and so on [Figure 1].

The common symptoms of cyanotic CHDs were commonly murmur (90.3%), shortness of breath (85.5%), cyanosis (76.6%), fatigue (76.5%), poor feeding (66.1%), clubbing (47.6%), and fever (27.4%) [Figure 2].

Mean oxygen saturation of children with cyanotic CHDs was 78.9%; 10.5% of them had saturation of less than 60%. Sinus tachycardia was present in 18.5% of the children with cyanotic CHDs and sinus bradycardia was present in 3.2% of them. Moderate undernutrition was present in 16.1% of children with cyanotic CHDs and severe undernutrition was present in 11.3% of them. Moderate stunting was present in 13.7% of the children with cyanotic CHDs and severe stunting was present in 7.3% of them. Down syndrome was detected in 5.6% of the children with cyanotic CHDs. The complications

were absent in 59.7% of children with cyanotic CHDs, whereas the common complications reported were spell (26.6%), chronic heart failure (11.3%), infective endocarditis (1.6%), and pulmonary hypertension (0.8%) [Table 3].

No significant differences were observed between children with cyanotic CHDs of different age groups regarding CHD types ($P = 0.11$), isomerism ($P = 0.89$), and dextrocardia ($P = 0.82$). A significant association was observed between age of children with cyanotic CHDs and interventional procedure ($P = 0.001$), and total repair was related to older age children [Table 4].

There was a significant association between younger age children with cyanotic CHDs and SOB ($P = 0.001$). A significant association was observed between cyanotic CHDs children with age 1–6 years and murmur ($P = 0.01$). There was a significant association between cyanotic CHDs children with age 1–11 months and poor feeding ($P = 0.01$). There was a significant association between

Table 3: Signs and complications of cyanotic CHDs

Variable	No.	%
Oxygen saturation, mean±SD (78.9 ± 13.5%)		
<60%	13	10.5
60–79%	52	41.9
80–90%	28	22.6
>90%	31	25.0
Heart rate		
Normal	97	78.2
Sinus tachycardia	23	18.5
Sinus bradycardia	4	3.2
Undernutrition		
Normal	90	72.6
Moderate	20	16.1
Severe	14	11.3
Stunting		
Normal	98	79.0
Moderate stunting	17	13.7
Severe stunting	9	7.3
Syndrome		
No	117	94.4
Down syndrome	7	5.6
Complications		
No	74	59.7
CHF	14	11.3
Spell	33	26.6
Infective endocarditis	2	1.6
Pulmonary hypertension	1	0.8
Total	124	100.0

cyanotic CHDs children with age 1–11 months and fever ($P = 0.02$). A significant association was observed between cyanotic CHDs children with age 1– years and fatigue ($P = 0.05$). A highly significant association was observed between cyanotic CHDs children with age 1–6 years and clubbing ($P < 0.001$) [Table 5].

Mean oxygen saturation was significantly lower among younger age children with cyanotic CHDs that increased with increase of age ($P = 0.02$). There was a significant association between increased age of cyanotic CHDs children and complications ($P = 0.04$), and chronic heart failure and pulmonary hypertension are prevalent in older age children with cyanotic CHDs. No significant differences were observed between children with cyanotic CHDs of different age groups regarding heart rate ($P = 0.93$), undernutrition ($P = 0.4$), stunting ($P = 0.66$), and syndrome ($P = 0.7$) [Table 6].

DISCUSSION

During a 1-year study, between May 2021 and May 2022, a total of 124 children who had been diagnosed to have cyanotic CHD were studied. This study does not reflect the incidence of CCHD in the population, but shows the relative frequency of various types and clinical

characteristics of CCHD that attend Erbil surgical specialty hospital-cardiac center. Among all cases 68 of them were male (54.8%) and 56 cases were female. Male-to-female ratio was 1.21:1, which showed slightly higher cases among males than females. This is quite close to a study done by Amro in Jordan^[11]; it is also close to another study done by Dilber and Malčić^[12] in Croatia and is slightly higher than that shown by other studies of equal frequency.^[13] All children between first day of life and 18 years were included in the study; the most frequent age group was the 1–6-year age group, which comprises 49.2% and the least age group was 12–18 years which comprises just 4% of all cases, this finding is similar to other studies.^[14] This may be explained taking that into account the age group 1–6 years was prepared for surgery or just surgeries were done. Most of the surgeries had been done in this age group probably due to the fact that surgery may be difficult be done before 1 year in our center because of low weight issue which is not fit to the cardiopulmonary bypass machine.

Tetralogy of Fallot (TOF) with its variants was found to be the most common CCHD in our study, with proportion of 46.8% among all cyanotic CHDs. Its expected and well-established that TOF is the most cyanotic CHD.^[4,15,16] The second most common cyanotic CHD was D-TGA, which constituted 12.1% of the total cases; this is consistent with other studies^[11,17,18] and in contrast to the study done by Patra *et al.*,^[15] which was 7%. Our study showed DORV was the third most common cyanotic CHD which covers 10.4% of all cases and its comparable to other studies.^[19] Truncus arteriosus, hypoplastic left heart syndrome (HLHS), and primary pulmonary hypertension of newborn (PPHN) were at the bottom of the studied list, which comprises 0.8% of total cases for each one.

There were eight cases of visceral heterotaxy, five of them were right isomerism and the others were left isomerism. It comprises 6.4% of all the cases. This is notably higher than that shown by other studies, which stated that it occurs in 0.8% of cases of CHD.^[20] This is probably due to that our study was about cyanotic congenital heart, whereas other studies mentioned all CHDs, and visceral heterotaxy is highly associated with critical CHDs.^[3]

Physical examination is not an optimal way in determining specific anatomic diagnosis, but it is very helpful in suspecting children to have CHDs.^[2] In our study, the cardinal clinical symptom was heart murmur, and it was detected in around 90% of the cases, although intervention was done for about 45% of the cases. But because of residual cardiac lesion, still murmur is predominant, and this is consistent with a study conducted by Al-Fahham and Ali,^[21] which also showed that murmur was the main clinical presentation. The study showed that heart

Table 4: Distribution of CHD characteristics according to age groups of children

Variable	1–30 days	1–11 months	1–6 years	7–11 years	12–18 years	P-value
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Congenital heart disease types						0.11 ^{NS}
TOF	0	19 (52.8)	30 (49.2)	6 (42.9)	3 (60.0)	
D-TGA	1 (12.5)	4 (11.1)	8 (13.1)	2 (14.3)	0	
L-TGA	0	0	2 (3.3)	0	0	
DORV	3 (37.5)	2 (5.6)	6 (9.8)	2 (14.3)	0	
Tricuspid atresia	1 (12.5)	5 (13.9)	4 (6.6)	0	2 (40.0)	
Pulmonary atresia	1 (12.5)	1 (2.8)	1 (1.6)	0	0	
Single ventricle	0	1 (2.8)	7 (11.5)	3 (21.4)	0	
TAPVC	0	2 (5.6)	1 (1.6)	0	0	
Ebstein anomaly	1 (12.5)	0	1 (1.6)	0	0	
Truncus arteriosus	0	0	0	1 (7.1)	0	
PPH	0	1 (2.8)	0	0	0	
Hypoplastic left HS	0	1 (2.8)	0	0	0	
Critical neonatal PS	1 (12.5)	0	1 (1.6)	0	0	
Isomerism						0.89 ^{NS}
No	8 (100.0)	32 (88.9)	58 (95.1)	13 (92.9)	5 (100.0)	
Right isomerism	0	2 (5.6)	2 (3.3)	1 (7.1)	0	
Left isomerism	0	2 (5.6)	1 (1.6)	0	0	
Dextrocardia						0.82 ^{NS}
Yes	0	2 (5.6)	2 (3.3)	0	0	
No	8 (100.0)	34 (94.4)	59 (96.7)	14 (100.0)	5 (100.0)	
Procedure						0.001 ^S
No	6 (75.0)	29 (80.6)	29 (47.5)	4 (28.6)	1 (20.0)	
BT shunt	0	5 (13.9)	9 (14.8)	0	0	
Glenn	0	0	10 (16.4)	3 (21.4)	2 (40.0)	
Fontan	0	0	1 (1.6)	1 (7.1)	0	
PA banding	0	0	0	0	0	
Total repair	0	1 (2.8)	9 (14.8)	6 (42.9)	2 (40.0)	
Rashkind	1 (12.5)	1 (2.8)	2 (3.3)	0	0	
PVP	1 (12.5)	0	1 (1.6)	0	0	

S=significant, NS=not significant

murmur was more common in the age group 1–6 years and least common in the age group 12–18 years, with significant differences between the two age groups and *P*-value was 0.01, which is statistically significant. This is probably due to surgical correction in which murmur disappears in some of the cases. Despite palliative and corrective surgeries cyanosis was observed in 76.6% of all cases, presumably the palliative surgeries may relieve symptoms of CCHD but unlike total corrective surgeries it cannot normalize cyanosis.^[22] Nail clubbing was found in 59 cases, which comprised 47% of the total cases; there were significant differences between the age groups: it was never observed in the age group 1–30 days and was highest in the age group 1–6 years. It was also observed that it declines in the age group 12–18 years, with the *P*-value less than 0.001, which is statistically significant because it is less than 0.05. These differences can be explained by that prolonged arterial desaturation is required for clubbing to be clinically apparent and its reversible when cyanosis has been ameliorated.^[2]

Interventions have been done for 55 out of 124 patients; predominant procedure was total surgical correction which was 14.6%. some of the patients underwent palliative surgery because surgical correction may be impossible.^[23] The most frequent palliative procedures were bidirectional Glenn (BDG) and modified Blalock Taussig shunt (mBT), which account for 12% and 11.3%, respectively. We found that two kinds of interventions were done by cardiac catheterizations, which were Rashkind atrial septostomy and balloon pulmonary valvuloplasty (BPV). Rashkind procedure was done for 26% of D-TGA cases, which was convenient with the similar result of a study conducted by Hamzah *et al.*^[24]

The most common complications encountered was hypoxic spell, it was reported in 26.6% of the cases, this is lower shown by other studies,^[25] as it occurs in patients with right ventricular outflow tract obstruction (RVOT) and in our study more than half of cases associated with RVOT obstruction, which may justify why cyanotic

Table 5: Distribution of CHD symptoms according to age groups of children

Variable	1–30 days	1–11 months	1–6 years	7–11 years	12–18 years	P-value
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Cyanosis						0.1 ^{NS}
Yes	7 (87.5)	32 (88.9)	45 (73.8)	8 (57.1)	3 (60.0)	
No	1 (12.5)	4 (11.1)	16 (26.2)	6 (42.9)	2 (40.0)	
SOB						0.001 ^S
Yes	8 (100.0)	35 (97.2)	52 (85.2)	8 (57.1)	3 (60.0)	
No	0	1 (2.8)	9 (14.8)	6 (42.9)	2 (40.0)	
Murmur						0.01 ^S
Yes	7 (87.5)	34 (94.4)	58 (95.1)	10 (71.4)	3 (60.0)	
No	1 (12.5)	2 (5.6)	3 (4.9)	4 (28.6)	2 (40.0)	
Poor feeding						0.01 ^S
Yes	6 (75.0)	30 (83.3)	39 (63.9)	5 (35.7)	2 (40.0)	
No	2 (25.0)	6 (16.7)	22 (36.1)	9 (64.3)	3 (60.0)	
Fever						0.02 ^S
Yes	1 (12.5)	16 (44.4)	16 (26.2)	1 (7.1)	0	
No	7 (87.5)	20 (55.6)	45 (73.8)	13 (92.9)	5 (100.0)	
Fatigue						0.05 ^S
Yes	3 (37.5)	28 (77.8)	51 (83.6)	10 (71.4)	3 (60.0)	
No	5 (62.5)	8 (22.2)	10 (16.4)	4 (28.6)	2 (40.0)	
Clubbing						<0.001 ^S
Yes	0 (0)	7 (19.4)	41 (67)	8 (57.1)	3 (60.0)	
No	7 (100)	29 (80.6)	20 (33)	6 (42.9)	2 (40.0)	

S=significant, SOB=shortness of breath, NS=not significant

Table 6: Distribution of CHD symptoms according to age groups of children

Variable	1–30 days	1–11 months	1–6 years	7–11 years	12–18 years	P-value
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Oxygen saturation						0.02 ^S
Mean±SD (%)	73.8 ± 12.4	74.6 ± 13.2	80 ± 13.2	83.7 ± 13.8	90.4 ± 7.1	
Heart rate						0.93 ^{NS}
Normal	7 (100.0)	28 (77.8)	48 (78.7)	11 (78.6)	3 (60.0)	
Sinus tachycardia	1 (12.5)	7 (19.4)	11 (18.0)	2 (14.3)	2 (40.0)	
Sinus bradycardia	0	1 (2.8)	2 (3.3)	1 (7.1)	0	
Undernutrition						0.4 ^{NS}
Normal	6 (75.0)	27 (75.0)	43 (70.5)	10 (71.4)	4 (80.0)	
Moderate	2 (25.0)	2 (5.6)	13 (21.3)	2 (14.3)	1 (20.0)	
Severe	0	7 (19.4)	5 (8.2)	2 (14.3)	0	
Stunting						0.66 ^{NS}
Normal	6 (100.0)	31 (86.1)	45 (72.5)	11 (78.6)	5 (83.3)	
Moderate stunting	0	2 (5.6)	12 (19.3)	2 (14.3)	1 (16)	
Severe stunting	0	3 (8.3)	5 (8.)	1 (7.1)	0	
Syndrome						0.7 ^{NS}
No	8 (100.0)	35 (97.2)	56 (91.8)	13 (92.9)	5 (100.0)	
Down syndrome	0	1 (2.8)	5 (8.2)	1 (7.1)	0	
Complications						0.04 ^S
No	8 (100.0)	21 (58.3)	31 (50.8)	10 (71.4)	0	
CHF	0	2 (5.6)	11 (18.0)	1 (7.1)	4 (80.0)	
Spell	0	12 (33.3)	18 (29.5)	3 (21.4)	0	
Infective endocarditis	0	0	1 (1.6)	0	0	
Pulmonary hypertension	0	1 (2.8)	0	0	1 (20.0)	

S=significant, NS=not significant

spell was more common. Also, it was found a significant relation between cyanotic spell and age of the patients, and it was more common in older age groups.

Malnutrition was detected in 26.3% of all the cases; moderate undernutrition was occurred in 14.8%, but severe undernutrition was observed in 11.5%. This is higher than what is reported by Ghazi *et al.* in normal preschool children at Baghdad.^[26] There were high prevalence of CHD-related undernutrition in Egypt, India, and previous studies showed 84% and 59%, respectively.^[27,28] The current study is close to a study done by Zhang *et al.*^[29] in China, which showed 23.3% and is higher than other studies done by Blasquez *et al.*^[30] in France which displayed just 15% of CHD patients developed undernutrition. Our study showed a notable decline of prevalence of undernutrition in totally repaired cases when compared with unoperated cases, which were 11.2% and 32.8%, respectively.

As shown in our study, 19.7% of the children in the study group developed stunting, it is quite lower (7.8%) than what was shown by Zahraa *et al.*^[31] at Babylon in normal children 7.8%. Other study done by Zhang *et al.*^[19] also showed lower prevalence of stunting; however, its near to a study done by Castello *et al.*^[32] Other studies in Kurdistan Region, Iraq, reported similar findings.^[33,34]

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Conflicts of interest

There are no conflicts of interest.

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