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Echocardiographic Evaluation in Neonates Suspected to Congenital Heart Disease in NICU

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ABSTRACT

Background and Objective: Congenital heart disease (CHD) is the most form of cardiovascular disease in children. CHD have different presentations, from defects that progress asymptomatically to those with significant symptoms and high mortality. This study was performed to highlight the importance of signs and symptoms to diagnosis of CHD neonates.

Materials & Methods: This descriptive analytic study was performed on 113 newborns in NICU ward of Mostafa Khomeini hospital from March 2010 to March 2011, referred for cardiac evaluation by echocardiography. Data and echocardiography results were extracted from patients' documents. PDA in preterm newborns was excluded.

Results: Echocardiographic findings were normal in 20 newborns and abnormal in 93 cases. Murmur and cyanosis were reasons for referral to cardiologist in 45 (39.82%) newborns, of which 42 (93.33%) newborns had CHD. DM in mothers was the reason for referral in 21 (18.85%) newborns, of which 17 (80.95%) newborns had CHD. Asphyxia was the reason for referral in 17 (15.04%) newborns, of which 14 (82.35%) newborns had CHD. Bradycardia was the reason for referral in 13 (11.50%) newborns, of which 11 (84.62%) newborns had CHD. Arrhythmia, associated congenital malformation, chromosome disorders, tachycardia, RDS and CHF were uncommon reasons for referral.

Conclusion: The main reasons for referral were heart murmur and cyanosis. Although other reasons were uncommon, their presence indicated a high probability of diagnosis of heart disease.

Key Words:
Congenital Heart Disease
Echocardiography
Murmur
Newborn
NICU

1. Introduction

Congenital heart diseases are amongst the most common hereditary abnormalities diagnosed in neonates (1-3). Performed investigations estimated its prevalence as 6-9 per a thousand live births (2-4). This amount of difference is probably due to the age of studied population or considering mild forms of abnormalities in some studies (5, 6). Prompt diagnosis is of great importance, because delay in diagnosis in many cases leads to heart failure, cardiovascular collapse and even death (7); moreover, it has led to surgical intervention in one fourth of neonates in early years of life (8).

Congenital heart diseases manifestations are varied from an asymptomatic defect to forms with prominent signs and symptoms (9). Physical examination to detect primary sings of CHD is the basic part of assessing neonates and can diagnose those without any symptoms.

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Common manifestations of CHD include heart murmur, cyanosis, heart failure, arrhythmia, respiratory distress and some others (10), which depend on the type of heart disorder and its severity. Cyanosis is one of the most important clues to diagnose CHD, which its central form is a presentation of decreased arterial oxygenation. Neonates with polycythemia may appear to be cyanotic due to high amounts of non-saturated hemoglobin. Besides, neonates with severe anemia may look pink despite improper arterial saturation. Heart disorders with low systemic output and acidosis such as those in which there is an increased pulmonary flow, lead to respiratory distress (11, 12). Heart sounds are also important but rarely diagnostic. Despite this fact, 50% of CHD neonates have no murmur at early stages of their life (13); moreover, innocent murmur is found in nearly 80% of normal neonates in some years of their life (14). Hepatomegaly is helpful but not diagnostic. Assessing pulse and peripheral perfusion is vital. Comparing femoral pulse with an upper limb one is helpful to assess neonates suspicious to aorta coarctation (15). Evaluating blood pressure and comparing between lower and upper limbs is also helpful.

Congenital heart diseases are divided into two groups of cyanotic and non-cyanotic ones. Congenital non-cyanotic heart diseases include ventricular septal defect, arterial septal defect, patent ductus arteriosus, endocardial cushion defect, pulmonary stenosis, aortic stenosis and coarctation of aorta. Congenital cyanotic heart diseases include Tetralogy of Fallot, Transposition of Great Artery, Tricuspid Atresia, single arterial trunk, Total Anomalous Pulmonary Vein Return and hypoplastic left ventricle.

There are different diagnostic modalities to assess a neonate suspected with CHD. In hyperoxic test, first a blood sample is taken to assess the neonate arterial blood gases. Thereafter, 100% oxygen is provided to neonate, and then another blood sample is obtained to be compared with the first one (16). Chest radiography can be performed to find some CHD clues such as boot shape in TOF, or some other signs like “egg on string”. Electrocardiography is widely used to assess CHD. Echocardiography is the best non-invasive tool in assessing CHD with a high accuracy rate. Other diagnostic tools include CT-scan, MRI and heart catheterization (16). The present investigation was performed to highlight the importance of clinical signs and symptoms to diagnose congenital heart diseases and to evaluate Echo findings.

2. Materials and Methods

This research was a perspective descriptive analytic study. Study population was 113 neonates born between March 2010 and March 2011 admitted to Neonatal Intensive Care Unit of Mostafa Khomeini hospital suspected of Congenital Heart Diseases who underwent echocardiography. In total, 324 neonates were admitted to NICU of this hospital during the study. After precise examinations, 113 ones were suspected to CHD who underwent echocardiography. To collect data, file number of eligible neonates was extracted from the hospital archive computer system. Then required information including mother age, history of congenital heart disease in the first or second degree relatives, mother past history and drug history during pregnancy, birth history taking, gestational age, birth weight, NICU admission reasons (respiratory distress, pneumonia, septicemia), and reasons for ordering echocardiography (murmur, cyanosis, tachycardia, arrhythmia, chromosomal abnormalities, multiple congenital abnormalities, cardiomegaly, dextrocardia, asphyxia, neonate of diabetic mother, etc.) were recorder in a designed questionnaire. Premature neonates with PDA were excluded, because it may resolve without intervention and sequelae.

2.1. Statistical analysis

Gathered data were coded and entered into SPSS software version 18 and analyzed using chi-square and Fisher exact tests. In this investigation, incidence of CHD and association between clinical symptoms and each parameter was assessed.

3. Results

From 113 neonates, 68 were males and 45 females. In addition, 33 were low birth weight (29.2%) and 44 were premature (38.94%). In total, 93 had some positive findings in Echo study, which 36 were females and 57 were males with a male to female ratio of 3;2. In total, 28 of 93 (30%) with positive Echo, weighted below 2500 grams at birth, also 34 of 93 were premature (36.56%). Demographic characteristics of neonates are presented in Table 1.

The most common symptoms were respiratory distress (74.36%), tachypnea (74.34%), murmur (71.68%), cyanosis (61.06%) and hypotony (59.29%). Shock or fever was not reported in admitted neonates. Most neonates had more than one clinical symptom (Table 1). Seventeen of 113 neonates were only diagnosed with CHD, but in other 96 ones, CHD was together with other disorders.

In CXR study, pneumothorax was found in 13.28% of 113 cases, also a single case of dextrocardia was detected. Seventy-eight from 113 neonates (69.03%) had a blood oxygen saturation below 90% at admission, which in 68 ones, echo had positive results.

Table 1. Demographic Characteristics of the Study Population

	Study neonates	**Positive Echocardiography**	**Negative Echocardiography**
Gender			
Female	45 (39.82%)	36 (38.71%)	9 (45%)
Male	68 (60.18%)	57 (61.29%)	11 (55%)
Birth Weight			
Below 2500 grams	33 (29.2%)	28 (30.11%)	5 (25%)
Equal to or more than 2500 grams	80 (70.8%)	65 (69.89%)	15 (57%)
Gestational age			
Below 37 weeks	44 (38.94%)	34 (36.56%)	10 (50%)
Equal to or more than 37 weeks	69 (61.06%)	59 (63.44%)	10 (50%)
Oxygen saturation			
Equal to or more than 90%	35 (30.97%)	25 (71.42%)	10 (28.57%)
Below 90%	78 (69.03%)	68 (87.18%)	10 (12.82%)
Overall	113	93	20

Table 2. Frequency of Clinical Symptoms in Neonates

	Hypotony	Seizure	Tachypnea	Granting	Pallor	Murmur	Cyanosis	Fever	Respiratory distress	Others
Studied neonates	67 (59.29%)	15 (13.27%)	84 (74.34%)	37 (32.74%)	3 (2.6%)	81 (71.68%)	69 (61.06%)	0	84 (74.34%)	6 (5.31%)
Echo positive neonates	58 (62.37%)	13 (13.99%)	70 (75.27%)	28 (30.11%)	3 (3.2%)	73 (78.49%)	56 (60.22%)	0	70 (75.27%)	6 (6.45%)
Echo negative neonates	9 (45%)	2 (10%)	14 (70%)	9 (45%)	0	8 (40%)	13 (65%)	0	14 (70%)	0

The most important reasons to consider CHD were first concurrent presence of murmur and cyanosis in 45 (39.82%) [83 murmur (73.45%) and 64 cyanosis (56.64%)], diabetic mother in 21 (18.59%), asphyxia in 17 (15.04%) and bradycardia in 13 (11.50%). Multiple congenital abnormalities in 3 (2.65%), chromosomal abnormalities in 2 (1.77%), arrhythmia in 2 (1.77%), tachycardia in 6 (5.31%) and cardiomegaly in 10 (8.85%) were of rare reasons to suspect CHD. It is noteworthy that one case was referred for Echocardiography due to dextrocardia.

Thirteen of 113 neonates in this study were born from mothers older than 35 years, which in

11 cases (84.61%) congenital heart disease was found. While, there was no significant statistical association between mothers' age and presence of congenital heart diseases in neonates using statistical tests. Sixteen of 113 neonates (14.16%) were born of relative parents, which in 13 (81.25%) congenital heart disease was found, but no significant statistical association was found between relative marriage and presence of congenital heart diseases in neonates. Three of 113 neonates with CHD were born from parents with congenital heart diseases, but there was no significant statistical association between the presence of congenital heart diseases in parents and CHD in their neonates. Four of 113 neonates had another sibling with CHD, but the association was not statistically significant.

Thirty-three of 113 neonates (29.30%) were born from mothers with some disorders during pregnancy, which included 23 patients with diabetes, six hypertension, three hypothyroidism and others, combination of these three disorders. One mother was opium addicted. Twenty-eight of these 33 neonates (84.84%) had CHD, which 20 cases were born from diabetic mothers. Despite the fact, due to low number of samples and distribution of different disorders, it was not possible to conclude about mother disease during pregnancy and CHD in this study. Sixteen of 28 mothers with diseases during pregnancy used drugs in the course of their treatment, which CHD was found in 14 (87.5%) of these mothers. Frequency of clinical symptoms in the study population is presented in Table 2. Besides, echocardiographic findings of the neonates can be seen in Table 3.

Table 3. Echography findings in the study population

	Number	Percentage
Tricuspid regurgitation	51	54.84%
Patent ductus arteriosus	49	52.69%
Pulmonary hypertension	21	22.58%
Atrial septal defect	20	21.50%
Pulmonary insufficiency	11	11.83%
Ventricular septal defect	11	11.83%
Left ventricular hypertrophy	10	10.75%
Mitral regurgitation	6	6.45%
Right ventricular enlargement	6	6.45%
Mitral valve prolapse	5	5.38%
Dilated pulmonary artery	5	5.38%
Translocation of great arteritis	3	3.32%
Pulmonary regurgitation	2	2.15%
Aortic regurgitation	2	2.15%
Pulmonary stenosis	1	1.08%
Dextrocardia	1	1.08%

4. Discussion

Congenital heart diseases are amongst the most common hereditary abnormalities in neonates (1). Prompt diagnosis and management is of paramount importance to lessen long-term complications for neonates. This study was performed to investigate signs and symptoms,

which guide physicians to diagnose CHD. In the present study, prevalence of CHD was 28.7%, which is different from other investigations. Ivon Romero Rivera et al. reported a prevalence of 13.2% in 1000 neonates (11). In another study performed by Amiri Moghadam in Imam Hosein hospital, the incidence of CHD was found to be 9.3% (16). In addition, in Shima Y et al study, the prevalence of CHD was found to be 7.5 in 1000 live births (19). This difference in the prevalence of CHD in our investigation might be due to our study population who were only symptomatic neonates in admitted in NICU. Furthermore, the most common reasons to perform echocardiography were cyanosis and murmur in physical examination, in which CHD of most was verified by echocardiography. While other reasons including diabetic mother, asphyxia, bradycardia, tachycardia, arrhythmia, cardiomegaly, dextrocardia, chromosomal and respiratory distress were uncommon, but were associated with high probability of CHD. These results indicate the importance of clinical symptoms and precise physical examination to diagnose CHD at birth.

VSD was the most common disorder reported in different studies by Poorali in Ardebil (22), Amir Moghadam in Tehran (16) and Max Godfrey (17), but the present study reported PDA as the most common disorder by a prevalence of 52.69%. Most of VSD cases are asymptomatic at birth, and become symptomatic at 6-8 weeks, therefore neonates with isolated VSD did not undergo echocardiography due to lack of signs and symptoms.

In addition, in some studies, PDA was omitted from congenital heart diseases, which has been important in decreasing its prevalence rate in those investigations. One of the reasons of increased PDA prevalence in the present study might be due to higher prevalence of respiratory distress in our sample, leading to patent ductus secondary to respiratory disorder. Besides, our study sample was symptomatic neonates admitted to NICU.

In an investigation performed by Poorali, TR was the second cardiac disorder in patients with murmur, with a prevalence of 14.3% (22). In the present investigation, TR was the second cardiac disorder found in 77.98% of all symptomatic neonates and 55% of those with heart murmur. This high rate of TR prevalence in our study might be due to sensitivity of papillary muscles to ischemic changes and transient dysfunction of papillary muscles. TR was seen in 47.43% of neonates with oxygen saturation under 90%. In our study, 11.76% of heart murmurs were of innocent type, while this rate was 30.8% in Poorali investigation. In a study performed by Pooraryan in NICU ward of Namazi hospital, 14.9% of premature neonates had PDA (23), while in the present study it was reported as 72.72%. In a study performed by Ivan Romero Rivera, the most important reason for referring to cardiologist was murmur in 72%, from whom 15% had congenital heart disease (11). Moreover, cyanosis was the reason in 4%, in whom 57% had CHD. In the present study, the most important reason for referring to a cardiologist was concurrent murmur and cyanosis in 45 cases (39.82%) [83 murmur (73.45%) and 64 cyanosis (56.64%)], from whom 93.33% had CHD.

In a study performed by Chehab et al (20) in NICU, secondary PHT (pulmonary hypertension) was found in 14 neonates (8.8% of all neonates, and 23.73% of neonates with positive Echo), TR in 52% of cases, and PDA in 49%. In the present investigation, PHT was found in 22.58%, TR in 54.84%, PDA in 52.69% and MR in 6.45%, which is in agreement with the mentioned study.

In conclusion, the present study highlighted the importance of physical examination and clinical manifestations, especially murmur and cyanosis in detection of congenital heart diseases. Other clues were diabetic mother, asphyxia, bradycardia, etc. which should be considered as well. Our findings did not support the role of gender, birth age, mother age, a history of cardiac diseases in mother and siblings and other relatives to predispose CHD. It is suggested to perform studies with larger sample size to assess these factors again because there are some discrepancies in the findings of different studies in this field.

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