Journal of Experimental and Clinical Medicine
https://dergipark.org.tr/omujecm

Clinical Research

J. Exp. Clin. Med., 2021; 38(1): 11-15
doi: 10.5835/jecm.omu.38.01.003

Results of cardiologic evaluation at our newborns intensive care unit

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ARTICLE INFO

Article History
Received 13 / 05 / 2020
Accepted 27 / 06 / 2020
Online Published 26 / 01 / 2021

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Keywords:
Congenital heart disease
Incidence
Murmur
Newborn intensive care unit

ABSTRACT

Congenital heart disease (CHD) are the most common congenital anomaly in newborns. In this study, we aimed to evaluate the frequency and distribution of CHD among babies in the neonatal intensive care unit (NICU) of our center. Between June 2018 and February 2020, 109 babies were diagnosed with congenital heart disease among 1779 babies who were admitted to the NICU. The most frequent reasons of pediatric cardiology consultation were murmur and respiratory problems. Of newborns with CHD, 85.3%, have acyanotic and 11.1% have cyanotic CHD. The mean gestational age, postnatal age and the bodyweight of the cases were 33.4 weeks, 2.5 days and 1.58 kg, consecutively. 52.3% were male and 47.7% were female. The incidence of CHD in our center was 6.05%. The most common acyanotic CHDs were ventricular septal defect (24.8%), patent ductus arteriosus (23%) and atrial septal defect (16.6%). The most common cyanotic CHDs were Tetralogy of Fallot (3.7%) and transposition of the great arteries (1.8%). As a result, a significant portion of our patients were diagnosed acyanotic CHD. We think that the frequency of CHDs in our NICU will possibly change as the preferability of our center increases for pediatric cardiac surgery. Congenital heart diseases remain as common and important health problem in the neonatal period. Therefore, early cardiological evaluation is very important for management of these patients. The incidence of CHDs in the NICU is higher than in all live births.

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1. Introduction

Congenital heart disease (CHD) is still responsible for 3% of all infant deaths and 46% of congenital malformation deaths despite advances in diagnosis and treatment (Hoffman and Kaplan, 2002). Although it varies through centers, the overall incidence in the neonatal period is between 0.5-0.8% (Wren et al., 2000).

There is an increasing interest in demonstrating cardiac pathologies by antenatal evaluations. As a result of this, the distribution of CHD in the neonatal intensive care unit (NICU) of the centers changes as the babies with complex CHD are transferred before birth to the centers' where they will be operated (Geggel, 2004). In newborns, symptoms of CHD can be severe, such as dyspnea, tachypnea, cyanosis, acidosis, shock, or mild, such as isolated murmur. The aim of this study is to determine the frequency and distribution of CHDs in newborns who are evaluated with suspicion of CHD in our NICU.

2. Materials and methods

In our study, newborns who were admitted to NICU of Ondokuz Mayıs University Faculty of Medicine between

June 2018 and February 2020 and who were asked for a pediatric cardiology consultation with suspicion of CHD were evaluated retrospectively. Postnatal age, gender, body weights and echocardiographic diagnoses of the patients were recorded. Local ethics committee approval was obtained for the study protocol.

In the NICU, newborns were evaluated by neonatologist. Pediatric cardiology consultation was requested for babies who had mild symptoms such as murmur, dysmorphic findings, infant of diabetic mother (IDM), or severe symptoms such as cyanosis, respiratory problems that could not be explained by pulmonary disease. Echocardiography was performed on all the newborns by the same pediatric cardiology specialist and the examination was repeated when necessary. Two-dimensional (2D), M-Mode, color Doppler, continuous wave (CW) and pulse wave (PW) Doppler capable device (Vivid 7 ultrasound-GE Medical Systems, Norway) and 10S sector probe is used. Cardiovascular anatomy was determined using two-dimensional and color doppler echocardiography using standard four chamber, long axis, parasternal, subcostal and suprasternal views. Valve-vessel stenoses were evaluated by CW and PW Doppler. Left ventricular internal diameters, interventricular septum thickness, posterior wall thickness of left ventricle were measured during diastole and systole by M-mode. Cases of atrial septal defect (ASD) (<3 mm), patent foramen ovale (PFO), and small asymptomatic patent ductus arteriosus (PDA) which closed spontaneously were not included to the CHD group and were considered normal. In cases where the anatomy could not be clarified by echocardiography, multislice computed tomography was performed.

Statistical analysis

"Statistical Package for Social Sciences for Windows", version 18.0 (SPSS Inc, Chicago IL, USA) was used for statistical analysis. Categorical variables were expressed as percentages. Descriptive statistics were used for frequency and percentage, which are descriptive parameters.

3. Results

1799 patients were admitted to the NICU between June 2018 and February 2020. Four hundred seventy-seven of these were consulted to the pediatric cardiology division for a total of 998 times. Of the consulted newborns, 261 (45.1%) were girls and 214 (54.9%) were boys; average gestational age 36.4 ± 3.1; postnatal age was 5.0 ± 5.6 days and body weight was 1.93 ± 0.84 kg.

The reasons for neonatologists to request pediatric cardiology consultation are shown in table 1, among which the most common were murmur and respiratory problems. CHD was found in 72 (33.4%) of the newborns with murmur and in 37 (14.1%) of those without a murmur and consulted for other reasons.

Table 1. Reasons of pediatric cardiology consultation

Reasons	n	%
Murmurs	215	45.07
Respiratory problems	112	23.48
Non-cardiac congenital anomalies	48	10.06
Low oxygen saturation	32	6.70
Cyanosis	21	4.40
Infant of diabetic mother	20	4.19
Antenatal diagnosis	14	2.93
Circulatory deterioration	10	2.09
Metabolic acidosis	5	1.04

60 (12.5%) of the newborns who were included in the study has normal cardiac anatomy. Three hundred eight cases [91 (19%) PFO, 133 (27.8%) ASD less than 3 mm, 41 (8.5%) small atrial septal aneurysm, 18 (3.7%) mild valve deficiencies lost at follow-up (tricuspid 11, pulmonary 2, aortic 2, mitral 3) and 25 (5.2%) asymptomatic small self-closing PDA] were considered normal. Thus, the number of newborns without significant CHD was found to be 368 (77.1%). Therefore, the rate of patients with CHD among all newborns who were admitted to the NICU was 6.05% (109/1799) and 109/477 (22.9%) among the newborns for whom pediatric cardiology consultation was requested.

In the study group, 57 (52.3%) of the cases were male; 52 (47.7%) girls; 43 (39.4%) were premature, 66 (60.6%) were mature. Average gestational age, postnatal age and body weight were 33.4 ± 2.8 weeks; 2.5 ± 3.1 days (0-30 days) and 1.58 ± 0.74 (0.525-4.260 kg), respectively.

93 (85.3%) of cases have acyanotic, 12 (11.1%) have cyanotic CHD. Echocardiography showed asymmetric septal hypertrophy (ASH) in two, hypertrophic cardiomyopathy in one and intracardiac mass in one case. Table 2 shows the types and frequencies of CHD detected in our study.

The most common CHD was VSD (27/109, 24.8%) in this group. 23 of these were small and 4 were large VSD. In the second frequency, wide PDA was detected in 25 patients (23%). Although 4 of them were large according to echocardiographic criteria, they were not clinically hemodynamically significant. These closed spontaneously within an average of 22 days at follow-up. Four newborns PDA has become smaller during follow-up and these were planned to be followed up in pediatric cardiology outpatient clinic with the diagnosis of small PDA. In 15 cases, PDA closure treatment was applied pharmacologically using ibuprofen or paracetamol depending on the clinical condition. Successful results were obtained in 13 cases.

Table 2. The types and frequencies of CHD detected in the neonatal intensive care unit

Type of CHD*	n	%
Ventricular septal defect (Total)	27	24.8
small (apical muscular)	8	7.4
(central muscular)	13	12
(perimembranous outlet)	2	1.8
large (central muscular)	1	0.9
(perimembranous outlet)	3	2.7
Patent ductus arteriosus (large)	25	23
Atrial septal defect (secundum)	18	16.6
Endocardial cushion defect	7	6.5
Tetralogy of Fallot	4	3.7
Pulmonary stenosis (mild)	4	3.7
Pulmonary stenosis (peripheral, mild)	4	3.7
Bicuspid aortic valve + Aortic regurgitation	2	1.8
Aortic coarctation	2	1.8
Transposition of the great arteries	2	1.8
Asymmetric septal hypertrophy	2	1.8
Single ventricle	2	1.8
Pulmonary stenosis (severe)	1	0.9
Hypoplasia of arcus aorta	1	0.9
Aortic stenosis (severe)	1	0.9
Tricuspid atresia	1	0.9
Pulmonary atresia / Ventricular septal defect	1	0.9
Hypoplastic left heart syndrome	1	0.9
Total pulmonary venous return anomaly	1	0.9
Hypertrophic cardiomyopathy / Pompe disease	1	0.9
Intracardiac mass	1	0.9
Aortic stenosis (mild)	1	0.9
Total	**109**	**100**

* Only major pathology of the patients with multiple heart diseases has been shown.

Two cases did not respond to pharmacological closure. In these, hemodynamically significant PDA continued, and surgical closure was successfully performed at our center.

Cyanotic heart diseases were 11.1% in our study group and the most common one was Tetralogy of Fallot (TOF) (3.7%). Balloon angioplasty for a patient with aortic coarctation, balloon valvuloplasty for a patient with severe PS and balloon atrial septostomy for a patient with transposition of great arteries (TGA) were performed successfully at our center. A patient with TGA and another with cyanotic CHD were transferred to another center for advanced surgery.

4. Discussion

Congenital heart diseases are the most common congenital anomalies with unknown etiology (Gürkan, 2004). Its incidence ranges from approximately 0.5-0.8% in all live births (Baş et al., 2013). In terms of developments in echocardiography, screening methods and NICU monitoring, the prevalence of CHD has increased over the years (Zan et al., 2015). Although the frequency of CHD varies from center to center, it is reported to be 1.6-6.6% in our country (Baş et al., 2013). In our study, the frequency of CHD among the patients hospitalized in our center was found to be 6.05%. In our study, we think that the reason for the high incidence of CHD in our center is the admission of the babies from the other centers of North Anatolian region whom were suspected to have CHD.

In the neonatal period, CHD may cause symptoms such as cyanosis, shock, restlessness, and lack of nutrition, and may not cause any symptoms (Güven et al., 2006). In neonatal units, evaluation of heart diseases should be prioritized by a team of newborn and pediatric cardiology specialists. Echocardiographic examination is very important for diagnosis and treatment at the neonatal period, since hemodynamic changes of CHD should be fast. Therefore, patients should be evaluated more than once if necessary. In our study, 477 cases were evaluated by echocardiography for whom neonatologists requested pediatric cardiology consultation. Four hundred seventy-seven cases were assessed by echocardiography a total of 998 times. Re-evaluations were due to clinical deterioration of some case with severe CHD and the persisting suspicion for CHD in some newborns who were found to be normal before. The gender distribution of the patients was screened. Of those diagnosed with CHD, 52.3% were boys and 47.7% were girls. Although there was no significant difference in our study, male newborns constituted the majority of cases in accordance with the literature (Morris, 2004). In two studies conducted in our country, 54.3% and 54.5% of babies with CHD in the neonatal intensive care unit were reported as males (Zan et al., 2015). According to these results, male gender appears to be disadvantageous in terms of the frequency of CHD.

Half of babies with congenital heart disease are diagnosed in the first week and the other half in the first month. In one study, the average time of diagnosis was determined as 11 (1-45) days, while in the other, the average age of diagnosis was 5.7 days in acyanotic patients and 2.7 days in cyanotic patients (Kadivar et al., 2008; Zan et al., 2015). In our study, the average age of diagnosis of our patients was found to be 2.5 ± 3.1. This situation made us think that we were successful in evaluating our newborn patients earlier than the studies in the literature.

Over 50% of murmurs heard in newborn babies are innocent murmurs with increased pulmonary blood flow (Zan et al., 2015). These innocent murmurs can be confused with pulmonary stenosis or PDA murmurs.

CHD type and severity can not be determined only with murmur. Murmur of tricuspid regurgitation in the neonatal period can also be confused with VSD. Also, murmur may not be present in severe CHDs such as aortic coarctation and TGA. Despite these, murmur in the neonatal period is still the most important symptom of CHD. In our study, murmur was the most common reason (45.07%) for requesting pediatric cardiology consultation.

Less than 50% of congenital heart diseases can be detected by routine examination of healthy newborns in the first weeks. In the presence of murmur, this rate rises to 54% (Güven et al., 2006). In one study, the sensitivity of murmur in detecting CHD was 54.1% and its specificity was 92.9% (Yıldız et al., 2015). In our study, CHD was found in 33.4% of newborns who were consulted for murmur, and in 14.1% of those who were consulted for other reasons. We think that the reason for the low rates in our study was the large number of cases that we did not include in the patient group like PFO (n=91), ASD (n=133), atrial septal aneurysm (n=41), mild valve insufficiency (n=18) and small-asymptomatic-spontaneously closed PDA (n=25). Indeed, in a study, it was reported that PFO, ASD and PS were found to be the most common in neonates with murmur (Yıldız et al., 2015). In another study, it was stated that PFO, ASD and VSD were the most common CHDs among 455 newborns who applied to the pediatric cardiology outpatient clinic (Özkan et al., 2016). Instead of performing echocardiography at the neonatal period only due to a prominent murmur, we prefer to perform echocardiographic evaluation in every suspicious auscultation finding. As a matter of fact, the frequency of CHD was found to be quite high (37.1%) than other studies in a study in which all patients hospitalized in NICU were evaluated with ECO (Ertuğrul et al., 2011). The fact that we have determined a flexible attitude towards the severity and quality of murmur is another reason for the low frequency of CHD in patients with murmur in our study.

In our study, acyanotic and 11.1% cyanotic CHD were detected in 85.3% of the patients diagnosed with CHD. Asymmetric septal hypertrophy in two (1.8%), hypertrophic cardiomyopathy in one (0.9%) and intracardiac mass in one (0.9%) were detected. Among the congenital heart diseases, the most common acyanotic diseases are ASD and VSD (Güven et al., 2006). In another large study, the most common acyanotic heart disease was found as VSD (Zan et al., 2015). In a meta-analysis, VSD prevalence was reported to be the first with 2.62/1000, second with ASD 1.64/1000 and third with PDA 0.87/1000 in all live births (Van der Linde et al., 2011). In our study, the most common CHD (n=27) was determined as VSD with 24.8%. However, it was noticed that huge part of them was small VSD (n=23). Large PDA was the second most common (23%) and despite the exclusion of small ASDs, ASD was the third most common (16.6%) CHD. The most common cyanotic CHDs in the literature are TOF and TGA (Van der Linde et al., 2011; Zhao et al., 2018) and the most common cyanotic heart disease in our study was TOF. Although the ranking of acyanotic and cyanotic CHDs are compatible with the literature in our NICU, low frequency of acyanotic CHDs attracts attention.

In the literature, different reports are present about the frequency of cyanotic heart diseases in patients followed up in NICU. In a study conducted in our country, the most common symptom was detected as cyanosis in neonates with 190 CHD (Tokel et al., 2001). In other studies, cyanosis was detected in 9.6% to 13.1% of newborns with CHD and it was stated that cyanosis was the second most common symptom of CHD (Zan et al., 2015). This situation is related to whether the study center is a reference center for complex heart disease treatment. As in our center, the centers without the division of "Pediatric Cardiovascular Surgery" are not the centers that these patients prefer primarily. In recent years, we think that cyanotic CHD rate is lessened in our unit due to admission of these patients to the advanced "Pediatric Cardiovascular Surgery centers and this is related with improvement of antenatal diagnosis techniques and transportation facilities.

The most common congenital heart anomalies in IDMs were reported ASH and VSD (Edwards et al., 2001; Güvenç and Güzeltaş, 2017). In one study, the frequency of ASH was 38% in IDMs and 7% in normal population (Weber et al., 1991). In our study, only two (10%) of the 20 newborns who were consulted as IDM were diagnosed as ASH. Although the relation between ASH and IDM remains a popular information, we think that the frequency of ASH is not high in IDMs.

In conclusion, it is difficult to diagnose CHD only by physical examination during the neonatal period. Due to the rapid hemodynamic changes in the neonatal period, early cardiological evaluation is required of early diagnosis and treatment for whom has suspicious signs of CHDs. For this reason, we think that even if there is no characteristic findings of CHD, suspicion may be an indication for echocardiographic examination which is non-invasive. Thus, early diagnosis, early treatment, reducing morbidity and mortality will be possible at NICU. Although, our results are generally consistent with the literature, we think that the frequency of CHD in our NICU will change as the preferability of our center increases for pediatric cardiovascular surgery.

Conflict of interest: The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The author received no financial support for the research and/or authorship of this article.

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