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Original Article

Evaluation of the outcomes of congenital heart disease after cardiac surgery or angiographic interventions in children: A cross-sectional descriptive-analytical study

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Abstract

Introduction: Congenital heart defects (CHDs) are diagnosed in ≈8 to 10 per 1,000 live births in the United States. This study aimed to determine the outcomes in children with congenital heart disease.

Methods: This cross-sectional descriptive-analytical study was conducted using the census method on all patients with a CHD who referred to the pediatric heart clinic in Valiasr Hospital, Birjand, Iran, and underwent heart operation during the desired period. The information contained in the patients' files was used to collect the required data. The rest of the information was gathered by calling the patients' parents. The collected data were analyzed in the SPSS-19 software using the Chi-square test and Fisher's exact test. The significant level was considered at the p-value of ≤ 0.05.

Results: The results of the statistical analysis indicated that the type of intervention (i.e., operation, intrusion) had no statistically significant relationship with demographic indicators of gender, age by month, chromosomal abnormalities, the type of heart disease, and the development of children under-study; however, it showed a statistically significant relationship with the type of initial complaint. The rate of operation was significantly higher in the subjects, especially in those who had an initial complaint of murmurs. Based on the results, the age of children had a statistically significant relationship with the need for pacemakers and the amount of pleural effusion; these two outcomes increased significantly with the child's aging.

Conclusion: A large number of demographic and clinical factors were effective in children's postoperative outcomes. Consequently, by conducting further studies at a wider level and controlling variables it is possible to compare the findings, achieve more favorable results, and improve clinical indicators.

Keywords: Angiography, Cardiac Catheterization, Cardiac Surgery, Congenital, Heart Defects

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Introduction

Congenital heart defects (CHDs) are diagnosed in approximately 8-10 per 1,000 live births in the United States (1). The prevailing trend among all CHDs involves the abnormal development of normal embryonic structures or the stopping maturation of these structures in the early stages of the embryo, which includes the disorders of its heart, valves, and artery walls. Congenital heart defects are categorized into two types, namely cyanotic and non-cyanotic, which are diagnosed in half of the cases for up to 1 month. Congenital heart defects are different in severity; some are critical and are identified at an early lifetime; however, on the other side of the spectrum, there are people with mild disabilities who may not be symptomatic until adulthood and are consequently discovered at older lifetimes (2-6).

A total of 130 million babies are born each year worldwide, 4 million of whom die during infancy, with 7% of these deaths due to CHDs (7). The prevalence rate of CHDs differs in African and Asian countries, accounting for 1.9-9.7% of births annually, while it only involves 1% of births per year in the United States (8, 9). Congenital heart defects place an enormous burden on the healthcare system due to their various complications, mortality, and high costs; thus the best way for correction of these defects has been considered in different communities. Congenital heart defects have different effects depending on their type and severity, and therefore, leave different complications.

In general, the ventricular septal defect (VSD) is the most common CHD, followed by the atrial septal defect (ASD). In the cyanotic group, tetralogy of Fallot (TOF) is the most common subgroup (10). Congenital heart defects are usual birth defects in children, accounting for approximately 25% of all congenital malformations (11, 12). With the advancement of technology and skills and the improvement of operational procedures, the management of congenital cardiac malformations has considerably progressed in developed countries. As a result, highly complex injuries are conducted with high success rates today. This may be different in developing countries since fewer children born with CHD may be accurately diagnosed and treated at the right time and then receive timely treatment (13). Although numerous patients with CHDs would lose their lives in the past owing to the lack of diagnostic and therapeutic facilities, significant advances in recent years in the field of diagnosis and treatment of these diseases have led to an 85% increase in the survival rate of these patients, and consequently, more patients have reached adulthood (5, 14).

Considering the lack of information on the operation and angiographic interventions for CHD in Birjand city, Iran, this study was conducted to determine the consequences of operational and Interventional radiology procedures in children with CHD in South Khorasan Province, Iran.

Methods

The present study was approved by the Ethics Committee of the Birjand University of Medical Sciences, Birjand, Iran (ir.bums.REC.1396.242). The statistical population included children with CHD who underwent heart operation or angiographic interventions in the pediatric heart clinic in Valiasr Hospital, Birjand University of Medical Sciences. Eligible patients were children with a CHD, while children who had acquired or defective heart disease and those who migrated and their files were not available were excluded from the study.

This cross-sectional descriptive-analytical study was conducted using the census method on all patients with a CHD who referred to the pediatric heart clinic in Valiasr Hospital and underwent heart operation during the desired period (113 people). All patients with CHD who underwent operation or angiography within 2014-2017 and met the inclusion criteria were included in the study after describing the objectives of the study and acquiring informed consent. In this study, each patient was allocated a separate questionnaire, which was completed using the information contained in the patients' files. The demographic information of the patients, along with the complaint at the

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time of referral and the final diagnosis of CHD, was recorded. The rest of the information was completed by calling the patients' parents and utilizing the patients' existing files in the hospital. For each patient, the following information was provided: the age and gender of the patients, complaint at the time of referral, maternity age, maternal education, maternal diseases, comorbid anomalies in patients, mother's age, parents' place of residence, type of diagnosed CHD, type of operation, the outcomes after procedure including the development process (proper weight gain and appropriate height increase), reduction in the number of cyanosis or pneumonia attacks, and the need to use antiarrhythmic, anti-heart failure, and antithrombotic drugs, duration of hospitalization, bleeding, infection, diaphragmatic paralysis, post-pericardiotomy syndrome, postoperative pleural or pericardial effusion, arrhythmia, chylothorax, mortality, or the need for the operational intervention or angiography. The data were separately recorded and collected in the information form and were then analyzed.

The collected data were analyzed in the SPSS-19 software using the Chi-square test and Fisher's exact test. The significant level was considered at the p-value of ≤ 0.05.

Results

A total of 113 patients, including 52 (46.0%) male patients and 61 (54.0%) female patients, were entered into the study. The mean age of the participants was obtained at 36.51±31.44 months. A total of 98 (86.7%) patients lacked chromosomal abnormalities. Regarding the prevalence of CHD, 26 (23.0%) and 87 (77.0%) subjects had cyanotic and non-cyanotic CHD, respectively. In total, 99 (87.6%) children were normal in term of developmental processes (e.g., proper weight gain, height increase, neurodevelopment). The initial complaints were related to 92 (81.4%) children with murmurs and 21 (18.6%) with cyanosis, and the mean age of the children was 36.51±44.32 months.

It was found that a total of 101 (89.4%) mothers had full-term pregnancies, and 82 (72.6%) and 31 (27.4%) children underwent an operation and intervention, respectively. Based on the results of statistical analysis, the type of intervention (i.e., operation or intervention) had no statistically significant relationship with demographic indicators of gender, age by month, chromosomal abnormalities, the type of heart disease, and the development of children under study; however, it showed a statistically significant relationship with the type of initial complaint. It was revealed that the rate of operation was significantly higher in the subjects, especially in those who had an initial complaint of murmurs.

The mean age scores of the patients undergoing operation and intervention were estimated at 35.76±46.50 and 38.50±38.60 months, which was not significant based on the results of the independent t-test (t=-0.29, df=111, P=0.77) (Table 1). The highest outcomes of the intervention in the studied children were the reduction of pneumonia and cyanosis with a frequency of 106 (93.81%) patients, the need to use antiepileptic drugs with a frequency of 13 (11.50%) subjects, and infection with a frequency of 12 (10.62%) cases. Moreover, the mean length of hospitalization was 7.50±5.29 days (Table 2). It was shown that the highest mortality rate in the studied patients in the first 7 days after the intervention was 10 (8.85%).

The results of the statistical analysis showed that the type of CHD of the subjects had no statistically significant relationship between demographic indicators of gender, age in months, chromosomal abnormalities, and developmental trend of children; nevertheless, there was a statistically significant relationship between the type of CHD and patients' initial complaints (Table 3). The mean age scores were estimated at 24.84±30.35.35 and 40.00±47.29 months in the cyanotic and non-cyanotic groups, respectively, which was not statistically significant (t=-1.54, df=111, P=0.12). There was no statistically significant relationship between the results of the pediatric intervention and maternal gestational age, except in pericardial effusion. The highest pericardial effusion was in preterm pregnancies.

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Table 1. Comparison of neonatal demographic indicators with the type of intervention

Variable		Type of intervention		
		Operation	Intervention	Chi-Square test
		N (%)	N (%)	
Gender	Boy	39 (47.6)	13 (41.9)	χ^2=0.28, df=1
	Girl	43 (52.4)	18 (58.1)	P=0.59
Chromosomal abnormalities	Down syndrome	12 (14.6)	3 (9.7)	χ^2=0.48, df=1
	Normal	70 (85.4)	28 (90.3)	P=0.48
Type of heart disease	Cyanotic	22 (26.8)	4 (12.9)	χ^2=2.46, df=1
	Non-cyanotic	60 (73.2)	27 (87.1)	P=0.14
Evolution process	Normal	73 (89.0)	26 (83.9)	χ^2=0.55, df=1
	Abnormal	9 (11.0)	5 (16.1)	P=0.52
Initial complaint	Murmur	63 (76.8)	29 (93.5)	χ^2=4.15, df=1
	Cyanosis	19 (23.2)	2 (6.5)	P=0.04

Table 2. Consequences of the intervention in the studied children

Benefits and risks of the procedures		N (%)
Reduction in the rate of pneumonia and cyanosis	Positive	106 (93.8)
	Negative	7 (6.2)
Bleeding	Positive	2 (1.8)
	Negative	111 (98.2)
Infection	Positive	12 (10.6)
	Negative	101 (89.4)
Diaphragm paralysis	Positive	1 (0.8)
	Negative	112 (99.2)
Post-pericardiotomy syndrome	Positive	2 (1.8)
	Negative	111 (98.2)
Plural effusion	Positive	5 (4.4)
	Negative	108 (95.6)
Pericardial effusion	Positive	3 (2.6)
	Negative	110 (97.4)
Arrhythmia	Positive	6 (5.3)
	Negative	107 (94.7)
Dialysis	Positive	1 (0.8)
	Negative	112 (99.2)
Need for reoperation	Positive	8 (7.1)
	Negative	105 (92.9)

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Table 2. Consequences of the intervention in the studied children. (Continued)

Need for re-angiography	Positive	7 (6.2)
	Negative	106 (93.8)
Need a pacemaker	Positive	6 (5.3)
	Negative	107 (94.7)
Antiarrhythmic drug	Positive	6 (5.3)
	Negative	107 (94.7)
Cardiac antidepressant drug	Positive	13 (11.5)
	Negative	100 (88.5)
Antithrombotic drug	Positive	4 (3.5)
	Negative	109 (96.5)

The statistical analysis of the results of this study showed that there was a statistically significant relationship between the consequences of the intervention in children in the need to use antiarrhythmic and arrhythmic drugs with gender; nonetheless, no significant relationship was observed among other results. The mean length scores of hospitalization were obtained at 8.10±6.44 and 7.00±4.06 days for male and female infants, respectively, which was not statistically significant (t=1.09, df=111, P=0.27). Based on the results, the age of children showed a statistically significant relationship with the need for pacemakers and the amount of pleural effusion; accordingly, these two outcomes increased significantly with the child's aging; however, the other consequences of the intervention had no statistically significant relationships with the age of children. It should be noted that the most common types of CHD in the subjects were patent ductus arteriosus (PDA; 31.9%), VSD (22.1%), and TOF and ASD (8.8%) in descending order (Table 4).

Table 3. Demographic indicators of children according to the type of CHD

Variable		**Type of heart disease**		**Significance of Chi-Square test**
		Cyanotic	**Non-cyanotic**	
		N (%)	**N (%)**	
Gender	Boy	9 (34.6)	43 (49.4)	χ^2=1.76, df=1 P=0.18
	Girl	17 (65.4)	44 (50.6)	
Chromosomal abnormalities	Down syndrome	4 (15.4)	11 (12.6)	χ^2=0.13, df=1 P=0.72
	Normal	22 (84.6)	76 (87.4)	
Evolution process	Normal	23 (88.5)	76 (87.4)	χ^2=0.02, df=1 P=0.88
	Abnormal	3 (11.5)	11 (12.6)	
Initial complaint	Murmur	5 (19.2)	87 (100.0)	χ^2=86.31, df=1 P=0.001
	Cyanosis	21 (80.8)	0 (0.0)	

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Table 4. Frequency distribution of congenital heart disease

Type of congenital disease	Number	Percent
TOF	10	8.8
TAPVC	2	1.8
VSD	25	22.1
PDA	36	31.9
AVSD	7	6.2
ASD	10	8.8
PAVSD	3	2.7
anomaly Ebstein	2	1.8
Ventricular diverticulum	1	0.9
PS	3	2.7
atresia Pulmonary	1	0.9
Tricuspid atresia	3	2.7
AP windows co-repair	1	0.9
TGA	2	1.8
COA	4	3.5
Subaortic web	1	0.9

TOF: Tetralogy of Fallot; TAPVC: Total anomalous pulmonary venous connection; VSD: Ventricular septal defect; PDA: Patent ductus arteriosus; AVSD: Atrioventricular septal defect; ASD: Atrial septal defect; PAVSD: Partial atrioventricular septal defect; PS: Pulmonary stenosis; AP: Aortopulmonary; TGA: Transposition of the great arteries; COA: Coarctation of the aorta

Discussion

Congenital heart defects are generally common neonatal disorders with a prevalence of 2-3 neonates per 1,000 births. Since the late 1980s, mortality from CHD has significantly declined following advances in diagnostic, therapeutic, and operational techniques (15). nevertheless, the factors affecting morbidity, mortality, and post-treatment consequences of CHD are still of great importance (16). The results of this showed that the prevalence of non-cyanotic CHD was higher than cyanotic heart disease in this population. Consistent with the findings of our study, those of a study conducted by Mocumbi et al. revealed that non-cyanotic heart diseases, such as VSD, ASD, PDA, and TOF, were more common than cyanotic diseases (13). The results of investigations carried out by Okoromah et al., Mocumbi A et al., and Sani et al. have shown similar results (17-20).

In general, the mortality rate in periodic follow-ups showed no statistically significant relationship with the type of intervention and was obtained at 8.85% in the short-term 7-day follow-up, which was a desirable rate compared to those in other studies. According to the findings of a study by Mocumbi et al., the mortality rate was 0.4%, and in another study conducted in Sudan, this rate was reported at 8.4% after evaluating 125 patients (13).

In the present study, the length of hospitalization of patients after the operation was much longer. There were no significant differences in other complications regardless of the type of intervention (percutaneous and surgical), or the type of CHDs; however, the most reported outcome in patients was the reduction in pneumonia and cyanosis. Generally, CHDs are important risk factors for lung diseases and can lead to airway infections in people with a direct structural effect on the airways or effects of pathophysiological and functional changes in the cardiovascular system. This in turn prolongs the length of hospital stay and delays the improvement of patients' cardiovascular system function.

According to the results, postoperative complications

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were not common in patients. In a study conducted by Murray et al. in Tokyo (2003-2008), a total of 2,134 patients underwent cardiac catheterization and 576 procedures were performed on this population. The total number of complications was 65 (11.3%), 13 of which were major complications, including death for 1 (2.3%) case and arrhythmias for the other 12 cases (97.7%) (21). Another study was conducted by Sultan et al. in Rawalpindi, Pakistan (December 2010 to June 2012) on 208 patients who underwent interventional interventions due to CHD. Based on the results of the mentioned study, reported complications included transient arrhythmia in 4 patients, inability to close ASD in 5 participants, and groin hematoma in 1 case, with a total complication and outcome of less than 5% (15).

It should be noted that because the data collected in this study involved all types of CHD, the results cannot be generalized to a particular type of heart disease and defect. Nevertheless, this procedure has been used in general investigations of cardiac defects and their treatment consequences (16). In the present study, the patients without chromosomal abnormalities had significantly fewer complications in postoperative follow-up. This finding was in line with that of a study conducted by Majnemer et al., which revealed that patients with CHD of the nervous system had more complications than other patients. The results of the current indicated that there was a significant relationship between children's age and follow-up results during the first 7 days after the intervention. (16)

Since this study was conducted in a specific geographical and social location (i.e., Birjand), the generalizations of the results to other cities should be performed with caution. The limitation of this research was related to its small sample size which highlights the conduction of comprehensive investigations on this topic.

Conclusion

In general, except for the length of the hospital admission, there was no difference between percutaneous and surgical interventions. Furthermore, it was found that the type of CHDs had no effects on the prevalence of complications. Regarding this, it can be concluded that the best technique for each patient is related to variable items, such as personnel, equipment, patient conditions (e.g., tolerance to anesthesia and surgery), and the consensus of a team consisting of surgeons and cardiologists.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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