







Evaluation of Congenital Heart Diseases in Neonates with Diabetic Mothers Who Referred to Teaching Hospitals in Qom, Iran

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Article Info	ABSTRACT
<p>Article type: Original article</p>	<p>Background and Aim: Neonates of diabetic mothers are more prone to congenital heart diseases than others. These abnormalities are the leading cause of fetal death in diabetic neonates. Therefore, the determination of a screening method and evaluation of its value seems necessary in such neonates. The present study investigated the various types of congenital heart diseases in neonates of diabetic mothers.</p> <p>Materials and Methods: The present descriptive cross-sectional study evaluated the prevalence of congenital heart malformations on 200 neonates of diabetic mothers who had referred to the teaching hospitals of Qom, Iran. The designed checklists included the maternal age, gestational age, gender of the infant, occupation of the mother, family history, maternal diabetes, Apgar, respiratory distress, cyanosis, and echocardiographic results.</p> <p>Results: Based on the findings, echocardiographic results of 82 neonates of diabetic mothers were abnormal. Moreover, it was concluded that the infant weight abnormality, reception of oral medications, overt diabetes, and the decrease of fasting blood glucose had a significant relationship with heart diseases in infants of diabetic mothers. Moreover, the study found that echocardiographic results were abnormal in 49% of neonates of diabetic mothers. Furthermore, 3%, 1.5%, 69.5%, 41%, 0%, and 3.5% of the participants had VSD, ASD, PFO, PDA, MR, and TR.</p> <p>Conclusion: Based on the results, it was concluded that 9 out of each 10 diabetic neonates have congenital heart anomalies, with PFO being the most common one of them.</p>
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Introduction

Diabetes, with a prevalence rate of 10-30% in pregnancy, is one of the major causes of intrauterine growth defects and congenital anomalies (1, 2). Various studies have indicated that the risk of fetal anomalies in diabetic mothers is 4-5 times higher than non-diabetic mothers (3, 4). These anomalies can be divided into two categories, namely cardiac and non-cardiac diseases (5, 6). Non-cardiac diseases include cerebral, renal, gastrointestinal, and vascular diseases. According to previous studies, heart diseases account for most of the birth disorders (6).

Based on the statistics, the incidence rate of congenital heart diseases in the normal population is 0.39-0.39% (4), while this rate is 2.8-21% in infants of diabetic mothers (7, 8). Furthermore, it should be mentioned that the most common heart diseases caused by maternal diabetes include PDA, HCM, VSD, ASD, TGA, LVH, PFO, MR, TR, AI, COA, Tetralogy of Fallot, and cardiomegaly (9, 10). Among such diseases, interventricular septal hypertrophy resolves over time (11-15); however, some of them might require intensive care and sometimes

medical-surgical interventions. Therefore, there is a need for early detection of such cases and the determination of a method for screening these disorders in high-risk patients (7, 12).

Congenital anomalies are the most important cause of fetal death in diabetic neonates (4), therefore, it is necessary to determine a screening method for them. Echocardiography is increasingly used as a non-invasive method for examining the functional and structural characteristics of the heart. However, it has not yet received much attention in our country as a suitable tool for screening heart diseases. Nevertheless, with the increasing use of these diagnostic tools in our country, further investigations are needed to determine its value as a diagnostic and screening tool. The present study aimed to investigate the types of congenital heart disorders in neonates of diabetic mothers who referred to or were hospitalized in teaching hospitals of Qom, Iran.

Materials and Methods

This cross-sectional study was performed on neonates of diabetic mothers who referred to or were hospitalized in Hazrat Masoumeh Hospital, Qom, Iran. The required sample size for this study was estimated at 200 subjects, by using the sample size formula and based on 5% Type I error, 9% accuracy, and a frequency rate of 50% echocardiographic abnormalities in the diabetic mothers, based on the results of similar studies. Moreover, the participants were selected using the convenience sampling method and were investigated for congenital heart disorders. Furthermore, the inclusion criteria consisted of having mothers who use drugs, such as anticonvulsants, lithium, and warfarin.

On the other hand, the exclusion criteria consisted of 1) alcohol abuse of mothers, 2) infliction of mothers with diseases, such as hypertension, thyroid disorders, and lupus, and 3) infliction of neonates with genetic diseases, such as Down and Turner syndromes. The instrument used in this study was a checklist, which included variables, such as the maternal age, gestational age, gender of the infant, occupation of the mother, family history, maternal blood glucose, Apgar score, respiratory distress, cyanosis, and echocardiographic results. These checklists were completed when the participants visited the hospital for neonatal cardiology and in collaboration with the mothers. Regarding the ethical considerations, all the families were told that the information will be kept confidential. After

the collection of the questionnaires, the data were analyzed in SPSS software (version 20) using independent t-test, chi-squared, and Fisher tests. Moreover, the mean and standard deviation were calculated for quantitative variables while frequency and percentage were calculated for qualitative variables. A p-value of 0.05 was considered statistically significant for all the tests.

Results

For the purposes of the study, 200 patients were studied (72% [n=144] male and 28% [n=56] female). In total, 8%, 44%, and 48% of the participants weighed >2500 gr, 2500-4000 gr, and <4000 gr, respectively. Moreover, the birth of 192 neonates (96%) was term while 8 neonates (4%) were born preterm. Furthermore, the age of 52%, 36%, and 12% of mothers were 20-30, 30-40, and <40 years. In addition, 76% of the mothers had occupations outside of their houses. In total, 56% (n=112) and 44% (n=88) of the mothers were inflicted with gestational diabetes mellitus and overt diabetes. Moreover, 25% (n=50) and 19% (n=38) of the subjects were diagnosed with type 1 and type 2 diabetes. In the present study, 8% (n=16) of neonates had a family history of congenital heart disease and 76% (n=152) of the parents were cousins. It should be mentioned that 72% of the deliveries were Cesarean section while the rest were normal vaginal delivery. Birth Apgar scores in 4% and 96% of the participants were 4-7% and 8-9%, respectively.

In this study, the echocardiographic results were abnormal in 49% (n=82) of the participants which are shown in Table 1.

Table 1. Echocardiographic results of diabetic mothers

Variable	Result	Frequency	Percent
PFO	POS	139	69.5
	NEG	61	30.5
PDA	POS	82	41
	NEG	118	59
ASD	POS	3	1.5
	NEG	197	98.5
VSD	POS	6	3
	NEG	194	97
TR	POS	7	3.5
	NEG	193	96.5
MR	POS	0	0
	NEG	200	100
CHD	POS	0	0
	NEG	200	100

Table 2. Relationship between demographic planners and echocardiographic evaluation

		Gestational age		Gender		Occupation of Mothers		Residence		Blood Relationship between parents		Family history	
		Term	Pre-term	Male	Female	Clerk	Housewife	Urban	Rural	Cousins	Non-cousins	Yes	No
Echo	Normal	80	38	62	56	2	116	110	8	86	32	1	117
	Abnormal	20	62	53	29	3	79	5	77	55	27	80	2
p-value		0.000		0.089		0.382		0.847		0.377		0.749	

Based on the results of analytical tests, the female gender ($P=0.089$), family history ($P=0.749$), occupations of mothers ($P=0.382$), place of residence ($P=0.847$), and blood relationship of parents ($P=0.377$) had no significant relationship with the abnormal echocardiography results (Table 2).

However, variables, such as abnormal birth weight ($P=0.037$), infliction with overt diabetes ($P=0.0001$), blood pressure medications ($P=0.023$), cousin marriage ($P=0.0001$), neonatal Apgar score ($P=0.0001$), Cesarean section delivery ($P=0.0001$), and fasting blood glucose ($P=0.004$) had a significant relationship with the abnormal echocardiography results.

Discussion

Based on the findings, the echocardiographic results were abnormal in 49% of diabetic mothers. Moreover, 3%, 1.5%, 69.5%, 41%, 0%, and 3.5% of the infants were inflicted with VSD, ASD, PFO, PDA, MR, and TR. Abousoleyman and Subayeh in their study investigated the echocardiographic results of 100 neonates of diabetic mothers with the aim of evaluating heart disorders (2000-2001). In the aforementioned study, the most prevalent cardiac disorders were PDA (70%), PFO (68%), and ASD (5%). In total, except for HCM and PDA, the prevalence rate of congenital heart diseases (15%) was lower than that of the present study (8). However, the prevalence rate of PFO was high, similar to that of the present study. In addition, Ardakani et al. conducted a prospective study on 75 infants of diabetic mothers and investigated them through color Doppler echocardiography during 2005-6. In the abovementioned study, the prevalence rate of congenital heart disease regardless of HCM and PDA was reported to be 3%, and the most common heart diseases were PDA, HCM, and VSD (15). These results were inconsistent with those of the present study which showed the necessity of regional investigations.

Based on the results of a case-control study performed on 64 neonates who were divided into two groups ($n=32$), the prevalence rates of heart disease were 19 and 9 in the case (neonates with diabetic mothers) and control groups, respectively. In the aforementioned study, echocardiographic

features, including an increase in the left ventricular internal diameter, interventricular septum thickness, left ventricular posterior wall thickness, the amount of left ventricular interior shrinkage, cardiac output, and left ventricular mass were significantly higher in the group infants with diabetic mothers, compared to the control group (16). However, the present study did not have a control group. Russell et al. investigated the heart diseases of the stillborn neonates of diabetic mothers during 1980-2003. Finally, they reported that stillborn infants of diabetic mothers had higher heart weights and ventricular free wall size, compared to stillborn infants of non-diabetic mothers. Moreover, they reported cardiomegaly as a common disease in neonates of diabetic mothers (9). However, the heart size of the neonates was not evaluated in the present study.

Conclusion

In conclusion, based on the results of the present study and a comparison with other similar studies performed in this area, it is concluded that 9 out of every 10 neonates of diabetic mothers have congenital heart diseases, and PFO and LVH are the most common ones. Infants of diabetic mothers are more at the risk of infliction with heart diseases, whether in the form of congenital malformations or hypertrophic cardiomyopathy. Moreover, the incidence rate of congenital heart disease in neonates of mothers with pre-gestational diabetes is higher than those of mothers with gestational diabetes, signifying the teratogenic role of diabetes in the first trimester. Furthermore, the female gender of the infant, abnormal birth weight, occupational status of mothers, control of pre-gestational diabetes with oral medications, blood relationship between parents, low Apgar score at the time of birth, and inappropriate control of fasting blood glucose prior to the gestation increase the risk of heart diseases in infants. In general, echocardiography is recommended for screening congenital heart diseases in neonates of diabetic mothers.

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Conflicts of interest

There were no conflicts of interest among the authors of this study.

Suggestions

Given the small sample size of this research, it is recommended for future studies to have a larger sample size in order to confirm the results of this study. Therefore, it would be possible to more accurately comment on the impact of diabetes on the incidence of congenital heart diseases.

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