Pediomaternal Nursing Journal

Original Article

The spectrum of congenital heart defects in neonates of diabetic mothers

Abdul Muhib Sharifi*, Khesrow Ekram, Wali Wali

ABSTRACT

Introduction: Insulin-dependent diabetes mellitus (IDDM) in a mother is considered a risk factor for congenital malformation, including congenital heart diseases. Many studies signify a five to six times increased frequency of congenital heart diseases in neonates born from insulin-dependent diabetic mothers. This study aimed to identify the spectrum of congenital heart diseases (CHDs) in neonates born from insulin-dependent diabetes mellitus (IDDM) mothers.
Methods: Between April 2019 and March 2021, a descriptive cross-sectional study involved 120 consecutive neonates aged 0-28 days of mothers with insulin-dependent diabetes mellitus (IDDM) at Maiwand Teaching Hospital, Kabul University of Medical Sciences. Neonates born to non-diabetic mothers were excluded. IDDM refers to mothers using Insulin upon admission to control blood glucose. CHD encompasses various heart defects affecting function. Family and maternal history were noted, focusing on health issues and delivery details. Neonatal mothers' ages ranged from 23 to 45 (mean 33), with diabetes onset spanning 2.5 to 25 years. Pediatric cardiologists conducted physical and echocardiographic exams. All CHD forms were documented using 2D echocardiography and Doppler studies (Sono Ace X-6 Machine).
Results: 120 consecutive neonates born to mothers with insulin-dependent diabetes mellitus (IDDMs) were investigated during the two-year study period. Of them, 18 (15%) had congenital heart abnormalities. The prevalence of solitary and multiple CHD was 66.6 percent (12 patients) and 33.3 percent (6 patients) in the 18 infants born from IDDMs. The most prevalent isolated defects were PDA (22.2%) and Ventricular septal defect (16.6%). The most common multiple CHDs (16.6 percent) were PDA and ASD. PDA + ASD (16.6%) and VSD + PDA were the most frequent correlations with CHD (11.1 percent).
Conclusion: Maternal insulin-dependent diabetes mellitus is an important risk factor for congenital heart disease. Careful assessment and early diagnosis of CHD in this high-risk group are very important in a pediatric population. Expansion of prenatal screening programs for CHDs in mothers suffering from insulin-dependent diabetes mellitus is necessary.

Keywords: congenital heart diseases; diabetic mothers; insulin dependent; neonates

INTRODUCTION

The most common congenital disability among newborns globally is congenital heart disease (CHD). The most frequent cause of death in newborns with congenital impairments is congenital heart disease (Becker et al., 2001). It causes 1-1.5 percent of pediatric populations, particularly those under 5 years old, to die (Chung & Myrianthopoulos, 1975). Across the board, there are roughly 6–8 incidences of CHD for every 1000 live births (Criley et al., 1976). In the USA, congenital cardiac disorders impact roughly 1% of all births annually (Ferencz, 1990). Although many children with CHD do not require surgical intervention, around 1 in 4 require heart surgery (Alabdulgader, 2001). Although the exact cause of most CHDs is unknown, numerous risk factors have been identified. Studies have proven that diverse combinations of environmental teratogens, genetic factors, and maternal problems contribute to CHD exposure (Ferencz et al., 1990). One of these factors that has a teratogenic effect on the fetal heart is maternal diabetes mellitus (DM). Maternal diabetes mellitus (DM) during pregnancy harms the mother's and fetus's health, including heart abnormalities, cesarean section (CS), and suffocation (Gladman et al., 1997). In pregnant women, the additional blood glucose is transferred to the fetus. The fetus's body is forced to secrete more Insulin; as a result, resulting in numerous syndromes in newborns. One of the main causes of intrauterine development deficits and congenital abnormalities is diabetes, which affects 10–30% of pregnant women. According to studies, diabetes women are 4-5 times more likely to experience fetal abnormalities than non-diabetic mothers (Goldman et al., 1986). Infants of diabetes moms have a 3-6 percent higher frequency of heart abnormalities (IDMs). CHD is five times more common in these infants than in babies born to healthy mothers, and it frequently takes complex forms (Gutgesell et al., 1976; Heinonen, 1976). According to statistics, congenital heart disease incidence rates range from 0.39 to 0.39 percent in the general population but range from 2.8 to 21 percent in newborns of diabetes mothers.

Congenital malformations, such as congenital heart disorders, have a high-risk factor associated with maternal insulin-dependent diabetic mellitus (IDDM) (Alabdulgader, 2001). Numerous studies show that newborns born to mothers

*Correspondence: Abdul Muhib Sharifi (abdulmuhibsharifi@gmail.com)
Pediatric Cardiology Department of Maiwand Hospital, Kabul Medical University, Afghanistan

Volume 9 (2): 54-58
http://dx.doi.org/10.20473/pmnj.v9i2.39020

e-ISSN: 2355-1577 | p-ISSN: 2656-4629

Article History
Received: October 31, 2021 | Revised: February 16, 2023 | Accepted: July 13, 2023 | Published : August 31, 2023

with insulin-dependent diabetes mellitus have a five to six times higher incidence of congenital heart disorders (CHDs) (Henry et al., 1973; Miller et al., 1982). However, it has been discovered that this risk is incredibly minimal among children born to gestational diabetic mothers (Mills et al., 1979). Congenital heart disorders (CHDs) are substantially more common in the pediatric population, according to many researchers studying IDDM (Ferencz, 1990). Researchers found that taking diabetes-related drugs was connected with a fourfold greater risk. If the mother had the condition for more than five years before becoming pregnant, the relative risk rose to almost eightfold (Heinonen, 1976).

Although the frequency of CHD in Afghanistan has not been determined in a large sample size study, it is hypothesized that the country has a high prevalence of CHD due to its high consanguinity marriage rate, poor economic status, and lack of prenatal care facilities. A lack of information exists regarding the prevalence and range of CHD in Afghan neonates born to insulin-dependent diabetic moms.

This study examines congenital defects in newborns of insulin-treated diabetic moms, paying particular attention to the cardiovascular system in the Afghan population since this is the first study in English literature (to date) to analyze CHDs in newborns of insulin-dependent diabetic women in Afghanistan using echocardiography.

METHODS

Design

The design of the study was a descriptive cross-sectional study.

Sample and Setting

The study included 120 consecutive neonates born to mothers with insulin-dependent diabetes mellitus (IDDMs) at Maiwand Teaching Hospital of Kabul University of Medical Sciences.

Variables

The independent variable in this study was maternal status, specifically whether the mothers have insulin-dependent diabetes mellitus (IDDM) or not. The dependent variables include the presence of congenital heart defects (CHDs) in neonates and any medical conditions or complications observed in neonates due to their mothers' diabetes.

Instruments

The instrument used in the study for data collection was transthoracic echocardiography. The equipment used for this purpose is the Sono Ace X6 echocardiography equipment with an 8- to 12-MHZ/pediatric probe. Additionally, skilled pediatric cardiologists conducted the echocardiographic studies

Procedure

Neonates born to mothers with insulin-dependent diabetes mellitus (IDDM) were included in the study. Neonates born from healthy mothers and non-insulin-dependent diabetic mothers were excluded from the study.

The family history and maternal history of the neonates were recorded. Family history included medical health problems within the neonates' families, while maternal history included maternal age, conditions affecting the newborns, and details of delivery and resuscitation.

The patient (neonate) was physically inspected by two skilled pediatric cardiologists. All 120 newborns underwent transthoracic echocardiography using the specified equipment and pediatric probe. Two experienced pediatric cardiologists conducted and examined all echocardiographic studies. Patients without a full echocardiography report and those with insufficient medical records were eliminated from the study.

Data Analysis

The data analysis was performed using descriptive analytic.

Ethical Considerations

Before data collection, permission was obtained from Ethics committee of Kabul University of Medical Sciences and the parents of the neonates.

RESULTS

The newborns involved in this study had mothers who ranged in age from 23 to 45. (Mean, 33 years). Between 2.5 and 25 years ago, moms of newborns began to develop diabetes. A total of 120 neonates born to moms with IDDM were evaluated in this study. 50 (41.6% of the population) males and 70 (58.3%) females made up the 1:1.4 ratio. Regarding the gender distribution of the neonates included in the study, there were no notable variations (Table 1). The average gestational age was 38.3 weeks, and 5% of births

Table 1. Gender distribution of CHD status in children born from IDDMs

		Male 50 (41.6%)	Female 70 (58.4%)	Total 120 (100%)	p-value
Newborns of Insulin Dependent Diabetic Mothers	CHD	8 (16%)	10 (14.2%)	18 (15%)	0.38
	non-CHD	42 (84%)	60 (85.8%)	102 (85%)	0.40

Table 2. Birth weights 120 neonate born from Insulin Dependent Diabetic Mothers

Birth weight (g)	n (%)
<2500	6 (5)
2500–3999	68 (56.6)
>4000	46 (38.3)
Total	100 (100)

Table 3. Prevalence and types of CHDs in Neonates of IDDMs

Congenital heart diseases	Type of CHD	Number	% of CHD	% of children born from IDDMs
No heart disease		102		85
Heart disease		18	100	15
Isolated CHD	PDA	4	22.2	3.3
	VSD	3	16.6	2.5
	ASD	2	11.1	1.6
	PFO	2	11.1	1,6
	PS	1	5.5	0.8
Multiple CHD	PDA + ASD	3	16.6	2.5
	VSD+PDA	2	11.1	1.6
	TOF+ASD	1	5.5	0.8

Note: ASD=atrial septal defect, CHD=congenital heart diseases, PDA=patent ductus arteriosus, PFO=patent foramen ovale, PS=pulmonary stenosis, TOF=tetralogy of Fallot, VSD=ventricular septal defect

were premature and underweight (37 weeks). The gestational age varied from 32 to 42 weeks. The average weight at birth was 3560 620 g. (Table 2). Only 6% of the newborns had heart murmurs audible to them. During the echocardiography evaluation, cyanosis and respiratory distress occurred in four patients.

Echocardiography was performed 48 to 72 hours after delivery. Data from echocardiography are summarized in (Table 3). The most frequent echocardiographic findings were isolated VSD (16.6%), PDA + ASD (22.2%), and patent ductus arteriosus (PDA) (22.2%). (16.6 percent).

PDA (22.2%), VSD (16.6%), ASD (11.1%), PFO (11.1%), and isolated pulmonary valve stenosis were among the acyanotic forms of CHDs (5.5 percent).

Tetralogy of Fallot plus ASD were the cyanotic forms of CHDs that were observed (8 percent). In contrast to other investigations, the lack of hypertrophic cardiomyopathy in our study may have been caused by the limited sample size.

Patients' associations with extracardiac problems were also investigated. Genitourinary abnormalities (bilateral undescended testes), a minor deformity, were observed in 3.5 percent of cases. One of the four Down syndrome patients also had tetralogy of Fallot.

DISCUSSION

In this study, we discovered a high prevalence of CHD (15%); prevalence rates for congenital cardiac diseases have been reported in IDDMs in a variety of ranges. Similar to our findings, studies conducted in Iran have estimated the prevalence of CHD to be 9.3 to 18.7 per 1000 live births (Roodpeyma et al., 2013). In the eastern region of Saudi Arabia, Alabdulgader (2001) found a prevalence of congenital cardiac conditions (14.5 percent) comparable to our findings (Alabdulgader, 2001).

In our study, the most frequent echocardiographic findings were patent ductus arteriosus (PDA) (22.2%), isolated ventricular septal defect (VSD) (16.6%), and PDA + ASD (16.6%), which is almost identical to a Gladman G. study in which they discovered that PDA was the most common congenital heart defect (CHD) found (23%) in fetal echocardiography screening of diabetic mothers, followed by VSD (15 percent) (Gladman et al., 1997).

PDA in (22.2%), VSD (16.6%), ASD (11.1%), PFO (11.1%), and isolated pulmonary valve stenosis (5.5%) were all included in our analysis as acyanotic forms of CHDs. This is similar to a study published by Rowland, whose findings included VSD (15.5%) and PFO 12% (Rowland et al., 1973).

According to the Baltimore-Washington Study (BWS), a sizable population-based case-control study project, the total risk of structural heart disease associated with overt maternal diabetes mellitus was 4 times higher than the risk compared to non-diabetic mothers (Ferencz, 1990; Ferencz et al., 1990). In patients with managed and uncontrolled diabetes mellitus, Mills et al. reported an incidence of 2.8 and 3.2 percent, respectively (Mills et al., 1988). In our study, moms had very poor diabetic control, but we could not determine the HbA1c of all mothers due to their dire financial circumstances.

It is well known that inadequate diabetes control and hyperglycemia in mothers of newborns increase the risk of congenital heart disorders in offspring, which may be one of the causes of the high incidence in our study (Goldman et al., 1986; Kitzmiller et al., 1978; Mills et al., 1979; Roodpeyma et al., 2013; Shields et al., 1993).

Researchers have discovered that environmental and genetic factors may also be important (Henry et al., 1973). For instance, the prevalence of consanguinity in the neighborhood is linked to certain CHDs such as ASD and VSD (Becker et al., 2001). We could not find any cases of hypertrophic cardiomyopathy in our investigation, which may have been owing to the small sample size. Gutgesel et al. originally described its occurrence in children of diabetic mothers (Gutgesell et al., 1976). The clinical result of diabetes mellitus in pregnancy is improved by early treatment and control, but the condition does not stop progressing, according to Reller and his colleagues (Reller et al., 1985). In particular, tetralogy of Fallot and pulmonary valve stenosis have been linked to severe CHDs in IDDM moms (Chung & Myrianthopoulos, 1975; Gladman et al., 1997; Mills et al., 1979; Rowland et al., 1973). The study's conclusions are very similar to those of earlier studies. Following PDA, VSD and PDA + ASD were the most often observed CHDs in this investigation, consistent with earlier studies (Mills et al., 1979).

Diabetes in mothers who are insulin-dependent is a significant risk factor for CHDs. Comparing this study population (the population of Afghanistan) to previous national and international studies, a high prevalence of CHDs was found. Rapid treatment and early diagnosis are crucial for this particular population. To find fetuses at risk of severe CHDs, fetal diagnosis systems must also be developed.

CONCLUSION

Congenital heart disorders are significantly more likely in mothers with maternal insulin-dependent diabetes mellitus. Congenital, cyanotic, or acyanotic heart abnormalities are more likely to occur when gestational diabetes is poorly controlled. Careful evaluation and early detection of CHDs in this high-risk group are crucial in the pediatric population. Expanding prenatal screening programs for CHDs in moms with insulin-dependent diabetes mellitus is essential.

Declaration of Interest

Non-declared.

Acknowledgment

We would like to acknowledge Kabul University of Medical Sciences, for the assistance of this research.

Funding

No specific grant was given to this work by any funding organization in the public, private, or nonprofit sectors.

Author Contribution

M. S performed the analysis and wrote the paper.
K. E collected the data.
W.W designed the ananlysis

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

REFERENCES

Alabdulgader, A. A. A. (2001). Congenital heart disease in 740 subjects: Epidemiological aspects. *Annals of Tropical Paediatrics, 21*(2). https://doi.org/10.1080/02724930120058160

Becker, S. M., Halees, Z. Al, Molina, C., & Paterson, R. M. (2001). Consanguinity and congenital heart disease in Saudi Arabia. *American Journal of Medical Genetics, 99*(1). https://doi.org/10.1002/1096-8628(20010215)99:1<8::AID-AJMG1116>3.0.CO;2-U

Chung, C. S., & Myrianthopoulos, N. C. (1975). Factors affecting risks of congenital malformations. II. Effect of maternal diabetes on congenital malformations. *In Birth defects original article series (Vol. 11,* Issue 10).

Criley, J. M., Lennon, P. A., Abbasi, A. S., & Blaufuss, A. H. (1976). Hypertrophic cardiomyopathy HJ Levine (Ed.) (pp. 771–827). Grune and Stratton.

Ferencz, C. (1990). A case-control study of cardiovascular malformation in live born infants: the morphogenic relevance of epidemiological findings. In Developmental cardiology: Morphogenesis and function future (Clark EB, pp. 523–539). Mount Kisco.

Ferencz, C., Rubin, J. D., McCarter, R. J., & Clark, E. B. (1990). Maternal diabetes and cardiovascular malformations: Predominance of double outlet right ventricle and truncus arteriosus. *Teratology, 41*(3). https://doi.org/10.1002/tera.1420410309

Gladman, G., McCrindle, B. W., Boutin, C., & Smallhorn, J. F. (1997). Fetal echocardiographic screening of diabetic pregnancies for congenital heart disease. *American Journal of Perinatology, 14*(2). https://doi.org/10.1055/s-2007-994098

Goldman, J. A., Dicker, D., & Feldberg, D. (1986). Pregnancy outcome in patients with insulin-dependant diabetes mellitus with preconception diabetic control: A comparative study. *Am J Obstet Gynecol, 155*, 293–297.

Gutgesell, H. P., Mullins, C. E., Gillette, P. C., Speer, M., Rudolph, A. J., & McNamara, D. G. (1976). Transient hypertrophic subaortic stenosis in infants of diabetic mothers. *The Journal of Pediatrics, 89*(1). https://doi.org/10.1016/S0022-3476(76)80945-6

Heinonen, O. P. (1976). Risk factors for congenital heart disease: A prospective study. In Birth defects, risks and consequences (pp. 221–264). Academic Press.

Henry, W. L., Clark, C. E., & Epstein, S. E. (1973). Asymmetric septal hypertrophy. Echocardiographic identification of the pathognomonic anatomic abnormality of IHSS. *Circulation, 47*(2). https://doi.org/10.1161/01.CIR.47.2.225

Kitzmiller, J. L., Cloherty, J. P., Younger, M. D., Tabatabaii, A., Rothchild, S. B., Sosenko, I., Epstein, M. F., Singh, S., & Neff, R. K. (1978). Diabetic pregnancy and perinatal morbidity. *American Journal of Obstetrics and Gynecology, 131*(5). https://doi.org/10.1016/0002-9378(78)90120-5

Miller, E., Hare, J. W., Cloherty, J. P., Dunn, P. J., Gleason, R. E., Soeldner, J. S., & Kitzmiller, J. L. (1982). Elevated maternal hemoglobin A1c in early pregnancy and major congenital anomalies in infants of diabetic mothers. *Obstetrical and Gynecological Survey, 37*(2). https://doi.org/10.1097/00006254-198202000-00020

Mills, J. L., Baker, L., & Goldman, A. S. (1979). Malformations in infants of diabetic mothers occur before the seventh gestational week. Implications for treatment. *Diabetes, 28*(4). https://doi.org/10.2337/diab.28.4.292

Mills, J. L., Knopp, R. H., Simpson, J. L., Jovanovic-Peterson, L., Metzger, B. E., Holmes, L. B., Aarons, J. H., Brown, Z., Reed, G. F., Bieber, F. R., Van Allen, M., Holzman, I., Ober, C., Peterson, C. M., Withiam, M. J., Duckles, A., Mueller-Heubach, E., & Polk, B. F. (1988). Lack of Relation of Increased Malformation Rates in Infants of Diabetic Mothers to Glycemic Control during Organogenesis. *New England Journal of Medicine, 318*(11), 671–676. https://doi.org/10.1056/NEJM198803173181104

Reller, M. D., Tsang, R. C., Meyer, R. A., & Braun, C. P. (1985). Relationship of prospective diabetes control in pregnancy to neonatal cardiorespiratory function. *The Journal of Pediatrics, 106*(1). https://doi.org/10.1016/S0022-3476(85)80474-1

Roodpeyma, S., Rafieyian, S., Khosravi, N., & Hashemi, A. (2013). Cardiovascular complications in infants of diabetic mothers: An observational study in a pediatric cardiology clinic in Tehran. *Journal of Comprehensive Pediatrics, 4*(2). https://doi.org/10.17795/compreped-8432

Rowland, T. W., Hubbell, J. P., & Nadas, A. S. (1973). Congenital heart disease in infants of diabetic mothers. *J. Pediatr, Nov*, 815–820.

Shields, L. E., Gan, E. A., Murphy, H. F., Sahn, D. J., & Moore, T. R. (1993). The prognostic value of hemoglobin A1c in predicting fetal heart disease in diabetic pregnancies. *Obstetrics and Gynecology, 81*(6).