Type of the Paper (Research article)

Cardiac Abnormalities in Infants of Diabetic Mothers

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Received: 12 May, 2024 Reviewed: 1 June, 2024
Accepted: 22 June, 2024 Published online: 30 Sep, 2024

Abstract:

Introduction: Babies of diabetic mothers (IDM) have a higher chance of congenital defects. Transposition of great arteries, aortic stenosis and ventricular septal defect are the three most common cardiac defects in IDMs.

Aim of the study: Estimating the incidence of infants with cardiac abnormalities whose mothers have diabetes in Fayoum University Hospital.

Subjects and Methods: The research used a case-control methodology. By using the exclusion criteria, newborns with chromosomal abnormalities, all births from diabetic moms who managed their diabetes well or poorly were compared to healthy births from non-diabetic mothers. Delivery data from February to September of 2023 was used in the analysis. Data were gathered at Fayoum University Hospital through chart review utilizing the Best-Care system. The statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) version 20.

Results: There was a statistically significant greater percentage of cardiac anomalies in both groups I and II in comparison to group III but no distinction among both groups I, and II in cardiac anomalies (p <0.05). In contrast, there wasn't statistically significant variation with (p >0.05) as regards types of cardiac anomalies between the three study groups.

Conclusions: In this case-control study, 61.1% of newborns whose moms were included had heart abnormalities. PFO was the most common echocardiographic abnormality seen in diabetic newborns. Mothers with poorly managed diabetes had a greater risk of heart abnormalities.

Keywords: Cardiac Abnormalities; Diabetic; Pregnancy.

1. Introduction

The leading global cause of death and morbidity is cardiovascular disease (CVD) [1]. In contrast to recent decades, when the prevalence of cardiovascular disease among kids and adolescents has risen, occurrence and mortality rates have reduced in many nations [2, 3].

Lifetime variability exists among cardiovascular disease risk factors, and the etiology of early-onset cardiovascular disease may be distinct from that of cardiovascular disease that develops later in life [4].

Obesity, heart defects, and offspring diabetes have also been linked to prenatal vulnerability to mother diabetes. A higher chance of CVD later in life may result from these illnesses [5]. Although the exact mechanism underlying this altered gene expression is unknown, experimental research indicates that early-stage hyperglycemia may modify the expression of genes in key developing cardiac cellular components, specifically the outflow regions of the embryonic heart [6, 7].

An estimate indicated that 5.4 out of every 1000 newborns worldwide are estimated to have serious heart defects each year [8]. Although the exact cause is uncertain, several genetic and/or environmental variables may be involved [9]. Risk factors include, but are not limited to, advanced maternal age, vitamin deficiencies, phenylketonuria, folic acid insufficiency, rubella virus, maternal diabetes mellitus, influenza, and febrile illness [10]. Numerous researches have demonstrated a robust correlation between maternal diabetes, congenital cardiac malformations, and patterns of COVID-19 viral pneumonia in CT scans as well as HRCT chest [4–10].

This study's objectives were to evaluate the occurrence of infants with cardiac anomalies due to the strong evidence that supports the link between maternal diabetes and cardiac anomalies, as well as the paucity of studies in Egypt regarding the significant effects of cardiac anomalies on patients, families, communities, and the nation's finances. Furthermore, the work aimed to correlate and compare HRCT chest findings and the severity of the clinical condition of coronavirus disease.

2. Subjects & Methods

2.1. Subjects

The present study involved fifty-four neonates, of both sexes, who were born to diabetic mothers. The infants were categorized into three groups: group I comprised eighteen neonates whose mothers had well-controlled diabetes (HbA1c levels were below seven), group II comprised eighteen neonates whose mothers had poorly controlled diabetes (HbA1c levels were above seven), and group III served as the control group. Eighteen infants from healthy, mother's non-diabetic comprise this sample. A case-control study was performed from February to September 2023 in the pediatrics department's neonatology and cardiology units at Fayoum University Hospital in Fayoum, Egypt.

Inclusion criteria

Neonates of Both genders, who had diabetic mothers were included.

Exclusion criteria

Neonates with chromosomal abnormalities were excluded.

2.2. Study design

The laboratory workup included studies to determine the glycemic status of IDM moms, as well as Imaging investigations, including tissue Doppler imaging and conventional echocardiography, which are typically performed within the initial week of life.

A full history was obtained for each case, which involved factors such as mode of birth, gestational age, NICU hospitalization history, type of maternal diabetes, history of jaundice, maternal illnesses other than diabetes, and respiratory distress.

Vital signs and main anthropometric measurements, such as recumbent length, weight, and head circumference, were all included in the whole general assessment. The systemic examination comprised chest, heart, abdominal, and neurological exams.

A General Electric Vivid five-color Doppler US system was utilized to carry out the echocardiography., which was equipped with transducers running at 3.75 MHz or 5 MHz, depending on the age of the infant or child. A comprehensive echocardiographic test to rule out the possibility of congenital heart disease, with a focus on RV

dimensions, global function, LV internal dimensions, and LV ejection percentage.

Employing conventional echo-cardiography with the parasternal long axis as the typical transthoracic aperture. In cardiac M mode, the transducer recorded LVESD, LVEDD, LVPW, and EF. The mean value was computed by averaging the A) wave velocity and transmittal E wave velocity (E) by pulsed wave Doppler imaging. The data was collected from an apical four-chamber view of the mitral septal leaflet. Many research investigations have established a significant correlation between maternal diabetes and infant cardiac abnormalities [4-10].

2.3. Statistical Methods

Statistical Package for the Social Sciences (SPSS) software, version twenty-two, was utilized on Windows 7 to do an analysis of information.

3. Results

Table 1 illustrated that there wasn't a statistically significant variance in the demographic characteristics between distinct research groups ($p > 0.05$). **Table 2** demonstrated that there wasn't a statistically significant distinction ($p > 0.05$) among research groups as regards gestational age and mode of delivery.

Table 1: Comparisons of demographic differences between distinct research groups.

Variables		Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	Group III (healthy END Ms) (N= 18)	*P*-value
Age (years)		5.7S ±0.S1	6.06 ±1.1	6.28 ±0.83	0.27
Sex	Female	7 (38.9%)	12 (66.7%)	6 (33.3%)	0.09
	Male	11 (61.1%)	6 (33.3%)	12 (66.7%)	

Table 2: Comparisons of gestational characteristics in distinct groups of research.

Variables		Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	Group III (healthy END Ms) (N= 18)	*P*-value
Gestational age (weeks)		37.9 ±0.83	38.1 ±0.64	38.5 ±0.92	0.11
Mode of delivery	Vaginal	1 (5.6%)	1 (5.6%)	2 (11.1%)	0.76
	CS	17 (94.4%)	17 (94.4%)	16 (88.9%)	

Table 3 shows that there was a statistically significant greater level of HBA1c% level (p <0.001) in group II (uncontrolled diabetic mothers). In contrast, there wasn't a statistically significant distinction regarding types of diabetes (p >0.05) **(Table 3)**.

Table 2: Comparisons of demographic characters in distinct patient groups.

Variables		Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	*P*-value
HBAlc (%)		6.37 ±0.67	7.73 ±0.74	<0.001*
Type of maternal diabetes	Type one	0 (0%)	1 (5.6%)	0.14
	Type two	2 (11.1%)	6 (33.3%)	
	Gestational	16 (88.9%)	11 (61.1%)	

Table 4 demonstrated that there was a statistically significant variance in (LVIDd, IVSd, IVSs, and LVID) levels among groups I and III and groups II and III (p <0.05), but no variance among groups I and II. As regards ESPAP level; there was a statistically significant distinction (p <0.01) between groups II and III with a greater mean amongst group II. Conversely, there wasn't a statistically significant distinction regarding other echo findings between the three study groups (p >0.05).

Table 4: Comparisons of Echo results in various research groups.

Variables	Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	Group III (healthy END Ms) (N= 18)	*P*-value
IVSd (cm)	0.66 ±0.18	0.65 ±0.12	0.53 ±0.06	0.9[a] 0.009[b] 0.03[c]
IVSs (cm)	0.77 ±0.12	0.76 ±0.15	0.64 ±0.11	0.9[a] 0.01[b] 0.03[c]
LVIDd (cm)	1.4 ±0.24	1.3S ±0.23	1.78 ±0.34	0.9[a] <0.001[b, c]
LVIDs (cm)	0.87 ±0.18	0.91 ±0.14	1.07 ±0.17	0.09a 0.001[b] 0.01[c]
LVPWd (cm)	0.49 ±0.12	0.4S ±0.09	0.4S ±0.04	0.94
L\TW (cm)	0.61 ±0.13	0.59 ±0.11	0.62 ±0.11	0.81
EF (%)	71 ±6.9	69.9 ±7.9	69.5 ±6.3	0.80
FS (%)	37.7 ±6.3	36.6 ±6.7	36.5 ±4.9	0.79
TAPSE (mm)	11.33 ±2.1	10.94 ±1.9	ll.S3 ±0.9S	0.31
LA diameter (mm)	10.S3 ±1.5	11.44 ±2.2	11.61 ±1.6	0.39
AR diameter (mm)	10.7S ±1.3	11.22 ±1.6	11.44 ±0.9S	0.30

LA[1] AO root ratio	1 ±0.10	1 ±0.12	1 ±0.09	0.99
EA ratio	1.13 ±0.26	1.20±0.27	1.21 ±0.21	0.61
ESPAP (mmhg)	31.22 ±10.1	34.67 ±11.1	26.11 ±3.7	0.75[a] 0.27[b] 0.01[c]

Table 5 illustrated that there was a statistically significant variance in Z- scores of (IVSs, IVSd, LVIDs, and LVIDd) levels among groups I and III and groups II and III (p <0.05), but no variance amongst groups I and II. Conversely, there wasn't a statistically significant distinction regarding LVPWd and LVPW levels between the three study groups.

Table 5: Comparisons of Echo findings (Z-scores) in distinct research groups.

Variables	**Group I EDMs (well controlled) (N= 18)**	**Group II EDMs (poorly controlled) (N= 18)**	**Group III (healthy END Ms) (N= 18)**	***P*-value**
IVSd (cm)	2.5 (0/5)	2.5 (1.5/4)	1.5 (0/2)	0.86[a] 0.01[b] 0.002[c]
IVSs (cm)	2.5 (0 4)	2.25 (0/5)	1 (0/3)	0.67[a] 0.004[b] 0.002[c]
LVIDd (cm)	-2.75 (-5.5/-0.5)	-3 (-5.5/-l)	-0.25 (-3/3)	0.52[a] <0.001[b, c]
LVIDs (cm)	-2.5 (-5.5/-0.5)	-2.5 (40)	-0.25 (-3/3)	0.62[a] <0.001[b, c]
LVPWd (cm)	2 (04.5)	2.5 (1.5/4)	2.5 (1.5/2.5)	0.92
LVPWs (cm)	0 (-2/2)	0 (-2/2)	0 (-0.5/3)	0.87

Table 6 illustrated that there was a statistically significantly greater level of Tie of the left ventricle between group I compared to group III (p =0.02). In addition, there was a statistically significant difference in IVRT tricuspid measure between group III and both groups I and II (p =0.003 and 0.01, respectively). Conversely, there wasn't a statistically significant distinction regarding other tissue Doppler measures between the three study groups.

Table 6: Comparisons of tissue Doppler findings in distinctive research groups.

Variables	Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	Group III (healthy END Ms) (N= 18)	*P*-value
IVCT mitral (ms)	36.33 ±8.1	37.56 ±0.S	35.33 ±7.9	0.70
RUT mitral (ms)	42.7 ±10.3	43 ±9.9	36.7 ±7.5	0.08
ET mitral (ms)	134.6 ±21.9	139.1 ±21.5	147.2 ±26.3	0.26
Tie of mitral (ms)	0.59 ±0.10	0.56 ±0.11	0.49 ±0.09	0.9[a] 0.02[b]* 0.17[c]
IVCT tricuspid (ms)	36.2 ±7.6	34.6 ±6.4	33.9 ±6.9	0.58
RUT tricuspid (ms)	32.1 ±6.03	46.6 ±27.2	21.1 ±10.8	0.9[a] 0.003[b]* 0.01[c]*
ET tricuspid (ms)	144.5 ±18.5	135.9 ±42.S	140.8 ±23.6	0.70
Tie of tricuspid (ms)	0.54 ±0.12	0.53 ±0.11	0.47 ±0.07	0.09

Table 7 shows that there was a statistically significant greater percentage of cardiac anomalies in both groups I and II in comparison to group III but no distinction among both groups I and II in cardiac anomalies (p <0.05). Conversely, there wasn't a statistically significant distinction as regards types of cardiac anomalies between the three study groups.

Table 7: Comparisons of Cardiac anomalies in distinctive research groups.

Variables		Group I EDMs (well controlled) (N= 18)	Group II EDMs (poorly controlled) (N= 18)	Group III (healthy END Ms) (N= 18)	*P*-value
Cardiac anomalies	No	6 (33.3%)	3 (16.7%)	12 (66.7%)	0.44[a] 0.04[b]* 0.006[c]*
	Yes	12 (66.7%)	15 (83.3%)	6 (33.3%)	
Types of cardiac anomalies	PFO	8 (66.7%)	10 (66.7%)	5 (83.3%)	0.91
	PFO and PDA	3 (25%)	3 (20%)	1 (16.7%)	
	PFO and VSD	1 (8.3%)	2 (13.4%)	0 (0%)	

4. Discussion

Adverse maternal and fetal outcomes, including structural deformities like heart defects, are associated with maternal diabetes mellitus (DM) [11]. Mothers with any type of diabetes, whether type 1 or type 2 DM that existed before pregnancy or gestational diabetes mellitus (GDM) that developed during pregnancy, have an increased risk of cardiac abnormalities in their children [12,13].

The study found that 61.1% of infants whose mothers were included in the study had cardiac anomalies. Comparable studies were carried out in the Eastern Province of Saudi Arabia by Alabdulgader et al. [14] and in Peshawar, Pakistan, by Muhammad et al. [15],

who reported a lower incidence of cardiac anomalies among babies, 59.7% and 62.3%, respectively. Nonetheless, a higher prevalence of 75% was found by Abu-Sulaiman and Subaih [16].

The differences in the occurrence of various cardiac abnormalities across all studies can be attributed to the length of the study period and the selection of sample size. While other investigations have been conducted over five years, our research period was notably short [15].

According to our data, 677 (38.83%) of the 1838 registered newborns were infants of diabetic mothers (IDMs). Our findings differed from a local investigation carried out in Lahore by Aslam et al., who reported that 84 (6%) of the 1530 neonates were diagnosed as IDMs [17].

Our results also differed from those of Muhammad et al. [15], who reported that most infants of diabetic mothers (52.5%) had various congenital heart abnormalities. The researchers noted that the limited number of participants in their study, conducted in hospitals, might have contributed to the higher occurrence of congenital heart disease in babies of diabetic mothers.

Similar findings were observed in the study by Muhammad et al., which had a male-to-female ratio of 1.97:1, with 66.3% male and 33.7% female participants [15].

Infants of pre-pregnant diabetic mothers were found to have a higher incidence of cardiac abnormalities than those of gestational diabetic mothers, with rates of 65% and 35%, respectively, according to a separate study by Behjati et al. [18].

Our findings were similar to those of another Saudi study by Abu-Sulaiman and Subaih, which found that among the cardiac anomalies identified in infants of diabetic mothers, 70% had patent ductus arteriosus (PDA), 68% had patent foramen ovale (PFO), 5% had atrial septal defect (ASD), 4% had ventricular septal defect (VSD), 2% had mitral valve prolapse (MVP), and 1% had pulmonary stenosis (PS) [16]. Another study reported that asymmetrical septal hypertrophy, PFO, and PDA were the most prevalent echocardiographic abnormalities in IDMs, accounting for 80%, 37.5%, and 27.5% of cases, respectively [19].

In extremely preterm newborns without congenital abnormalities, gestational age (GA) is a substantial predictor of mortality [20]. Reduced birth weight is one of the most frequently noted outcomes in babies with heart abnormalities [21]. However, our findings showed that newborns who were overweight

had a noticeably increased frequency of heart defects.

5. Conclusion

In this case-control study, 61.1% of newborns whose mothers were included had heart abnormalities. PFO was the most common echocardiographic abnormality seen in diabetic newborns. Mothers with poorly managed diabetes had a greater risk of heart abnormalities.

Ethical Approval: The Institutional Ethics Committee gave its approval for the study (ethical committee approval number: M642).

Funding: This study is not funded.

Conflicts of Interest: All authors declare they have no conflicts of interest.

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