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ORIGINAL ARTICLE

ECOCARDIOGRAPHIC CHANGES IN CHILDREN OF DIABETIC MOTHERS HOSPITALISED IN A NEONATAL ICU

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ABSTRACT

Introduction: Pregnancy is a period where various endocrine metabolic changes occur. With the progressive increase of newborn (NB) survival, echocardiography has become an essential tool for a good diagnosis. Objectives: The objective of the present study is to describe the echocardiographic alterations of the children of diabetic mothers and characteristics of these newborns who were admitted in the neonatal intensive care unit. Methods: This is a retrospective descriptive study. The variables were extracted from medical records of patients hospitalized in this period. The sample consisted of 782 medical records, but only 37 were children of mothers with diabetes, from January 2017 to July 2019, using inclusion and exclusion criteria to achieve the proposed objective. Results: It was observed in the study that most women had on average 2-3 pregnancies equivalent to (46%), 13 patients had 1 equivalent pregnancy (35%), and patients with more than 4 pregnancies were 7, totaling an average of (19%). Regarding abortions, 7 patients showed having had an abortion and 30 patients (81%) had no abortion. Of the 37 deliveries performed, 26 of them were cesarean sections equivalent to (70%). 25 babies (68%) were born preterm. Regarding size, 14 newborns (38%) were GIG (large for gestational age). As for the length of the hospital stay among the 37 newborns15 of them (41%) were from 1 to 5 days in hospital, 16 newborns (43%) had to stay 6-10 days in hospital, while 6 (16%) had hospitalization over 11 days. Regarding the echocardiographic changes found in the present study, it is worth mentioning that some of the newborns presented more than one alteration in the exams, which differs in the means found. Conclusion: The changes in the echocardiograms that prevailed were FOP and PCA with a higher incidence in the children of diabetic mothers. Only 5 showed no changes in echocardiograms.

KEYWORDS: ECHOCARDIOGRAPHIC CHANGES, DIABETIC MOTHERS, NEONATAL.

INTRODUCTION

The pregnancy is a period in which there are several metabolic endocrine changes, the purpose of which is to meet both maternal and fetal needs. These changes in the organism require adaptations to favor the pregnancy and health of both mother and child, and if these demands are not met, they can damage the maternal-fetal prognosis. There is a greater performance of the pancreas and the whole endocrine system, which when not activated, can lead to glucose intolerance [1]. The most common metabolic alteration in pregnancy is dysglycemia, with gestational diabetes mellitus (GDM) being the most prevalent form (Guidelines of the Brazilian Society of Diabetes: 2014-2015).

Gestational diabetes is defined as any degree of impaired glucose tolerance, whose onset or detection occurs during pregnancy[2]. It occurs in women whose pancreatic function is insufficient to overcome insulin resistance due to the secretion of diabetogenic hormones by the placenta.

According to FRANCO (2008)[3], gestational diabetes affects globally 5% to 10% of pregnancies and according to population studies carried out in the last decades, the prevalence of gestational diabetes mellitus varies from 1% to 37.7%, with a world average of 16.2% (HOD, et al., 2015)[4]. Still according to FRANCO (2008)[3] nowadays, it is estimated that one in six births occurs in women with some form of hyperglycemia during pregnancy, and 84% of these cases would be due to the GDM.

Pregnant women diagnosed with type 1 and type 2 diabetes mellitus are at increased risk of severe congenital malformations5, as their effects start already in organogenesis (Guidelines of the Brazilian Society of Diabetes: 2014-2015). Among these complications is

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congenital heart disease, which occurs in 3 to 9% of pregnancies. The most frequent are: transposition of large arteries, double outflow tract of the right ventricle, atrioventricular septal defect, truncus arteriosus, tricuspid atresia, patent ductus arteriosus and hypertrophic cardiomyopathy[6].

Diabetes screening is performed from the first prenatal consultation, using fasting glucose measurement and with the aim of detecting the presence of pre-existing diabetes. From the 20th week of pregnancy, another measurement of fasting plasma glucose[7] is performed, with a cut-off point of 92mg/dl to detect gestational diabetes (Guidelines of the Brazilian Society of Diabetes 2017-2018). This cutoff point has a sensitivity of 69% and a specificity of 68% for the diagnosis of diabetes and, therefore, about 35% of pregnant women should undergo a definitive diagnostic test7. The oral glucose tolerance test (OGTT) is the procedure of choice and requested between the 24th and 28th weeks of pregnancy[8].

In the son of a diabetic mother, all organs and tissues may be affected due to hyperglycemia, with no predominance of a specific cardiac malformation. There is evidence that adequate maternal metabolic control at this stage of pregnancy would reduce the incidence of malformations to the levels observed in the general population, which is one of the current goals of treatment for diabetic pregnant women9. Therefore, it is worth emphasizing the importance of adequate care for pregnant women and of the conceptus.

The aim of the present study is to describe the echocardiographic changes of the children of diabetic mothers who were admitted at the Neonatal Intensive Care Unit (NICU) of the Hospital e Maternidade Dona Iris (HMDI) in the period between January 1st, 2017 and July 31st, 2019.

METHODS

This is a retrospective descriptive study. The study was carried out with newborns admitted at the NICU of the Hospital e Maternidade Dona Íris, in the city of Goiânia, in the period between January 1st, 2017 and July 31st, 2019. The Hospital e Maternidade Dona Íris is considered a reference for the care of pregnant women and high-risk newborns in the city of Goiânia. Approved by the Ethics and Research Committee of the Hospital e Maternidade Dona Íris (CAAE: 25748719.4.0000.8058).

RESULTS

A total of 782 newborns were admitted to the HMDI NICU during the study period. Of this total, 37 patients were selected for the study.

As for parity, most were multiparous with around 2-3 pregnancies. Regarding abortions, most pregnant women have never had an abortion (table 1).

	Number of patients (N=37)	
	N	%
QUANTITY OF PREGNANCIES		
1	13	35
2-3	17	46
>4	7	19
QUANTITY OF ABORTIONS		
0	30	81
1	6	16
2	1	3

Table 1. Obstetric data regarding number of pregnancies, amount of abortions at HMDI, Goiânia (GO), Brazil, 2017-2019.

Regarding the type of delivery, most were cesarean. The sex of the most prevalent concepts was male. And most of the newborns were premature, but with appropriate weight for gestational age, as shown in Table 2.

	Number of patients (N=37)	
	N	%
TYPES OF DELIVERIES		
Cesarean	26	70
Vaginal	11	30
SEX		
Female	9	25
Male	28	75
CLASSIFICATION FOR GESTATIONAL AGE		
Pre-term (<37sem)	25	68
Term (37s a 41sem)	12	32
Post-term (>42sem)	0	0
CLASSIFICATION BY WEIGHT:		
> 2.501g	24	65
1.500 – 2500g	8	22
Low weight: <1.500	5	13
CLASSIFICATION FOR WEIGHT AND GESTATIONAL AGE:		
AGA (appropriate for gestational age)	22	59
LGA (large for gestational age)	14	38
SGA (small for gestational age)	1	3

Table 2. Classification of newborns in relation to the variables covered in the study: childbirth, sex, gestational age, weight, at HMDI, Goiânia (GO), Brazil, 2017-2019.

Most babies were hospitalized between 1 and 10 days in the neonatal intensive care unit (table 3).

DURATION OF HOSPITALIZATION IN NEONATAL ICU:		
	Number of patients (N=37)	
	N	%
1-5 days	15	41
6-10 days	16	43
>11 days	6	16

Table 3. Number of days spent in a neonatal ICU at HMDI, Goiânia (GO), Brazil, 2017-2019

The most prevalent echocardiographic changes found in these newborns were PFO and ACP as shown in table 4.

ECOCARDIOGRAPHIC CHANGES FOUND:		
	Number of patients	Percentage (%)
Normal: no changes	5	14
PFO (Patent foramen ovale)	28	76
ACP (Artery Channel Persistence)	16	43
PH (Pulmonary hypertension)	5	14
Septum defect	3	8
Hypertrophic cardiomyopathy	3	8
Tricuspid valve insufficiency	1	3

Tabela 4. Resultados das alterações ecocardiográficas obtidas no HMDI, Goiânia (GO), Brasil, 2017-2019

DISCUSSION

When analyzing the amount of pregnancies, it was observed in the study that most women had an average of 2-3 pregnancies equivalent to (46%), in general, pregnancy is poorly tolerated in women with severe autonomic dysfunction, due to the increased risk hypoglycemia, especially in early pregnancy, and increased instability in glycemic control throughout the rest of the pregnancy (American Diabetes Association, 2004).

It appears that of the 37 deliveries performed, 70% of them were cesarean sections. This data is similar to the percentage of cesarean sections in Brazilian studies10, but in the international scenario the rates are lower[11]. The increase in deliveries by cesarean section is another of the main complications of GDM. One of the main indications for cesarean delivery is fetal macrosomia and, consequently, a greater chance of tocotraumatisms (brachial plexus injuries, clavicle fractures, shoulder dystocia and lacerations of the birth canal) and instrumentalization during vaginal delivery[12].

It is important that medical monitoring takes place regardless of the mode of delivery and gestational age, as GDM increases the morbidity and mortality of both the pregnant woman and the newborn.

The classification of newborns was adopted in Brazil by the Ministry of Health in 1994, being recommended by the World Health Organization (WHO), where the parameters related to the weight and gestational age of the newborn are listed. The WHO committee of specialists in Maternal and Child Health divides the gestational age of newborns into three basic categories, namely: pre-term: where all children born alive below 37 weeks of gestational age are described; term: defined for all children born alive between 37 and 41 weeks of gestational age and, finally, post-term: all children born alive with more than 42 weeks of gestational age.

In the present study, from 37 newborns 25 were premature, which is in line with the literature, since one of the complications of a diabetic pregnant woman is premature delivery. About 2/3 of premature births are due to premature labor or premature rupture of membranes and 1/3 due to the maternal and/or fetal indication of birth[13]. It was possible to verify that premature and underweight children when receiving follow-up multidisciplinary team throughout their development have fewer behavior problems than unaccompanied children. We must provide adequate support for these children to achieve a good neuropsychomotor development. Most of the babies were premature, which can be explained by the fact that it was a group of high-risk pregnant women.

In low birth weight newborns (birth weight less than 2500 grams) intrauterine growth restriction (IUGR) is the second leading cause of perinatal morbidity, surpassed only by prematurity[14]. In the present study, it was observed that 8 newborns presented that diagnosis. Newborns with very low birth weight are those with birth weight less than 1500 grams, which corresponded to 13% of the studied population. Most newborns had a birth weight greater than 2500g, representing 65% of the studied population. This finding was in agreement with the pathophysiology of diabetes in the management that leads to an increase in insulin levels in the fetus and consequently greater weight gain.

In the study, the number of newborns large for gestational age (LGA) was [14], which corresponds to 38% of the total. One of the most common complications of gestational diabetes is the birth of a LGA baby. These have a higher risk of tocotrauma, shoulder dystocia, hypoglycemia and respiratory dysfunction. Since the diabetic pregnant woman is more likely to have a LGA child, the indication for cesarean deliveries tends to increase[15].

Due to the different complications that the newborn

of a mother with gestational diabetes is subject to, at various times it is necessary refer them to the neonatal ICU to provide extra intensive care. In our study, 41% of newborns were hospitalized for 1 to 5 days, 43% had to be hospitalized for 6 to 10 days while 16% were hospitalized for more than 11 days. The reasons for admission to the neonatal ICU can be due to congenital abnormalities such as cardiovascular malformations, prematurity, perinatal asphyxia, respiratory distress, metabolic complications (hypoglycemia, hypocalcemia, polycythemia, hyperbilirubinemia), among others[16].

Regarding the echocardiographic alterations found in the studied population, only 14% of the patients had no echocardiographic alterations and some of the newborns presented more than one alteration in the exam.

The incidence of patent foramen ovale (PFO) was 76% in our study. The foramen ovale is an opening in the atrial septum allowing blood to pass from the right atrium to the left atrium in fetal life, which is essential for intrauterine life. Small deviations of blood from the left atrium to the right atrium can occur in the first days of life, which is practically normal. When the newborn's first breath occurs, the foramen ovale gradually closes and, in a few months, completely closes in about 75% of newborns.

Another structure that is essential for fetal life is the ductus arteriosus. This structure allows the blood present in the pulmonary artery to be diverted to the aortic artery, as in intrauterine life blood is not oxygenated in the lungs. Just after birth and the baby's first breaths, the ductus arteriosus becomes unnecessary with its closure occurring in the first days or weeks of life. However, sometimes the ductus arteriosus does not close completely, remaining open, and can cause important clinical repercussions, especially in premature infants. This cardiopathy is called patent ductus arteriosus (PDA). The more premature the baby is, the greater the prevalence of PDA. Some clinical data may suggest the condition, but the diagnosis of certainty is performed by echocardiogram[17].

Of the newborns selected for the study, 43% had a diagnosis of patent ductus arteriosus. In premature infants, especially those with very low birth weight, there is a high risk of patent ductus arteriosus, occurring in 20-40% of babies with birth weight below 1000g. In healthy term newborns, patent ductus arteriosus may be a normal finding in the first 48 hours of life[15].

The incidence of PDA decreases with the increase of the GA. There is a wide variation in this incidence depending on the degree of prematurity and the criteria for defining the disease. When studying 116 NBs with BW below 1,500g, in 1995, it was detected a 36% incidence of PDA and only one patient with GA greater than 28 weeks had the disease[18].

Although PDA is not among the main causes of death in the neonatal period[19], it can be inferred that the early identification of a hemodynamically significant arterial channel represents a warning sign for a potentially fatal evolution, even when the patient is asymptomatic.

Persistent pulmonary hypertension of the newborn (PPHN) is a syndrome that, despite being recognized for more than 30 years, continues to challenge the clinician, and little is known about its etiology, pathogenesis and prevention. Of the 37 newborns evaluated, 5 of them (14%), had the diagnosis of PH confirmed.

Contrary to adult's primary pulmonary arterial hypertension, the newborn's syndrome is not defined by a specific pulmonary circulation pressure. Whatever the pulmonary arterial pressure, provided it is accompanied by a right-to-left shunt and the absence of congenital anomalies of the heart, confirms the diagnosis of PPHN[20].

Certain maternal conditions, such as obesity, diabetes, asthma, black or Asian race, and other neonatal conditions, such as post-maturity and large for gestational age newborns, are associated with a higher incidence of PPHN[21].

The risk of congenital heart disease among children of diabetic mothers is related to the quality of health care provided to these pregnant women[22]. Type 1 and type 2 DM are associated with an increased risk of congenital malformations. Heart defects or congenital cardiomyopathies may be associated with syndromes or genetic malformations[23]. Among fetal malformations, heart disease affects approximately 8.5 out of 100 born to diabetic mothers, particularly those with inadequate metabolic control in the periconceptional period and the first trimester[24]. The same author states that the prenatal diagnosis of heart disease has implications that are important for delivery planning in specialized centers and adequate maternal counseling. It is known that hypertrophic cardiomyopathy, which has a genetic inheritance in 20% to 60% of cases, can be asymptomatic for years and manifest only in special situations, hence the concern with adolescents who have this background and who choose physical competitive activities[25].

Fetal cardiomyopathy is usually temporary with no apparent consequences in most children, but it can account for a greater susceptibility to hypoxia and fetal death in this population[26]. The findings of hypertrophic cardiomyopathy in the study were in 3 newborns (8%) of the total evaluated in the study.

The knowledge of functional disorders of the fetal heart, frequent in fetuses of diabetic pregnant women, was acquired with the use of quantitative indices of assessment of ventricular function, mainly using the analysis of the echocardiogram with Doppler in the flows of the mitral and tricuspid valves[27]. The findings of tricuspid valve in this study were 1 among 37 newborns.

It is essential to have glycemic control, because if there

is poor monitoring, there may be an increase in heart disease rates, making it necessary to control it through assessments and realizations of glycemic profiles, glycated hemoglobin, in addition to having all the appropriate treatment with diet and insulin, when needed.

CONCLUSION

This study showed a high prevalence of cardiac disorders in children of diabetic mothers. Only 5 patients in the total did not show changes in the echocardiogram, which shows the importance of this test in the care of children of diabetic mothers.

An echocardiographic evaluation is able to have high value information correlated to the impact when related to the therapeutic measures used. The echocardiogram is a precision tool for the neonatologist regarding the clinical treatment that will be used, since these newborns may present a complex cardiac alteration or even more than one echocardiographic alteration.

The practice of the neonatologist in performing functional echocardiography is necessary for a cardiac assessment to be carried out dynamically and in sequence to assess the imposed treatments. The support of the pediatric cardiologist is essential to better care for the children of diabetic mothers.

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