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Congenital Heart Defects and Neonatal Complications in Infants of Mothers with Gestational Diabetes Mellitus.

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Abstract

Background: Gestational diabetes mellitus (GDM) is a common metabolic disorder during pregnancy that affects fetal development and increases the risk of congenital heart defects (CHDs) and neonatal complications. This study aimed to assess fetal cardiac defects and early neonatal outcomes in infants born to mothers with GDM in the Kashmir division.

Methods: A prospective observational study was conducted over two years at the Postgraduate Department of Pediatrics, Government Medical College, Srinagar. A total of 130 pregnant women were enrolled, including 65 with GDM and 65 age-matched non-GDM controls. Fetal echocardiography was performed at a mean gestational age of 25 ± 3 weeks using standardized imaging techniques. Fetal echocardiographic findings were later confirmed by postnatal echocardiography. All pregnant women were followed until term, and the neonates were evaluated for early neonatal complications.

Results: Fetal cardiac defects were significantly higher in the GDM group (27.6% vs. 10.7%). Hypertrophic cardiomyopathy was the most common, observed in 12.3% of the GDM group and 3.07% of the non-GDM group. Early neonatal complications were seen in 20% of the GDM group versus 7.6% in the non-GDM group, with a statistically significant p-value of 0.02.

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Conclusion:

Infants of mothers with GDM have a significantly higher risk of fetal cardiac defects and early neonatal complications. Hypertrophic cardiomyopathy emerged as the most common cardiac anomaly. Early screening and close monitoring are essential for improving neonatal outcomes in this high-risk group.

Keywords:- Congenital heart disease, Infants of diabetic mothers, Neonatal complications

Introduction:

Gestational diabetes mellitus is a common metabolic disorder during pregnancy, affecting approximately 16.2% of pregnant women and significantly increasing the risk of congenital malformations and fetal cardiac anomalies (1–3). Even with optimal glycemic control, persistent fetal hyperglycemia and hyperinsulinism can contribute to both structural and functional cardiac defects, such as ventricular septal defects, conotruncal anomalies, and hypertrophic cardiomyopathy (4,5). These cardiac abnormalities may lead to neonatal complications, including respiratory distress, higher NICU admission rates, and prolonged hospital stays. Prenatal echocardiography plays a vital role in the early detection and management of such cardiac issues. This study aims to evaluate fetal cardiac anomalies using prenatal echocardiography in pregnant women with gestational diabetes mellitus (GDM) and compare the findings with age-matched non-gestational diabetes mellitus(non-GDM) pregnant women in the Kashmir division, along with assessing early neonatal outcomes in both groups.

Methodology:

This prospective observational study was conducted over a two-year period, from December 2022 to December 2024, at the Postgraduate Department of Pediatrics, Government Medical College, Srinagar. A total of 130 pregnant women were enrolled, including 65 women diagnosed with gestational diabetes mellitus and 65 age-matched non-gestational diabetes mellitus controls. Pregnant women with pre-existing diabetes or those diagnosed with gestational diabetes mellitus through an oral glucose tolerance test (OGTT) were included. Exclusion criteria

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comprised pre-existing congenital heart disease, a family history of congenital heart defects, hypertensive disorders, multiple gestations, and exposure to known cardiac teratogens.

Fetal echocardiography was performed at a mean gestational age of 25 ± 3 weeks using the Siemens ACCUSON 52000 echocardiography system. Standardized imaging techniques, including two-dimensional (2D) echocardiography, M-mode, Doppler imaging (continuous-wave and pulsed-wave), and color flow mapping, were employed.

All neonates underwent echocardiography during the first postnatal follow-up. Additionally, each newborn was assessed for early neonatal complications, and those requiring medical intervention were admitted to the Neonatal Intensive Care Unit (NICU).

Statistical Analysis:

Data were obtained from maternal and neonatal medical records and analyzed using MedCalc version 20. Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as percentages. Comparisons of fetal cardiac defects, postnatal echocardiographic findings, and neonatal complications between the gestational diabetes mellitus and non-gestational diabetes mellitus groups were conducted using the chi-square test for categorical variables and the independent t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

Results:

A total of 130 pregnant women were enrolled in the study, comprising 65 women with gestational diabetes mellitus (GDM) and 65 age-matched non-GDM controls. The mean age of participants in both groups was 28.2 ± 5.32 years (Table 1).

Among the women in the GDM group, glycaemic management included insulin therapy in 18 (27.6%) cases, metformin in 37 (56.9%), and a combination of both in 10 (15.3%).

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Congenital heart defects (CHDs) were diagnosed in 18 (27.6%) foetuses in the GDM group, with hypertrophic cardiomyopathy (HCM) being the most common anomaly, seen in 8 (12.3%) cases. Structural heart defects were identified in 10 (15.3%) cases, including ventricular septal defects in 6 (9.2%), coarctation of the aorta in 1 (1.5%), transposition of the great arteries in 1 (1.5%), and hypoplastic left heart syndrome (HLHS) in 2 (3.07%).

In comparison, the non-GDM group had 7 (10.7%) cases of CHDs, which included hypertrophic cardiomyopathy in 2 (3.07%) cases and structural defects in 5 (7.6%) cases—ventricular septal defects in 2(3.07%), transposition of the great arteries in 1(1.5%), and complete atrioventricular septal defect (AVSD) in 1(1.5%) case.(Table 2).

In the GDM group, 2 participants were lost to follow-up. One case resulted in intrauterine death (IUD) at term, and one pregnancy was terminated due to HLHS. Two preterm deliveries occurred at 27 and 28 weeks, respectively, and both neonates died due to extreme prematurity. In the non-GDM group, 4 participants were lost to follow-up. One preterm delivery occurred at 29 weeks, and the neonate died due to complications of prematurity.

Postnatal echocardiography was performed in all surviving neonates at the first contact after birth. Significant septal hypertrophy consistent with hypertrophic cardiomyopathy was more frequent in neonates of mothers with gestational diabetes mellitus (10.16%) compared to the non-GDM group (1.6%). Structural heart defects were also more common in the GDM group (13.55%) than in the non-GDM group (8.3%), including ventricular septal defects, transposition of the great arteries, patent ductus arteriosus (PDA), and complete atrioventricular septal defect. However, this difference was not statistically significant, possibly due to the inclusion of PDA, which may result from delayed ductal closure rather than congenital pathology.(Table 3)

All neonates were examined at birth. Thirteen neonates in the GDM group and five in the non-GDM group required NICU admission. In the GDM group, reasons for NICU admission included respiratory distress (n=3), hyperbilirubinemia (n=3), prematurity (n = 2), hypoglycaemia (n = 2), Meconium aspiration(n = 2), and perinatal asphyxia (n = 1). In the non-GDM group, admissions were due to respiratory distress (n=2), meconium aspiration syndrome (n=1), perinatal asphyxia (n=1), and hyperbilirubinemia (n=1). The incidence of neonatal complications was significantly higher in the GDM group (13 cases) compared to the non-GDM group (5 cases), with a statistically significant p-value of 0.03.(Table 4).

Discussion

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Our study demonstrates a significantly higher incidence of congenital heart disease (CHD) and neonatal complications in neonates born to mothers with gestational diabetes mellitus (GDM) compared to those born to non-GDM mothers. One of the most notable findings among foetuses of GDM mothers was significant septal hypertrophy extending to the right ventricular (RV) free wall, with fetal hypertrophic cardiomyopathy (HCM) observed in 12.3% of cases. This finding is consistent with the study by Yaseen MJ et al. (6), who reported a 23% incidence of HCM among infants of diabetic mothers (IDMs). Similarly, our results align with Lookzadeh et al. (8), who found a 12.7% prevalence of CHD in association with uncontrolled maternal diabetes, underscoring the critical role of glycemic control in fetal cardiac development.

Postnatal echocardiography was performed on all neonates at their first follow-up visit. Structural cardiac anomalies such as ventricular septal defects, transposition of the great arteries, and hypoplastic left heart syndrome were significantly more frequent in neonates of GDM mothers compared to non-GDM counterparts (13.55% vs. 8.3%, $p = 0.042$). The incidence of hypertrophic cardiomyopathy was also notably higher among GDM mothers (10.16% vs. 1.6%).

These findings support previous research, including studies by Senthilkumar et al. (9) and Khanal et al. (10), highlighting the increased prevalence of cardiac anomalies in neonates of diabetic mothers. In terms of postnatal outcomes, we observed a significantly higher number of NICU admissions among neonates born to GDM mothers, with the association being statistically significant ($p = 0.03$). Several studies [11, 12, 13] have similarly demonstrated that conditions such as respiratory distress syndrome (RDS), meconium aspiration syndrome (MAS), and overall NICU admissions are markedly elevated in the GDM group, indicating increased perinatal morbidity compared to neonates born to healthy mothers.

These results highlight the detrimental impact of maternal hyperglycemia on neonatal health. GDM contributes to increased maternal and neonatal adverse outcomes during the perinatal period, including fetal distress, developmental anomalies, hypoglycemia, congenital deformities, and increased susceptibility to infections [14].

In our study, we aimed to assess fetal cardiac abnormalities in pregnancies complicated by GDM and compared them with age-matched non-GDM controls. Our findings demonstrate a strong association between poor maternal glycemic control and increased risk of fetal cardiac defects. This reinforces the importance of early fetal echocardiographic screening in GDM pregnancies. We followed both GDM and non-GDM mothers until term

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and confirmed fetal echocardiographic findings postnatally. All neonates were examined by a pediatrician at birth, and a significant number of those born to GDM mothers required NICU admission.

Further research with a larger sample size is essential to determine the burden of GDM on fetal cardiac health in our region. Additionally, future studies should explore mechanisms and interventions aimed at improving maternal glycemic control during pregnancy to minimize adverse neonatal outcomes.

Conclusion.

Our study highlights a strong association between gestational diabetes mellitus (GDM) and increased risk of congenital heart defects and neonatal complications. Poor glycemic control during pregnancy significantly affects fetal cardiac development and postnatal outcomes. Early screening with fetal echocardiography is crucial in GDM pregnancies. Larger studies are needed to further explore preventive strategies and improve maternal-fetal outcomes.

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Table 1: Demographic Details of Study Participants

Parameter	GDM Group (n = 65)	Non-GDM Group (n = 65)
Mean Age (years)	28.2 ± 5.32	28.2 ± 5.32
Glycemic Management		
• Insulin only	18 (27.6%)	—
• Metformin only	37 (56.9%)	—

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Parameter	GDM Group (n = 65)	Non-GDM Group (n = 65)
• Combination therapy	10 (15.3%)	—
Participants lost to follow-up	2	4
Intrauterine Deaths (IUD)	1	0
Preterm Births (< 37 weeks)	2	1

Table 2: Comparison of foetal Congenital Heart Disease (CHD) in GDM vs. Non-GDM Groups

Type of CHD	GDM Group (n = 65)	Non-GDM Group (n = 65)	p-value
Total CHDs (fetal diagnosis)	18 (27.6%)	7 (10.7%)	< 0.05
Hypertrophic Cardiomyopathy (HCM)	8 (12.3%)	2 (3.07%)	—
Ventricular Septal Defect (VSD)	6 (9.2%)	2 (3.07%)	—
Transposition of Great Arteries (TGA)	1 (1.5%)	1 (1.5%)	—
Coarctation of Aorta	1 (1.5%)	0	—
Hypoplastic Left Heart Syndrome (HLHS)	2 (3.07%)	0	—
Complete AV Septal Defect (AVSD)	0	1 (1.5%)	—
Postnatal CHDs (confirmed)	13.55%	8.3%	0.042
Postnatal HCM	10.16%	1.6%	—

Table 3: Comparison of neonatal cardiac defects between GDM and Non-GDM Groups

	Neonates of GDM mothers N=59	Neonates of NON GDM mothers N=60	P value
Hypertrophic cardiomyopathy [significant septal hypertrophy]	6[10.16%]	1[1.6%]	0.02

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Structural heart defects	8[13.55%]	5[8.3%]	0.36
Ventricular septal defect	4	1	
Patent ductus arteriosus	2	2	
Transposition of great vessels	1	1	
Hypoplastic left heart complete AVSD	1	1	
Total	14	6	

Table 4: Neonatal Complications in GDM vs. Non-GDM Groups

Complication	GDM Group (n = 65)	Non-GDM Group (n = 65)	p-value
NICU Admissions	13 (20%)	5 (7.6%)	0.03
Respiratory Distress	3	2	—
Hyperbilirubinemia	3	1	—
Prematurity-related Issues	2	1	—
Hypoglycemia	2	0	—
Perinatal Asphyxia	1	1	—
Meconium Aspiration Syndrome	2	1	—
Total Neonatal Complications	13 (20%)	5 (7.6%)	0.03