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A Study of the Complications in Infants of Diabetic Mothers

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Abstract: ***Introduction: Diabetes Mellitus is a group of metabolic diseases characterized by chronic hyperglycemia associated with disturbances of carbohydrate, fat and protein metabolism due to absolute or relative deficiency in insulin secretion and or action. The complications in IDMs was studied and a comparison was made between babies born to mothers with pregestational diabetes and gestational diabetes. Objectives: The morbidities in IDMs was studied and a comparison was made between infants born to women with pregestational diabetes and gestational diabetes. Their perinatal outcome was also studied. Methods: All consecutive live born babies born to diabetic mothers were included in the study. IDMs were evaluated for morbidities like macrosomia, birth asphyxia, congenital anomalies, birth injuries, respiratory distress, hypoglycemia, hypocalcemia, hyperbilirubinemia and polycythemia. The neonatal complications in IDMs born to pregestational and gestational diabetic mothers was compared and data was analyzed. The perinatal outcome of these IDMs was studied. Results: The complications seen in IDMs were LGA (20.6%), birth asphyxia (14.7%), congenital anomalies (32.4%), respiratory distress (33.3%), RDS (6.1%), hypoglycemia (84.8%), hypocalcemia (3%), hyperbilirubinemia (21.2%) and polycythemia (6.1%). Hairy Pinna was observed in 52.9% of IDMs. There were no significant statistical differences in the incidence of complications among Infants born to women with pregestational and gestational diabetes. Complications like LGA, congenital anomalies and hypocalcemia were seen only in women with suboptimal glycemic control. Conclusion: Hypoglycemia is the commonest complication seen in IDMs. The other complications observed in IDMs are macrosomia, birth asphyxia, congenital anomalies, respiratory distress, RDS, hypocalcemia, hyperbilirubinemia and polycythemia. No significant difference is seen in neonatal morbidity profiles of IDMs born to pregestational and gestational diabetic mothers. Glycemic control has an important role in decreasing neonatal complications seen in IDMs. Thus early intervention and management of pregnancies complicated by diabetes with good neonatal care will result in decreased complications in IDMs and also will improve outcome in this high risk population.***

Keywords: Infant of diabetic mothers; Diabetes in pregnancy; glycemic control; complications in IDMs.

1. Introduction

Diabetes Mellitus is a group of metabolic diseases characterized by chronic hyperglycemia associated with disturbances of carbohydrate, fat and protein metabolism due to absolute or relative deficiency in insulin secretion and or action.[1]

Historically, infants of diabetic mothers have been at significantly greater risk for spontaneous abortion, stillbirth, congenital malformations and perinatal morbidity and mortality.[2] Poor glucose control during the critical weeks of organogenesis, 5-8 weeks after the last menstrual period, is thought to be the key etiologic factor.[3] Subsequently, advances in maternal and fetal care have improved the outlook of the infant of a diabetic mother.

The IDMs are at an increased risk for periconceptional, fetal, neonatal and long- term morbidities. They have double the risk of serious birth injury, triple the likelihood of caesarean section and quadruple the incidence of admission to a newborn intensive care unit. The causes of the fetal and neonatal sequelae of maternal diabetes are likely multifactorial; however, many of the perinatal complications can be traced to the effect of maternal glycemic control on the fetus and can be prevented or atleast reduced through meticulous prenatal and intrapartum care.[4]

The complications in IDMs was studied and a comparison was made between babies born to mothers with pregestational diabetes and gestational diabetes.

2. Methodology

All consecutive live born babies born to diabetic mothers in tertiary care center during the study period (October 2023 to April 2024) formed the study population. Data regarding the diabetic status of the mother was obtained from antenatal records. Diabetic mothers were grouped into two categories: pregestational (type I DM and type II DM) and gestational DM. The diagnosis of GDM was based on National Diabetes Data Group (NDDG) criteria .[5] [NDDG criteria: FBS > 105 mg/ dl, 1 hr post prandial value > 190 mg/dl, 2 hr post prandial value > 165 mg/dl and 3 hr post prandial value > 145 mg/dl. If two or more values are met or exceeded, the diagnosis of GDM is established].

The glycemic status of the diabetic mothers was ascertained based on the serial estimation of fasting and post prandial glucose levels. Each patient's fasting and 2hr post prandial blood glucose values were averaged, yielding one mean value per patient per blood glucose type (fasting or 2 hr post prandial). Blood glucose control was defined according to American college of obstetricians and gynecologists guidelines: a mean fasting value of < 95 mg/dl or mean 2 hour post prandial value of <120 mg/dl. Two groups were identified: women with blood glucose averages within the recommended guidelines (blood glucose controlled or optimal control) and women with blood glucose averages higher than the recommended guidelines (blood glucose not

controlled or suboptimal control).[6]

Mothers antenatal history included data regarding HbA1c levels during pregnancy (in I trimester in pregestational DM and at diagnosis in GDM) was estimated. Other associated obstetrical and medical problems were noted. Pregnancy induced hypertension was diagnosed if the systolic BP was more than 140 mm Hg and diastolic BP was more than 90 mm Hg. Hypertension prior to conception was diagnosed if BP was above 140/90 mm Hg before pregnancy. Any infections in the mothers during pregnancy a was noted.

Inclusion criteria

All consecutive live born infants of diabetic mothers born in tertiary care center from October 2023 to April 2024 were included under this study.

Exclusion criteria

- Stillborn babies of diabetic mothers.
- Abortions of diabetic mothers.

Babies born to diabetic mothers were evaluated immediately after birth. Those requiring resuscitation were resuscitated according to National Neonatology Forum protocol for newborn resuscitation. Birth asphyxia was defined as an apgar score of ≤ 6 at five minutes.[7]All babies born to diabetic mothers were then shifted to NICU for monitoring and treatment.

At admission, weight was recorded using digital weighing scale (to nearest 10gms). Gestational age assessment was done by modified Ballard score. Macrosomia was defined as either birth weight greater than the 90th centile for gestational age or > 4000 gm, independent of gestational age or sex.[8]Small for gestational age was defined as birth weight less than the 10th centile for GA. Detailed examination of the new born for Congenital anomalies were identified clinically and supported by Echocardiography. Respiratory distress was defined as respiratory rate of ≥ 60/min and/ or presence of subcostal and intercostal retractions.

At admission, blood glucose estimation was done on venous blood sample by glucose oxidase method. Subsequent blood glucose estimation at 1, 2, 3,6,12,24,36 and 48 hours of postnatal age was done by glucose dextrostix. Infants with blood glucose < 40 mg/dl were subjected to blood glucose estimation by glucose oxidase method. Hypoglycemia was defined as a blood glucose level less than 40 mg/dl in any infant, regardless of gestational age and whether symptomatic or not.[9]

Estimation of hemoglobin, hematocrit and serum calcium levels were done in clinical laboratory by automated analyser. Polycythemia was diagnosed if venous hematocrit was greater than 65%.[10] Hypocalcemia was defined as serum calcium level less than 7mg/dl. Bilirubin level estimation was done at the onset of clinical jaundice and repeated if necessary. If jaundice was not clinically evident, then serum bilirubin estimation was done on day 4 of life. Hyperbilirubinemia was diagnosed based on standard guidelines.[11]

Chest x-ray and electrocardiography (ECG) was done for all the babies and findings recorded.

3. Results

Family history of diabetes mellitus in mothers of the study sample

Family History of DM	DM		Total
	Pregestational	Gestational	
ABSENT	5 (71.4%)	15 (57.7%)	20 (60.6%)
PRESENT	2 (28.6%)	11 (42.3%)	13 (39.4%)
TOTAL	7 (100%)	26 (100%)	33 (100%)

In this study, Family History of DM (in parents of the mothers of the study sample) was present in 39.4% of the mothers of the study population. Family History of DM was present in 28.6% of pregestational diabetic mothers and 42.3% of gestational diabetic mothers.

Sex wise distribution of the study sample

Sex	Number
Male	22 (66.7%)
Female	11 (33.3%)
Total	33 (100%)

33 infants formed the study sample. Out of 33 infants, 22 (66.7%) were male and 11 (33.3%) were female.

Maternal Glycemic Control in Pregestational and Gestational Diabetes Mellitus.

Glycemic Control	DM		Total
	Pregestational	Gestational	
OPTIMAL	1 (14.3%)	9 (34.6%)	10 (30.3%)
SUB OPTIMAL	6 (85.7%)	17 (65.4%)	23 (69.7%)
TOTAL	7 (100%)	26 (100%)	33 (100%)

Sub optimal glycemic control was seen in 6 (85.7%) mothers with Pre gestational diabetes and 17 (65.4%) with gestational diabetes in the present study.

Antenatal factors in mothers of the study population

Antenatal Factor	DM		Total (n = 33)	P Value
	Pregestational (n=7)	Gestational (n=26)		
Preeclampsia	3 (42.8%)	11 (42.3%	14 (42.4%)	0.979
Multiple Pregnancy	0	1 (3.8%)	1 (3%)	-
Polyhydramnios	1 (14.2%)	8 (30.7%)	9 (27.2%)	0.385
Oligohydramnios	0	1 (3.8)	1 (3%)	-
Infections (UTI & Chickenpox)	0	2 (7.7%)	2 (6%)	-

Preeclampsia was present in 11 (42.3%) gestational diabetic mothers and 3 (42.8%) pregestational diabetic mothers (P < 0.979). Polyhydramnios was present in 1 (14.2%) pregestational diabetic mother and 8 (30.7%) gestational diabetic mothers. (P < 0.385). The other complications seen in gestational diabetic mothers included multiple pregnancy in 1 (3.8%), oligohydramnios in 1 (3.8%) and infections in 2 (7.7%) Mothers.

Distribution of study sample based on gestational age

Gestational Age	DM		Total
	Pregestational	Gestational	
< 37 Weeks (Pre term)	3 (42.9%)	12 (44.4%)	15 (44.1%)
> 37 Weeks (term)	4 (57.1%)	15 (55.6%)	19 (55.9%)
Total	7 (100%)	27 (100%)	34 (100%)

cc = 0.013 p < 0.940

Only 44% of the Gestational Diabetic Mothers delivered preterm babies as compared to term deliveries seen in 56% of gestational diabetic mothers.

Distribution of the study population on the basis of birth weight

Birth Weight	Number
< 2.5 Kgs	7 (20.6%)
2.5 – 3 Kgs	10 (29.4%)
3 – 4 Kgs	15 (44.1|%)
> 4 Kgs	2 (5.9%)
Total	34 (100%)

Low Birth Weight (< 2.5 Kgs) was observed in 20.6% of babies and Macrosomia (> 4 Kgs) was seen in 6% of the babies.

Distribution of study sample based on the birth weight for gestational age

Birth WT. for GA	DM		Total
	Pregestational	Gestational	
LGA	2 (28.6%)	5 (18.5%)	7 (20.6%)
AGA	5 (71.4%)	20 (74.1%)	25 (73.5%)
SGA	0	2 (7.4%)	2 (5.9%)
TOTAL	7 (100%)	27 (100%)	34 (100%)

CC = 0.151 p < 0.671.

2 (28.6%) LGA infants were born to mothers with pregestational diabetes and 5 (18.5%) were born to mothers with gestational diabetes. 2 (7.4%) SGA infants were born to gestational diabetes mothers.

Comparison of complications in babies born to mothers with pregestational and gestational diabetes mellitus

S. No.	Complication	Pregestational DM	Gestational DM	P Value
1	Macrosomia (n=34)	2/7 (28.6%)	5/27 (18.5%)	0.558
2	Birth Asphyxia (n = 34)	0	5/27 (18.5%)	-
3	Congenital anomalies (n = 34)	2/7 (28.6%)	9/27 (33.3%)	0.810
4	Birth Injuries (n = 34)	0	0	-
5	Respiratory Distress (n = 33)	1/7 (14.3%)	10/26 (38.5%)	0.228
6	Respiratory Distress Syndrome (n = 33)	0	2/26 (7.7%)	-
7	Hypoglycemia (n = 33)	6/7 (85.7%)	22/26 (84.6%)	0.943
8	Hypocalcemia (n = 33)	0	1/26 (3.8%)	-
9	Hyperbilirubinemia (n = 33)	0	7/26 (26.9%)	-
10	Polycythemia (n = 33)	0	2/26 (7.7%)	-

Neonatal Morbidities were studied in IDMs of which 7 were born to Pregestational Diabetics and 27 to Gestational Diabetics.

Hypoglycemia was the commonest complication observed in IDMs of both Pregestational (85.7%) and gestational Diabetes (84.6%) (P <0.943). Birth Asphyxia was seen in 5 IDMs born to gestational diabetic mothers. Congenital Anomalies were see in 2 (28.6%) infants born to pregestational diabetic mothers and 9 (33.3%) infants born to gestational diabetic mothers (P< 0.810).

Congenital anomalies in infants of pregestational and gestational diabetes mothers

Congenital Anomaly	DM		Total
	Pregestational (n=7)	Gestational (n=27)	
CVS	2 (28.6%)	8 (29.6%)	10 (29.4%)
None	5 (71.4%)	18 (66.7%)	23 (67.6%)
TOTAL	7 (100%)	26 (100%)	33 (100%)

CC = 0.214 p < 0.208

There was no significant difference in congenital anomalies observed in IDMs born to pregestational and gestational diabetic mothers.

Respiratory problems in infants of diabetic mothers

Respiratory Problem	DM		Total (n=33)
	Pregestational (n=7)	Gestational (n=26)	
HMD	0	2 (7.7%)	2 (6.1%)
MAS	0	2 (7.7%)	2 (6.1%)
Pneumonia	0	1 (3.8%)	1 (3.0%)
TTN	0	3 (11.5%)	3 (9.1%)

Respiratory problems were seen in infants born to gestational diabetic mothers. HMD was seen in 2 (7.7%), MAS in 2 (7.7%), pneumonia in 1 (3.8%) and TTN in 3 (11.5%).

Cardiac abnormalities detected by echocardiography in infants of diabetic mothers

ECHO Abnormality	Number
ASD	9 (27.3%)
ASD + VSD + PDA	1 (3.0%)
TOTAL	10 (30.3%)

Chi square = 6.40 P < 0.01

ASD was the most common cardiac anomaly observed in IDMs (27.3%) and only 1 (3.0%) IDM had combination of ASD, VSD and PDA (P < 0.01).

4. Discussion

Diabetes Mellitus is the most common medical complication of pregnancy. The burgeoning problem of childhood obesity across the world has led to an increasing incidence of Type –

II DM early in life. The first manifestation of this could be variable degree of glucose intolerance first detected during pregnancy. More than half women with GDM ultimately develop overt diabetes in the ensuing 20 years, and there is mounting evidence for long-range complications that include obesity and diabetes in their offspring.

The IDMs are at an increased risk of complications compared to infants of non diabetic mothers. The causes of the fetal and neonatal sequelae of maternal diabetes are likely multifactorial; however, many of the perinatal complications can be traced to the effect of maternal glycemic control on the fetus. Many of the perinatal complications in IDMs can be prevented by appropriate periconceptional and prenatal care.

Family History of Diabetes Mellitus was present in 39.4% of the mothers in the present study. In a study done by Ranade et al in 1989 at B.J. Wadia hospital in Mumbai, family history of diabetes was present in 20%[12]. The higher percentage in our study could be due to the increasing incidence of type – II DM in our country.

In the present study, 22 infants were male and 11 infants were female which showed a male preponderance.

In the present study, 30.3% of the mothers had optimal glycemic control during pregnancy and 69.7% had suboptimal control. The number of mothers with suboptimal control was more in the present study. Among pregestational diabetic mothers, 85.7% had suboptimal control and 65.4% among gestational diabetic mothers had suboptimal control.

In the present study, the incidence of prematurity was 44.1%. This varies in different studies from as low as 11% seen in a study done by Gabbe SG et al[13] in 1978 to 46% seen in a study done by Watson et al[14]in 2003.

The incidence of LGA in IDMs varies between 15% in some studies to 42% in some. In the present study the incidence of LGA IDMs was 20.6% which correlates with the study done by Deorari et al[15] in 1991.

In the present study, hypoglycemia was the commonest problem observed in IDMs seen in 84.4% of IDMs. The incidence of hypoglycemia in IDMs varies from 15-50%. The high incidence of hypoglycemia in the present study may be because cut off level considered for diagnosis of hypoglycemia was 40 mg/dl irrespective of gestational age. In some studies, a lower cut off level has been used to define hypoglycemia in preterm babies and also the cut off level used to define hypoglycemia in general is also less.

The rate of congenital anomalies was also high in the present study (29.4%). The reasons could be because all IDMs were subejcted to 2D – Echocardiography irrespective of symptoms and so asymptomatic congenital Heart Disease, mainly ASD was detected in 10 out of 33 IDMs subjected to ECHO. One infant who had ASD also had VSD and PDA.

The other complications seen in IDMs are comparable to other studies with some differences.

The incidence of macrosomia in IDMs of pregestational and gestational diabetes in the present study is comparable to the studies done by Ranade et al[16]and Deorari et al[17] in 1995. In both the studies incidence of macrosomia was higher in pregestational diabetics compared to gestational diabetics.

Respiratory distress was seen more commonly in infants of gestational diabetic mothers compared to pregestational diabetic mothers in the present study. This is comparable to the study done by Sudarshan et al [18] in 1987.

5. Conclusion

The neonatal complications commonly seen in infants of diabetic mothers are macrosomia, birth asphyxia, congenital anomalies, respiratory distress, RDS, hypoglycemia, hypocalcemia, hyperbilirubinemia and polycythemia. This has been reaffirmed in the present study.

There are no significant differences in neonatal morbidity profiles of IDMs born to pregestational and gestational diabetic mothers.

Management goals in pregnancies complicated by Diabetes Mellitus should be to achieve optimal glycemic control, as neonatal complications are more common in women with suboptimal glycemic control.

With appropriate care and management of diabetes during pregnancy, the perinatal outcome of IDMs can be improved.

6. Limitations of the Study

1) Heterogeneity of Diabetes: Diabetes can be type 1, type 2, or gestational diabetes, each with different impacts on pregnancy and infant outcomes, making it challenging to generalize findings.
2) Larger groups will be required in further studies.

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