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Macrosomia index in neonates of diabetic mothers as a simple predictor of maternal glycemic control

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Abstract
Background: About 2–5% of the pregnancies are complicated by diabetes and is recognized to be related with poor maternal and fetal outcomes. An abnormal Macrosomia index (MI) or Macrosomia index (HC in cm/CC in cm) of ≤1 can be considered as a marker for macrosomia in infants of diabetic mothers. The main objective of this study to correlate the maternal glycemic control with neonatal macrosomia index. This is a Cross sectional observational study done among the neonates of mothers with diabetes attending a Medical College Hospital. Birth weight, head circumference and chest circumference, MI, were measured. Glycated haemoglobin (HbA1C) were measured in mother at third trimester or at early puerperium. The results showed that there is a negative correlation of MI with HbA1C. So MI can be used as a predictor of maternal glycemic status and we also recommend strict glycemic control with regular monitoring of the HbA1C levels in antenatal mother and meticulous monitoring for the complications in neonates with abnormal MI (≤1).

Keywords: Macrosomia index (MI), Diabetic mothers, Infant of diabetic mothers, Glycated haemoglobin (HbA1C) levels.

Introduction
About 2–5% of the pregnancies are complicated by diabetes and is recognized to be related with poor maternal and fetal outcomes [1-4]. There are numerous adverse fetal outcomes following GDM contributing to the increase in neonatal mortality and morbidity such as, Macrosomia, respiratory distress syndrome, shoulder dystocia, erb's Palsy, birth injuries, neonatal hypoglycemia, hypocalcaemia, hypomagnesemia, neonatal Jaundice, Congenital anomalies and Stillbirths [5-7].
About 15-45% of babies born to diabetic mothers had macrosomia, and the incidence is 3-fold higher compared to normal mothers [8]. Data from the Diabetes in early Pregnancy Study indicate that fetal birth weight relates best with second- and third-trimester postprandial blood sugar levels [9], The incidence of macrosomia goes up from 20% to 35% when the postprandial blood glucose goes to 160mg%. Babies in diabetic pregnancies develop a unique pattern of overgrowth, involving the central deposition of subcutaneous fat in the abdominal and interscapular areas. As the fetal head size is not increased, but shoulder and abdominal girth can be markedly augmented, the risk of Erb's palsy, shoulder dystocia and brachial plexus trauma is more common. However, skeletal growth is largely unaffected [10].
Increase in chest circumference in utero as a result of maternal hyperglycemia effects in a lower head to chest circumference ratio (HC: CC called as MI)and may be a better indicator of macrosomia due to maternal diabetes as equated with birth weight [11]. An abnormal macrosomia index or MI (HC in cm/CC in cm) of ≤1 can be considered as a marker for macrosomia in infants of diabetic mothers, irrespective of maternal GDM status and birth weight [16]. This study aims to measure the MI of the baby and to correlate the maternal glycemic control with neonatal MI.

Methods
This is a Cross sectional observational study carried out in a tertiary care hospital from October 2019 to September 2020. 75 Neonates born to a mother with diabetes were included as a study group. Neonates born to mother with gestational hypertension, hypothyroidism or any other chronic illness and babies born by assisted vaginal delivery, asphyxiated babies were excluded from the study. After getting informed consent from the parents anthropometry of the neonates, which includes birth weight, head circumference, chest

circumference and MI were measured.

Glycated haemoglobin (HbA1C) levels are measured at third trimester or at early puerperium. MI >1 and HbA1C <5.4 is taken as normal. MI ≤1 is taken as abnormal. Values were obtained and statistically analysed.

Results

In the study, Majority of the diabetic mothers were having gestational diabetes. 0f 75 mothers studied, 64 had gestational diabetes, 9 had type 2 diabetes, 2 had type 1 diabetes as shown in table 1. MI was abnormal (≤1) in 33 (44.0%) and normal (>1) in 42 (56.0%) as shown in Table1 & Fig1. Among the diabetic mothers, Normal HbA1C (<5.4) levels in 13 (17.3%) mothers, 56 (74.7%) were having good control (5.5-7.9) and Poor control (>8) in 6 (8.0%) mothers as shown in fig 2. The mean HbA1C level is 6.3219 with SD of .98410. Table. 2 & 3, also shows that percentage of babies born with abnormal MI increases with increase in HbA1C levels in mother inspite of insignificant p-value.

Macrosomia index is significantly correlated with Head Circumference, Chest Circumference, HbA1C levels. As Head Circumference and Chest Circumference is used in calculating MI, it explains the correlation. There is a negative correlation of MI with HbA1C as depicted in Table 3. Hence MI can be used as a simple predictor of maternal glycemic control and its complication in neonates.

Table 1: Macrosomia Index correlation with various parameters

	Category	Macrosomia index			
A	Total Neonates	Normal (>1)		Abnormal (≤1)	
		Number	%	Number	%
		42	56%	33	44%
B	Type of Diabetes				
	Type1diabetes	1	50%	1	50%
	Type 2 diabetes	5	55%	4	44%
	Gestational diabetes	36	56.3%	28	43.8%

Table 2: Macrosomia Index correlation with HbA1C levels

S. No	Category	Macrosomia index				P-value
		Normal (>1)		Abnormal (≤1)		
		Count	%	Count	%	
	HbA1C Levels					
1.	Normal (<5.4)	9	69.2%	4	30.8%	0.336
	Good control (5.4 -7.9)	31	55.4%	25	44.6%	
	Poor control (>8)	2	33.3%	4	66.7%	

Table 3: Correlation between MI and anthropometric variables

		Macrosomia index
HbA1C	Pearson Correlation	-.418**
	p-value	<0.001

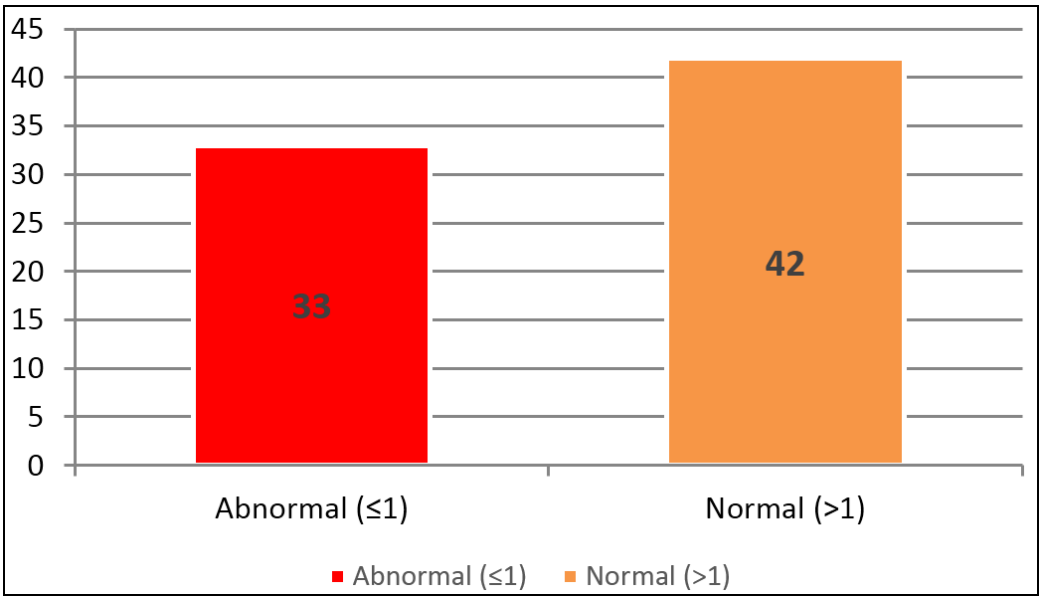

Fig 1: Distribution of MI

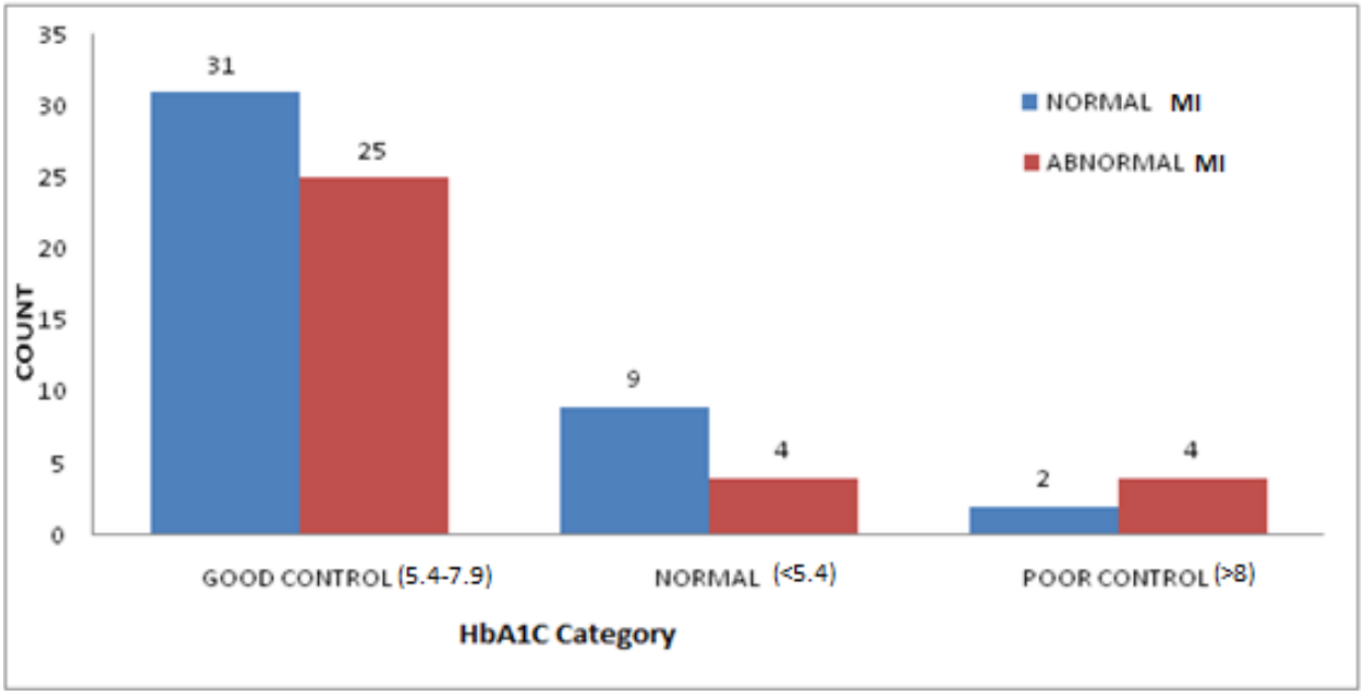

Fig 2: Macrosomia index distribution at different HbA1C levels

Discussion

Macrosomia index is the newer anthropometric measure under evaluation. Head and chest circumference are the most reliable measures for inter and intra-examiner variability, mid-arm circumference, and length are least reliable. Neonates with Macrosomia have 5-fold higher rates of severe hypoglycemia [13]. There are many studies conducted to find out the better anthropometric predictor in a baby born to mother with diabetes.

Ponderal index, weight of the baby, head circumference and chest circumference are widely used. In our study, there is statistically significant negative correlation of MI with HbA1C, Increase in HbA1C levels which means a poor diabetic control adversely affects MI and weight of the baby. This is similar to the findings from Y Song *et al*., in their study observed that higher Quetelet index and Kaup Index (KI), along with lower head circumference to chest circumference ratio (HC/CC) may be a predictor of macrosomia due to maternal diabetes when compared with birth weight alone. They found the HC:CC ratio is 1.007 (±0.038) in healthy babies versus 0.993 (±0.043) in babies of diabetic mothers [11].

Priya Jose *et al*., studied the Macrosomia Index (head to chest circumference ratio) as a better detector of macrosomia in infants of diabetic mothers as compared to birth weight >4000g. Study in Pondicherry among 715 mothers with Diabetes. They concluded that, in addition to birth weight ≥4000g, Macrosomia index ≤1 should also be used to identify macrosomia among the infants of diabetic mothers [15]. In our study, the macrosomia index was abnormal (≤1) in 33 (44.0%) and Normal (>1) in 42 (56.0%) babies of the study population respectively [16].

Our study shows high incidence of macrosomia index when compared to incidence of macrosomia by Wortsman J *et al*., where they observed a 12.4% incidence of neonatal macrosomia among infants born to women with normal glucose tolerance and to the 14.5% incidence among infants born to women with gestational diabetes [15].

Limitation of the study design was a cross sectional one and hence the role of Confounding factors in macrosomia index cannot be ruled out. The sample size was found smaller to study the associations like complications and adverse perinatal outcomes. The study was conducted in a tertiary care setting affiliated with a teaching medical college. Hence the standards of care will be high resulting in the better management of the complications. Hence the rate of the complications will be more in other settings.

We recommend that Macrosomia index must be measured in all term babies at birth in addition to birth weight and if ≤1, complications especially neonatal hypoglycemia, should be monitored for at least 24 hours.

Conclusion

Since Macrosomia Index is associated with the HbA1c, Strict glycemic control and regular monitoring of the HbA1c levels in antenatal mother is recommended. In addition to birth weight, MI must be measured in all babies of diabetic mothers, and if ≤1 complications especially neonatal hypoglycemia, should be monitored.

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