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ORIGINAL ARTICLE

Correlation of Cord Blood Lipid Heterogeneity in Neonates with Their Anthropometry at Birth

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Abstract Objective: Fetus with intrauterine stress may exhibit programmed changes that can alter its metabolism and bear severe risk for diseases in adult life. The current study was designed to assess the correlation between cord blood lipid profile with the anthropometric data in neonates. Materials and methods: 146 newborn babies born at Dr. T M A Pai Hospital, Udupi were screened and their birth weight, length, head circumference and abdominal circumference were noted at birth. Umbilical cord blood samples were analyzed for total cholesterol, triglycerides (TG), high density lipoprotein (HDL) and low density lipoprotein (LDL). Infants were also grouped further based on gestational age (GA) and sex-adjusted birth weight percentiles into three groups i.e. Small for gestational age (SGA), Appropriate for gestational age (AGA) and Large for gestational age (LGA) for comparison of their lipid profiles. Inclusion criteria were normal fetal heart rate at birth and an APGAR score >7. Statistical significance of relation between lipid profile and anthropometry was done using ANOVA and Pearson correlation coefficient. Results: Triglycerides were significantly higher in babies with higher ponderal index (PI) than those with lower PI ($P = 0.011$). The TG level of SGA babies were significantly higher as compared to AGA group ($P = 0.001$). The LDL levels in neonates with higher abdominal circumference were significantly lower than those with lower AC ($P = 0.019$). Mean HDL levels were higher in neonates with larger AC, but not statistically significant. Maternal BMI had no influence on neonates' lipid profile. Conclusion: Abnormal intrauterine milieu created by maternal changes during gestation may bear a profound impact on lipid metabolism in neonates, which may account for their differences in lipid profile and anthropometry at birth.

Keywords Anthropometry · Cord blood · Lipid profile

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Introduction

Human fetuses are known to permanently change their physiology and metabolism to adapt to limited supply of nutrients in utero. These programmed changes can later be the cause for the origin of diseases like coronary artery disease, diabetes mellitus and hypertension. The cord blood lipid profile may be associated with lifelong changes in the metabolic functions of the individual [1]. It is well documented that atherosclerosis starts in childhood and there is evidence that this association with adult levels may originate at birth, so assessment of serum lipid levels in neonates might be of importance. The triglycerides have an active role in surfactant synthesis and are needed for lung maturity in term neonates, but there are very few reports regarding their serum distribution pattern [2]. The relationship between low birth weight and adult cardiovascular disease has been attributed to intrauterine effects on fetal tissue development [3]. The correlation of cord blood lipid profile in neonates with their anthropometric data and their predictive role as markers for adulthood diseases is still not completely explored. Hence the present study was designed to study any such novel patterns of cord blood lipid heterogeneity among neonates and their correlation with anthropometry at birth in this part of Southern India.

Materials and Methods

Subjects

The current prospective study was carried out for a period of 1 year at our hospital. A total of 146 babies, 80 males and 66 females (1.21:1), were screened with the informed consent of their parents and under the approval acquired from the Hospital and University Ethical committee. Neonates with normal fetal heart rate patterns during labour with a 1 min APGAR score >7 were included into this study. Neonates born with perinatal asphyxia and congenital anomalies were excluded from the study. Age, parity, height and weight at 1st visit and at delivery was recorded as a part of maternal data recording. Gestational age was calculated from last menstrual period and by Ballard score. Out of the 146 neonates, 128 were appropriate for gestational age (AGA), 8 were small for gestational age (SGA) and 10 were large for gestational age (LGA).

Preparation of Anthropometric Data of Neonates

Anthropometric data included the neonates' birth weight (BW), head circumference (HC), length and abdominal circumference (AC). Weight was measured using electronic weighing scale with accuracy up to 5 g. Length was recorded using an infantometer. Head circumference was measured using non-stretchable tape passing above supra-orbital ridge and over occipital protuberance at the time of discharge. Abdominal circumference was measured with non-stretchable tape passing through the umbilicus soon after birth. Ponderal Index (PI) was calculated by the formula Weight (g)/Length (cm^3) X100.

Biochemical Estimations

The cord blood lipid profile included analysis for total cholesterol (TC), high density lipoprotein (HDL), low density lipoprotein (LDL) and triglycerides (TG). The mixed umbilical cord blood sample was obtained by clamping umbilical cord post-delivery and prior to the delivery of placenta. The parameters were estimated by enzymatic colorimetric method using Roshe, Hitachi autoanalyzer. LDL levels were calculated using the Friedwald Fredrickson formula i.e. LDL = [TC-HDL-(TG/5)].

Statistical Analysis

Data was analysed using SPSS 13.0, Apache software foundation 2000. The relationship between anthropometric data and cord blood lipid profile was analysed using the Pearson correlation coefficient and ANOVA.

Results

The cord blood lipid reference standards used for the current study for comparison were as per 'Prevention of coronary and Heart disease-1983'. The reference range in percentiles as shown in Table 1 is as per this reference. The present study revealed that the HDL mean value of 22.98 mg/dl, LDL mean value of 22.6 mg/dl and the TC mean value of 54.1 mg/dl were falling between the 5 and 50th percentile of lipid reference level standards as shown in Table 1. Our results are in conformance with earlier reports [4, 5]. However the TG mean value of 43 mg/dl, was between 50 to 95th percentile of cord blood lipid reference standards and hence was higher than observed by earlier researchers [5, 6]. (Table 1).

Table 2 shows the anthropometric data of the newborns screened. All parameters except abdominal circumference were in agreement with earlier reports [4, 5]. Birth weight showed a statistically significant positive correlation with the abdominal circumference ($r = 0.781$). Ponderal index showed a statistically significant positive correlation with abdominal circumference ($r = 0.15$).

The comparison of cord blood lipid profile in neonates with PI<10th percentile (Group A) and PI>10th percentile (Group B) are as shown in Table 3. The mean TG levels in Group A was significantly higher than those in Group B ($P = 0.011$) which implies that neonates who are thin at birth with low PI have had higher TG levels.

Neonates were divided into three groups based on their abdominal circumference for comparison of their LDL and HDL levels. Group 1 had AC between 26.1 and 29 cm, Group II with AC between 29.1 and 32 cm and Group III with AC >32 cm. Group III neonates had significantly higher LDL levels than group II ($P = 0.019$). However there was no statistically significant difference between HDL and LDL levels among these groups (Table 4).

Relationship between lipid profile and anthropometric data are as shown in Table 5. There was a statistically significant correlation between the TG levels and AC of neonates ($P = 0.048$, $r = -0.169$). However there was no significant correlation of TG levels with the BW and HC of

Table 1 Cord blood lipid profile in neonates ($n = 146$)

Serum lipids	Reference range (centiles) mg/dl	Minimum	Maximum	Mean	Standard deviation
Triglycerides mg/dl	5th = 14 50th = 34 95th = 84	19	109	43.06	±15.74
Total cholesterol mg/dl	5th = 46 50th = 68 95th = 103	27	150	54.21	±17.37
Low density lipoprotein mg/dl	5th = 17 50th = 29 95th = 50	6.4	99.4	22.65	±12.08
High density lipoprotein mg/dl	5th = 13 50th = 35 95th = 60	8.0	48	22.98	±7.86

Table 2 Anthropometric data of neonates and placental weight

$n = 146$	Minimum	Maximum	Mean	Standard deviation
Birth weight (BW) in g	1,900	4,560	2959.9	±450.03
Head Circumference (HC) in cm	29.1	37	33.49	±1.36
Abdominal circumference (AC) in cm	26	34.5	29.53	±1.74
Length in cm	45	53	48.65	±1.58
Placental weight in g	380	620	502.86	±48.79

Table 3 Relationship of cord blood lipid profile with their Ponderal index (PI) in group A (PI <10th percentile) and group B neonates (PI >10th percentile)

Lipid	Ponderal index (PI) percentile	*n*	Reference range (centiles) mg/dl	Mean	Standard deviation	*P* value
Triglycerides	Group A	39	5th = 14	49.5	±19.33	0.011*
	Group B	107	50th = 34	41.26	±14.16	
			95th = 84			
Total cholesterol	Group A	39	5th = 46	51.63	±16.56	0.36
	Group B	107	50th = 68	54.93	±17.60	(NS)
			95th = 103			
Low density lipoprotein	Group A	39	5th = 17	20.55	±11.10	0.28
	Group B	107	50th = 29	23.24	±12.32	(NS)
			95th = 50			
High density lipoprotein	Group A	39	5th = 13	21.5	±8.79	0.24
	Group B	107	50th = 35	23.39	±7.57	(NS)
			95th = 60			

*$P < 0.05$ statistically significant, *NS* not significant

neonates. There was a lack of correlation between TC levels and anthropometric data of neonates. The LDL levels showed a statistically significant positive correlation with BW ($P = 0.042$, $r = 0.174$) and a significant negative correlation with AC ($P = 0.031$, $r = -0.184$). HDL levels showed no significant correlation with the anthropometric data.

Among the comparisons of lipid profile parameters among groups of neonates classified as per gestational age (Table 6), only the TG levels of SGA babies were significantly higher than those of LGA babies. The variations of other parameters among groups were however statistically not significant.

The mothers differed in their gestational age at first visit and hence the maternal BMI was calculated after delivery though we had the height and weight recorded at 1st visit. Hence all mothers were weighed after delivery for purpose of calculation of BMI. Maternal body mass index (BMI) was also correlated with the cord blood lipid profile. It was observed that the lipid parameters were almost comparable with babies born to mothers with high and low BMI (Table 7).

Table 4 Comparison of LDL and HDL levels with their abdominal circumference (AC) in Group I (neonates with AC between 26.1 and 29 cm), Group II (neonates with AC between 29.1 and 32 cm) and Group III (neonates with AC >32 cm) neonates

AC at birth (cm)	$n = 146$	Reference range (centiles) mg/dl	LDL (Mean)	Reference range (centiles) mg/dl	HDL (Mean)
Group I	59	LDL	25.92	HDL	23.32
Group II	72	5th = 17	19.88	5th = 13	22.49
		50th = 29		50th = 35	
Group III	15	95th = 50	23.33	95th = 60	24.167
P value			0.019*		0.730 (NS)

*$P < 0.05$ statistically significant, *NS* not significant

Table 5 Relationship between lipid profile of neonates and their anthropometric data

$n = 146$	Triglycerides	Total cholesterol	Low density lipoprotein	High density lipoprotein
Birth weight				
r (Correlation coefficient)	−0.148	0.159	0.174	0.128
P Value	0.085	0.064	0.042*	0.135
Abdominal circumference				
R (Correlation coefficient)	−0.169	−0.153	−0.184	0.005
P Value	0.048*	0.074	0.031*	0.958
Head circumference				
R (Correlation coefficient)	0.018	0.113	0.099	0.059
P Value	0.837	0.187	0.249 (NS)	0.492

*$P < 0.05$ statistically significant, *NS* not significant

Table 6 Comparison of lipid profile of neonates grouped based on gestational age

Lipid	Gestational assessment	$n = 146$	Reference range (centiles) mg/dl	Mean (mg/dl)	Standard deviation	*P* value
Triglycerides	SGA	8	5th = 14	68.25	±33.5	
	AGA	128	50th = 34	42.36	±14.38	0.001***
	LGA	10	95th = 84	41.00	±19.10	0.67 (NS)
Total cholesterol	SGA	8	5th = 46	50.25	±11.17	
	AGA	128	50th = 68	53.94	±17.59	0.678 (NS)
	LGA	10	95th = 103	64.20	±14.41	0.20 (NS)
Low density lipoprotein	SGA	8	5th = 17	16.10	±6.10	
	AGA	128	50th = 29	22.67	±12.29	0.293 (NS)
	LGA	10	95th = 50	27.4	±8.18	0.76 (NS)
High density lipoprotein	SGA	8	5th = 13	20.50	±13.08	
	AGA	128	50th = 35	22.84	±7.48	0.549 (NS)
	LGA	10	95th = 60	28.6	±12.22	0.10 (NS)

SGA Small for gestational age, *AGA* Appropriate for gestational age, *LGA* Large for gestational age. ***SGA versus AGA; $P < 0.001$ statistically very significant, *NS* not significant

Discussion

The cord blood lipid profile screening of neonates in this part of southern India was almost comparable with babies screened in other parts of the world [4–7]. Comparison of anthropometric data of the present study with earlier reports [4, 5] revealed that the BW, Length, HC were in agreement, however the AC varied from the reports [4, 5]. Recent reports indicate that neonates with negative correlation of BW and AC have higher glycated serum proteins [8]. The disproportional intrauterine growth observed in these neonates are said to be in line with the concept of so-called brain sparing, a mechanism maintaining the intrauterine growth of the brain at the expense of trunk growth. The report has hence concluded that these changes can be linked to cardiovascular diseases like hypertension in later life and predicted that this might be a phenotype of disproportional intrauterine growth retardation and early life insulin resistance [8]. However our current study has varied from the above mentioned reports and the neonates

Table 7 Relationship between maternal body mass index (BMI) with the cord blood lipid profile of neonates

Lipid	BMI	*n*	Percentile	Mean (mg/dl)	Standard deviation
Triglycerides	15–20	40	5th = 14	42.07	±11.71
	20.1–25	15	50th = 34	44.47	±18.03
	25.1–35	29	95th = 84	41.13	±14.90
Total cholesterol	15–20	40	5th = 46	54.92	±14.79
	20.1–25	15	50th = 68	54.33	±20.90
	25.1–35	29	95th = 103	52.93	±10.64
Low density lipoprotein	15–20	40	5th = 17	23.45	±10.51
	20.1–25	15	50th = 29	22.70	±14.30
	25.1–35	29	95th = 50	21.24	±7.53
High density lipoprotein	15–20	40	5th = 13	23.05	±6.72
	20.1–25	15	50th = 35	22.73	±8.51
	25.1–35	29	95th = 60	23.45	±7.96

screened in the current study have showed a positive correlation between BW and AC. Our study revealed that the TG levels were higher in neonates born with low PI at birth. These results are comparable with earlier reports which have also reported that the serum insulin levels were lower in these neonates with low PI [9]. When insulin is reduced in fetal plasma, insulin-dependent activation of lipoprotein lipase is also reduced, hampering efficient lipolysis of triglyceride-rich lipoproteins. Thus insulin and its effect on lipid metabolism could play a major role in intrauterine growth. The current study has revealed that the LDL levels were raised at birth for neonates having smaller AC. These results are in agreement with reports made earlier [10]. The possible explanation of association between body disproportion at birth and LDL profile may be due to abnormal intrauterine growth. This retarded trunk and visceral growth could have resulted from cranial redistribution of oxygenated blood away from trunk to sustain brain metabolism. The HDL, LDL and TC levels were higher in LGA babies in the order LGA > AGA > SGA, however these changes were found to be statistically insignificant. Liver is thought to be the main site for LDL cholesterol synthesis in late gestation, and the human fetus requires large quantities at this time to sustain metabolic activities which include higher rate of synthesis of steroid hormones by adrenals. Persistent reduction of LDL receptor activity associated with failure of growth of fetal liver is a possible explanation for the above finding. In the present study the mean TG level of SGA group was significantly higher as compared to AGA group and is in agreement with earlier reports [6, 9]. These changes may be attributed to the maturity of pregnancy and also the nutritional status of the fetus. Earlier study [11] has found a close relationship between pregravid BMI and TG levels of neonates. But in the present study there was a lack of correlation between maternal post-delivery BMI and the neonates' lipid profile. Various factors during pregnancy are said to have strong influence on foetal lipid metabolism [12, 13] and hence the scope of extensive research in the current field remains plausible.

Conclusion

The current study has made us conclude that there is a close relationship between some of the lipid profile parameters and anthropometry at birth of neonates. The babies born with a LBW or with a PI less than 10th percentile or were SGA have exhibited a significantly higher TG levels. But the contrast has been observed with cholesterol levels, where the LGA babies have had higher LDL, HDL and TC levels as compared to AGA babies. More significant finding in this study is that the maternal BMI recorded post-delivery has had no significant influence on the neonatal lipid profile. There are many assumptions for the present findings in this study. This makes way for further research to compare the lipid profiles of babies born to mothers with uncomplicated pregnancies with those having complicated pregnancies. The present study thus provides enough scope for further insights into future prediction of coronary heart disease, stroke etc.

Strengths of This Study

Comparison of various anthropometric parameters of the neonate with different lipid parameters. It has taken into consideration the gestational age of the neonate and compared the lipid parameters among SGA/AGA/LGA neonates.

Limitations of This Study

Bigger sample size would have been better.

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