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Original Research Article

COMPARATIVE STUDY ON CORD BLOOD LIPID PROFILE AT BIRTH IN RELATION TO BIRTH WEIGHT AND GESTATIONAL MATURITY

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ABSTRACT

Background: Coronary artery disease (CAD) remains a leading cause of morbidity and mortality, and evidence increasingly points to its origins in fetal and neonatal life. Cord blood lipid profile at birth may serve as an early marker of future cardiovascular risk, with variations expected across gestational maturity and birth-weight categories. The objective is to estimate and compare cord blood lipid profile (total cholesterol [TC], triglycerides [TG], LDL-cholesterol, HDL-cholesterol) in term versus preterm neonates, and in small-for-gestational-age (SGA) versus appropriate-for-gestational-age (AGA) neonates within each gestational group.

Materials and Methods: This analytical, comparative study enrolled 70 neonates (35 term, 35 preterm) delivered at Father Muller Medical College Hospital, Mangaluru, over 18 months. Each gestational group was sub-classified as AGA or SGA using the Fenton growth chart. Umbilical cord blood was collected at delivery and analysed for TC, TG, HDL-C and LDL-C using standard enzymatic/oxidase-peroxidase methods. Gestational age was assessed by last menstrual period, ultrasound, and modified Ballard scoring. Data were analysed using mean ± SD, frequency, percentage, Student's t-test and Chi-square test.

Results: Preterm neonates had significantly higher TC (68.0 ± 14.16 vs 53.17 ± 8.52 mg/dL, p<0.001), LDL-C (33.4 ± 5.52 vs 30.7 ± 1.9 mg/dL, p<0.001) and HDL-C (23.1 ± 7.3 vs 19.05 ± 5.9 mg/dL, p=0.018) than term neonates, with no significant difference in triglycerides. SGA neonates had significantly higher TC (67.66 ± 19.32 vs 58.63 ± 10.93 mg/dL, p=0.044) and HDL-C (24.50 ± 9.43 vs 19.90 ± 5.51 mg/dL, p=0.047) than AGA neonates. Among term neonates, SGA babies had significantly higher TC and LDL-C than term AGA babies. Among preterm neonates, SGA babies had significantly higher TC, TG and HDL-C than preterm AGA babies. No significant differences were found between male and female neonates, or by maternal age (≤30 vs >30 years).

Conclusion: Gestational age and birth weight significantly influence neonatal cord blood lipid profile. Preterm and SGA neonates demonstrate a more atherogenic lipid pattern at birth, suggesting they may be at higher long-term risk for hypercholesterolemia and cardiovascular disease. Early identification and monitoring of lipid profile in these high-risk neonates, along with appropriate lifestyle guidance, may help in primordial prevention of coronary artery disease later in life.

Keywords: Cord blood, lipid profile, cholesterol, small for gestational age, low birth weight, atherosclerosis, preterm.

INTRODUCTION

Atherosclerotic cardiovascular disease continues to be an important cause of morbidity and mortality worldwide.[1] While the genetic and lifestyle risk factors for these diseases — hypercholesterolemia, hypertension, smoking, obesity and physical inactivity — are well established, the fetal origins hypothesis suggests that the roots of this epidemic can be traced back to fetal and neonatal life, progressing silently over subsequent decades.

In the 1980s, David Barker, an English physician and epidemiologist at the University of Southampton, proposed that the intrauterine environment shapes physiological processes in the fetus that may, under certain conditions, predispose to disease in later life.[2] In his analysis of birth records from Hertfordshire spanning 1911 onward, Barker demonstrated that individuals with lower birth weight had higher mortality from cardiovascular disease in adulthood over a 60-year follow-up period.[2]

Preterm infants activate lipid metabolism using endogenous reserves because they have not had adequate time to complete energy deposition in the later part of pregnancy.[3] In growth-restricted fetuses, limited nutrient supply likewise favours activation of lipid metabolism and gluconeogenesis, directing resources toward essential organs at the expense of non-essential ones such as the kidney and pancreas — changes that are associated with an increased long-term prevalence of cardiovascular disease, hypertension and type 2 diabetes mellitus.[4] Any disturbance during this sensitive intrauterine window can permanently alter organ structure and physiology.

An abnormal plasma lipid profile — hypertriglyceridemia, elevated LDL-cholesterol and total cholesterol with low HDL-cholesterol — is a recognised risk factor for cardiovascular disease, and lipid profile analysis is an important early marker for its recognition and prevention.[5] While dyslipidaemia and its cardiovascular consequences have been extensively studied in adults, comparatively few studies have examined the paediatric, and particularly the neonatal, population.

This study was undertaken to estimate cord blood lipid profile in term and preterm neonates, and to compare these values with respect to gestational maturity and birth weight (AGA versus SGA), with the aim of identifying early biochemical markers that may predispose neonates to a higher future risk of coronary heart disease.

Objectives:

Primary objectives:

1. To estimate cord blood lipid profile in term neonates;
2. To estimate cord blood lipid profile in preterm neonates;
3. To compare cord blood lipid profile between term and preterm neonates.

Secondary objectives:

1. To compare cord blood lipid profile between SGA and AGA term neonates;
2. To compare cord blood lipid profile between SGA and AGA preterm neonates.

MATERIALS AND METHODS

Study design and setting: This was an analytical, comparative study conducted in the Labour Room and Labour Operation Theatre of Father Muller Medical College Hospital, Mangaluru, over a period of 18 months (August 2022 – 2023), after approval from the Father Muller Institutional Ethics Committee.

Sample size: A total of 70 neonates were enrolled — 35 term and 35 preterm — calculated to achieve 80% power at 95% confidence interval, giving 35 neonates per group.

Inclusion criteria

Neonates with gestational age between 24 and 42 weeks, delivered by normal vaginal delivery or lower segment caesarean section (LSCS), whose parents provided written informed consent.

Exclusion criteria

Out-born babies and neonates with an APGAR score below 7 at 5 minutes.

Procedure: After written informed consent, maternal and neonatal details were recorded on a structured proforma: Umbilical cord blood (2 mL of free-flowing blood) was collected immediately after delivery by double clamping the cord and was allowed to clot at room temperature, then centrifuged at 3000 rpm for 10 minutes to separate serum. Serum total cholesterol was estimated by the oxidase-peroxidase method, triglycerides by the enzymatic method, and HDL-cholesterol and LDL-cholesterol by the direct polymeric method. Birth weight was recorded on an electronic infant weighing scale. Gestational age was determined from the first day of the last menstrual period, ultrasound dating, and clinical assessment by modified Ballard scoring. Neonates were classified as term (37–42 completed weeks) or preterm (<37 weeks). Within each group, neonates were further classified as AGA (birth weight 10th–90th centile) or SGA (birth weight <10th centile) using the Fenton growth chart for the corresponding gestational age.

Statistical analysis: Data were expressed as mean ± standard deviation, frequency and percentage. Comparisons between groups were performed using the independent-samples Student's t-test for continuous variables and the Chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 70 neonates were studied, comprising 35 term and 35 preterm neonates.

Baseline characteristics: Of the 70 neonates, 40 (57.1%) were male and 30 (42.9%) were female.

Forty-six mothers (65.7%) were ≤30 years of age at conception and 24 (34.3%) were >30 years. Thirty-six neonates (51.4%) were delivered vaginally and 34 (48.6%) by LSCS. Thirty-nine mothers (55.7%) were multigravida and 31 (44.3%) were primigravida. Overall, 52 neonates (74.3%) were AGA and 18 (25.7%) were SGA. Among the 35 term neonates, 23 (65.7%) were AGA and 12 (34.3%) were SGA. Among the 35 preterm neonates, 29 (82.8%) were AGA and 6 (17.2%) were SGA.

Table 1: Baseline demographic characteristics of the study population (N=70)

Variable	Category	Frequency	Percentage
Gender	Male	40	57.1%
	Female	30	42.9%
Maternal age	≤30 years	46	65.7%
	>30 years	24	34.3%
Mode of delivery	Vaginal delivery	36	51.4%
	LSCS	34	48.6%
Gravida	Primigravida	31	44.3%
	Multigravida	39	55.7%
Gestational age	Term	35	50.0%
	Preterm	35	50.0%
Birth weight category	AGA	52	74.3%
	SGA	18	25.7%
Term subgroup	Term-AGA	23	65.7%
	Term-SGA	12	34.3%
Preterm subgroup	Preterm-AGA	29	82.8%
	Preterm-SGA	6	17.2%

Overall cord blood lipid profile: The mean (± SD) values for the study population (N=70) were: total cholesterol 53.17 ± 8.52 mg/dL, triglycerides 28.3 ± 7.70 mg/dL, LDL-cholesterol 30.74 ± 1.93 mg/dL, and HDL-cholesterol 19.05 ± 8.52 mg/dL.

Comparison between term and preterm neonates: Preterm neonates had significantly higher total cholesterol, LDL-cholesterol and HDL-cholesterol than term neonates. Triglyceride levels were also higher in preterm neonates, but the difference was not statistically significant.

Table 2: Comparison of cord blood lipid profile in term and preterm neonates (N=70)

Parameter (mg/dL)	Term (mean ± SD)	Preterm (mean ± SD)	p-value
Total cholesterol	53.17 ± 8.52	68.0 ± 14.16	<0.001
Triglycerides	28.3 ± 7.7	30.6 ± 12.0	0.331
LDL-cholesterol	30.7 ± 1.9	33.4 ± 5.52	<0.001
HDL-cholesterol	19.05 ± 5.9	23.1 ± 7.3	0.018

Comparison between AGA and SGA neonates: SGA neonates had significantly higher total cholesterol and HDL-cholesterol than AGA neonates. No significant differences were noted for triglycerides or LDL-cholesterol.

Table 3: Comparison of cord blood lipid profile in AGA and SGA neonates (N=70)

Parameter (mg/dL)	AGA (mean ± SD)	SGA (mean ± SD)	p-value
Total cholesterol	58.63 ± 10.93	67.66 ± 19.32	0.044
Triglycerides	29.42 ± 10.53	29.72 ± 9.73	0.604
LDL-cholesterol	31.69 ± 4.63	33.16 ± 3.11	0.123
HDL-cholesterol	19.90 ± 5.51	24.50 ± 9.43	0.047

Comparison within term neonates: Term-AGA vs Term-SGA: Among term neonates, SGA babies had significantly higher total cholesterol and LDL-cholesterol than AGA babies. No significant difference was seen for triglycerides or HDL-cholesterol.

Table 4: Comparison of cord blood lipid profile in term-AGA and term-SGA neonates (N=35)

Parameter (mg/dL)	Term-AGA (mean ± SD)	Term-SGA (mean ± SD)	p-value
Total cholesterol	50.56 ± 1.37	58.16 ± 13.39	<0.001
Triglycerides	29.56 ± 6.8	25.91 ± 8.97	0.173
LDL-cholesterol	30.04 ± 0.2	32.08 ± 2.90	<0.001
HDL-cholesterol	17.60 ± 3.67	21.83 ± 8.38	0.118

Comparison within preterm neonates: Preterm-AGA vs Preterm-SGA: Among preterm neonates, SGA babies had significantly higher total cholesterol, triglycerides and HDL-cholesterol than AGA babies. No significant difference was seen for LDL-cholesterol.

Table 5: Comparison of cord blood lipid profile in preterm-AGA and preterm-SGA neonates (N=35)

Parameter (mg/dL)	Preterm-AGA (mean ± SD)	Preterm-SGA (mean ± SD)	p-value
Total cholesterol	65.03 ± 10.96	86.66 ± 14.98	0.008
Triglycerides	29.31 ± 12.86	37.33 ± 6.37	0.019
LDL-cholesterol	33.00 ± 5.92	35.33 ± 2.42	0.492
HDL-cholesterol	21.72 ± 6.08	29.83 ± 9.82	0.049

Influence of gender and maternal age: No statistically significant differences in cord blood lipid profile were observed between male and female neonates (total cholesterol p=0.766, triglycerides p=0.415, LDL-cholesterol p=0.804, HDL-cholesterol p=0.849), or between neonates born to mothers ≤30 years versus >30 years of age (total cholesterol p=0.737, triglycerides p=0.931, LDL-cholesterol p=0.474).

DISCUSSION

Abnormal serum lipid profiles are directly correlated with underlying cardiovascular disease and its associated mortality and morbidity. Because atherogenic changes are believed to originate in fetal life, cord blood lipid profile has drawn increasing research interest as an early, indirect window into a child's future cardiovascular risk. The present study was designed to estimate cord blood lipid profile at birth in term versus preterm neonates, and in SGA versus AGA neonates, so that high-risk babies could potentially be identified for closer long-term monitoring.

In our cohort, preterm neonates showed significantly higher total cholesterol, LDL-cholesterol and HDL-cholesterol than term neonates, consistent with the broader literature. Kenchappa et al. similarly reported significantly higher total cholesterol, LDL-cholesterol and triglycerides in preterm neonates, although in their series the higher HDL and VLDL values in the preterm group did not reach statistical significance. Mishra et al. likewise observed higher mean triglyceride levels in preterm compared with term newborns, and Kalra et al. found higher total cholesterol, HDL-cholesterol and LDL-cholesterol in preterm babies, with statistical significance confined to total cholesterol. Taken together, these findings support the concept that preterm neonates, having been delivered before completing normal intrauterine fat deposition, rely more heavily on activated endogenous lipid metabolism, resulting in an altered — and potentially more atherogenic — lipid profile at birth.

With respect to birth weight, SGA neonates in our study had significantly higher total cholesterol and HDL-cholesterol than AGA neonates. Katragadda et al. and Narayanaswamy et al. reported broadly comparable trends, including an inverse correlation between birth weight and total cholesterol/triglyceride levels, although the specific parameters reaching statistical significance varied between studies — for instance, some series found triglycerides, rather than total cholesterol, to differ significantly between SGA and AGA infants. This variability likely reflects differences in sample size, population characteristics and the criteria used to define SGA. Within our term subgroup, term-SGA neonates had significantly higher total cholesterol and LDL-cholesterol than term-AGA neonates; within our preterm subgroup, preterm-SGA neonates had significantly higher total cholesterol, triglycerides and HDL-cholesterol than preterm-AGA neonates — indicating that the combination of prematurity and growth restriction may compound the derangement in lipid metabolism.

No significant difference in lipid profile was observed between male and female neonates in our study, in keeping with earlier reports; although some studies have noted marginally higher lipid values in one sex over the other, these differences have generally not reached statistical significance. Similarly, maternal age (≤30 versus >30 years) did not significantly influence neonatal cord blood lipid values in our cohort. Other studies examining maternal factors have shown mixed results — some report higher LDL-cholesterol and total cholesterol in neonates born to older mothers or those with higher maternal BMI, while others found no significant influence of maternal age or BMI on cord blood lipid profile — suggesting that maternal metabolic factors may modulate fetal lipid metabolism in some but not all populations.

Collectively, these findings reinforce the fetal origins hypothesis proposed by Barker, wherein adverse intrauterine conditions — whether from prematurity or growth restriction — programme a lipid metabolic phenotype at birth that may predispose to future cardiovascular risk. The consistency of elevated total cholesterol across nearly every high-risk subgroup analysed in this study (preterm, SGA, term-SGA and preterm-SGA) is particularly notable and mirrors patterns described in the wider literature.

Limitations

This study was conducted at a single centre with a relatively small sample size, which may limit generalisability of the findings. Maternal factors such as nutritional status, dietary habits and socioeconomic status, and neonatal factors such as genetic variability and intrauterine growth restriction, were not comprehensively controlled for and could confound comparisons between groups. Additionally, the study lacked longitudinal follow-up, so the long-term clinical significance of the observed differences in cord blood lipid profile could not be assessed.

CONCLUSION

This study demonstrates a distinct cord blood lipid profile pattern according to gestational maturity and birth weight. Preterm neonates had significantly higher total cholesterol, LDL-cholesterol and HDL-cholesterol than term neonates, and SGA neonates had significantly higher total cholesterol and HDL-cholesterol than AGA neonates, with the combination of prematurity and SGA status associated with the most pronounced derangements. No significant differences were observed by gender or maternal age. These findings suggest that preterm and SGA neonates may be at higher risk of hypercholesterolemia and an atherogenic milieu from birth, underscoring the importance of early identification, monitoring, and appropriate lifestyle guidance in this population as a strategy for the primordial prevention of coronary artery disease in later life.

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