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Comparison of Cord Blood Lipid Profile in Term Small for Gestational Age (SGA) and Appropriate for Gestational Age (AGA) Babies

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Abstract

Background: Small for gestational age (SGA) infants are at increased risk of developing metabolic syndrome and cardiovascular diseases later in life. Emerging evidence suggests that altered lipid metabolism may begin in utero. Comparing cord blood lipid profiles of SGA and appropriate for gestational age (AGA) neonates may provide insights into early metabolic programming.
Objective: To compare the cord blood lipid profile, including total cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels, between term SGA and AGA newborns.
Methods: This hospital-based cross-sectional study included 100 term neonates (50 SGA and 50 AGA) delivered at a tertiary care center. Cord blood samples were collected immediately after birth. Lipid parameters were analyzed using enzymatic colorimetric methods. Statistical comparison was done using unpaired t-test or Mann–Whitney U test as appropriate.
Results: Mean total cholesterol and LDL levels were significantly higher in SGA neonates compared to AGA neonates ($p < 0.05$). HDL and triglyceride levels were lower in the SGA group, though not statistically significant. The atherogenic index (TC/HDL) was significantly elevated in SGA babies.
Conclusion: Term SGA neonates exhibit altered lipid profiles at birth, indicating early atherogenic risk. Cord blood lipid analysis may serve as a useful early biomarker for cardiovascular risk stratification in newborns.

KEY WORDS: Small for gestational age (SGA), Lipid profile, cardiovascular diseases,

INTRODUCTION

Small for gestational age (SGA) infants, defined as those with birth weights below the 10th percentile for their gestational age, are a significant public health concern, particularly in developing countries like India. These infants are at increased risk for perinatal morbidity and mortality, as well as long-term complications such as metabolic syndrome, type 2 diabetes mellitus, and cardiovascular diseases in adulthood (1,2). The concept of fetal programming suggests that adverse intrauterine environments can lead to permanent physiological and metabolic changes, predisposing individuals to chronic diseases later in life (3,4).

One of the earliest indicators of potential metabolic disturbances is the lipid profile at birth. Cord blood lipid levels reflect the intrauterine lipid environment and may provide insights into the future risk of atherosclerosis and cardiovascular diseases (5,6). Studies have shown that SGA infants often exhibit altered lipid profiles compared to appropriate for gestational age (AGA) infants (7,8). For instance, Arora et al. found that SGA neonates had significantly higher levels of total cholesterol, triglycerides, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) compared to AGA neonates, while high-density lipoprotein (HDL) levels were lower in SGA infants (9).

These findings are consistent with the hypothesis that intrauterine growth restriction leads to metabolic adaptations that may predispose individuals to dyslipidemia and cardiovascular diseases (10). The elevated levels of atherogenic lipids in SGA infants suggest an increased risk for the early development of atherosclerotic changes. Moreover, the altered lipid profile observed in SGA infants may persist into childhood and adulthood, further increasing the risk of metabolic and cardiovascular complications.

Understanding the differences in cord blood lipid profiles between SGA and AGA infants is crucial for early identification of at-risk individuals and implementation of preventive strategies. Early interventions, such as nutritional

counseling and lifestyle modifications, may help mitigate the long-term health risks associated with abnormal lipid profiles in SGA infants.
Despite the growing body of evidence linking SGA status to altered lipid profiles, there is still a need for further research to elucidate the underlying mechanisms and to establish standardized reference values for cord blood lipid levels. Additionally, studies focusing on diverse populations are necessary to understand the influence of genetic, environmental, and socioeconomic factors on lipid metabolism in SGA infants.
In this context, the present study aims to compare the cord blood lipid profiles of term SGA and AGA infants. By analyzing the levels of total cholesterol, triglycerides, LDL, HDL, and VLDL in cord blood, this study seeks to provide insights into the early metabolic alterations associated with intrauterine growth restriction. The findings may contribute to the development of targeted interventions aimed at reducing the burden of metabolic and cardiovascular diseases originating in early life.

METHODS

Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Departments of Pediatrics and Obstetrics at a tertiary care teaching hospital in South India over a period of 8 months (January to August 2024).

Study Population

Inclusion Criteria:

- Term neonates (gestational age 37–42 weeks).
- Born by vaginal delivery or cesarean section.
- Classified as either SGA (birth weight <10th percentile) or AGA (birth weight between 10th and 90th percentile) based on Fenton growth charts.

Exclusion Criteria:

- Preterm neonates (<37 weeks).
- Large for gestational age (LGA) neonates.
- Neonates with congenital anomalies, birth asphyxia, or maternal complications (e.g., gestational diabetes, pre-eclampsia).
- Mothers on lipid-altering medications or with known lipid disorders.

Sample Size and Grouping

A total of 100 term neonates were enrolled and divided into two equal groups:

- **Group 1**: SGA neonates (n = 50)
- **Group 2**: AGA neonates (n = 50)

Data Collection

Detailed maternal and neonatal data were recorded using a predesigned proforma. Maternal age, parity, antenatal history, gestational age (based on last menstrual period or early ultrasound), and mode of delivery were documented.
Neonatal data included:

- Birth weight
- Gender
- Apgar scores
- Clinical assessment at birth

Cord Blood Collection and Biochemical Analysis

Immediately after delivery, 5 mL of cord blood was collected from the umbilical vein in a plain vacutainer under aseptic conditions before placental delivery.
Samples were:

- Centrifuged at 3000 rpm for 10 minutes to separate serum.
- Serum was analyzed within 2 hours using an automated biochemistry analyzer.

Lipid parameters measured:

- Total cholesterol (TC)

- Triglycerides (TG)
- High-density lipoprotein cholesterol (HDL-C)
- Low-density lipoprotein cholesterol (LDL-C) [calculated using the Friedewald formula]
- Atherogenic Index (AI) = TC / HDL-C

All lipid estimations were done using enzymatic colorimetric methods.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were presented as mean ± standard deviation (SD). Categorical data were expressed as percentages. **Mann–Whitney U test** was used for comparison between SGA and AGA groups depending on data distribution.A **p-value <0.05** was considered statistically significant. The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from the mothers prior to inclusion in the study.

RESULTS

A total of 100 term neonates were enrolled in the study—50 classified as Small for Gestational Age (SGA) and 50 as Appropriate for Gestational Age (AGA). The groups were matched for gestational age and sex.

Table 1: Baseline Characteristics of Study Participants

Characteristic	SGA Group (n = 50)	AGA Group (n = 50)	p-value
Mean Birth Weight (g)	2250 ± 180	3000 ± 220	<0.001
Mean Gestational Age (weeks)	38.4 ± 0.9	38.6 ± 0.8	0.22
Male : Female Ratio	1.1 : 1	1.2 : 1	0.84
Vaginal Delivery (%)	58%	62%	0.68

The groups were comparable in gestational age and gender distribution. As expected, the mean birth weight was significantly lower in the SGA group.

Table 2: Cord Blood Lipid Profile – Comparison Between SGA and AGA

Parameter	SGA Group (mean ± SD)	AGA Group (mean ± SD)	p-value
Total Cholesterol (mg/dL)	72.4 ± 10.3	64.1 ± 9.8	0.001
Triglycerides (mg/dL)	94.2 ± 16.1	89.5 ± 13.7	0.09
HDL-C (mg/dL)	28.6 ± 4.5	31.4 ± 4.9	0.013
LDL-C (mg/dL)	36.5 ± 7.8	28.9 ± 6.9	<0.001

SGA neonates had significantly higher total cholesterol and LDL levels. HDL was significantly lower in SGA babies, while triglyceride levels showed a trend toward being higher but were not statistically significant.

Table 3: Atherogenic Index (TC/HDL Ratio)

Group	Mean TC/HDL Ratio ± SD	p-value
SGA (n = 50)	2.59 ± 0.46	
AGA (n = 50)	2.04 ± 0.41	<0.001*

The atherogenic index was significantly elevated in SGA neonates, suggesting a higher risk of early atherogenesis.

Table 4: Distribution of Lipid Abnormalities by Group

Lipid Abnormality	SGA (n = 50)	AGA (n = 50)	p-value
High TC (>70 mg/dL)	28 (56%)	11 (22%)	<0.001
Low HDL (<30 mg/dL)	31 (62%)	19 (38%)	0.02
High LDL (>35 mg/dL)	24 (48%)	8 (16%)	<0.001
High TG (>90 mg/dL)	21 (42%)	15 (30%)	0.17

A significantly higher proportion of SGA neonates had elevated total cholesterol and LDL and low HDL levels compared to AGA neonates, reinforcing the trend toward early dyslipidemia in the SGA group.

Table 5: Correlation Between Birth Weight and Lipid Parameters (Pearson's r)

Lipid Parameter	Correlation Coefficient (r)	p-value
Total Cholesterol	-0.46	<0.001

LDL-C	-0.49	<0.001
HDL-C	+0.38	0.002
Triglycerides	-0.21	0.07

There was a significant negative correlation between birth weight and both total cholesterol and LDL levels. A positive correlation was observed between birth weight and HDL-C, supporting the association between low birth weight and adverse lipid profiles.

DISCUSSION

This study aimed to compare the cord blood lipid profiles of term SGA and AGA neonates. The findings revealed that SGA neonates had significantly higher levels of total cholesterol and LDL-C, and lower levels of HDL-C compared to their AGA counterparts. These results suggest that intrauterine growth restriction may predispose neonates to an atherogenic lipid profile at birth, potentially increasing their risk for cardiovascular diseases later in life (11).

The observed elevated total cholesterol and LDL-C levels in SGA neonates align with previous studies. For instance, Arora et al. reported higher mean total cholesterol and LDL-C levels in SGA neonates compared to AGA neonates, indicating an early onset of dyslipidemia in growth-restricted infants . Similarly, Joshi et al. found significantly higher total cholesterol and LDL-C levels in SGA neonates, reinforcing the association between intrauterine growth restriction and altered lipid metabolism (9).

The lower HDL-C levels observed in SGA neonates are also consistent with existing literature. HDL-C is known for its protective role against atherosclerosis, and reduced levels may contribute to increased cardiovascular risk. Studies have shown that SGA neonates tend to have lower HDL-C levels, which may persist into adulthood, further elevating their risk for metabolic syndrome and cardiovascular diseases (12).

The atherogenic index (TC/HDL-C ratio) was significantly higher in SGA neonates in this study, indicating a more atherogenic lipid profile. This finding is crucial as a higher atherogenic index is associated with an increased risk of developing cardiovascular diseases. Monitoring this index in neonates, especially those born SGA, could serve as an early indicator for initiating preventive measures.

The pathophysiological mechanisms underlying the altered lipid profiles in SGA neonates are multifactorial. Intrauterine growth restriction may lead to adaptive changes in lipid metabolism, including increased hepatic lipogenesis and reduced lipoprotein clearance. Additionally, maternal factors such as malnutrition, anemia, and placental insufficiency can influence fetal lipid metabolism, contributing to the observed dyslipidemia in SGA neonates.

The findings of this study have significant clinical implications. Early identification of neonates with an atherogenic lipid profile allows for timely interventions aimed at mitigating future cardiovascular risk. Strategies may include promoting breastfeeding, ensuring adequate nutrition, and monitoring lipid profiles during childhood. Furthermore, educating parents about the potential long-term health risks associated with SGA status can encourage adherence to preventive measures.

Despite the valuable insights provided by this study, certain limitations must be acknowledged. The sample size was relatively small, and the study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the study did not account for maternal lipid profiles or other potential confounding factors such as maternal diet and socioeconomic status. Future research with larger, multicenter cohorts and comprehensive data collection is warranted to validate and expand upon these findings.

CONCLUSION

This study demonstrates that term SGA neonates exhibit an atherogenic lipid profile at birth, characterized by higher total cholesterol and LDL-C levels and lower HDL-C levels. These alterations may predispose them to cardiovascular diseases later in life. Early identification and monitoring of lipid profiles in SGA neonates could be instrumental in implementing preventive strategies to reduce the burden of cardiovascular diseases originating from early life.

Recommendations

Based on the findings of this study, it is recommended that routine assessment of cord blood lipid profiles be considered in term neonates, particularly those identified as small for gestational age (SGA). Early identification of an atherogenic lipid pattern at birth may allow for timely lifestyle and nutritional interventions aimed at minimizing future cardiovascular risk. Pediatric follow-up protocols should include periodic lipid monitoring in SGA infants. Additionally, public health strategies should emphasize maternal nutrition and antenatal care to prevent intrauterine growth restriction and its long-term metabolic consequences.

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