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# Serum lipid and lipoprotein-cholesterol values in cord blood and on the sixth postnatal day in newborns of varying maturity

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Trigliceride, total cholesterol, phospholipid, HDL-cholesterol, VLDL-cholesterol and LDL-cholesterol concentrations were studied in 22 eutrophic, 16 true premature and 22 small-for-gestational age neonates in cord blood and on the 6th postnatal day. According to the findings the lipid-lipoprotein metabolism was influenced primarily by gestational age. Parallel with increasing gestational age, phospholipide and triglyceride concentrations rose whereas cholesterol values decreased. Postnatal changes of lipid-lipoprotein metabolism developed more slowly in premature than in mature newborns. The effects of intrauterine malnutrition manifested themselves mainly in differences of the triglyceride and phospholipid levels.

Our knowledge on lipoproteins has been considerably augmented in recent years, mainly because of their connection with atherosclerosis. With the purpose of preventing cardiovascular diseases, lipoprotein standards have been worked out for infancy and childhood all over the world.

In several countries efforts have been made to screen congenital hyperlipoproteinaemias from cord blood [4, 5, 8, 9]; furthermore, some investigators have studied postnatal changes as well [3, 7]. It has been shown that serum lipoprotein values were influenced by the sex of the newborn [4], asphyxia, prenatal betamethasone treatment [9] and gestational age [1, 3, 6, 7, 13].

## Materials and Methods

In 60 neonates the serum triglyceride, total cholesterol, phospholipid and HDL-cholesterol concentrations were determined in cord blood and in blood samples taken in the morning of the 6th postnatal day after 6 hours fasting. VLDL- and LDL-cholesterol values were calculated. Blood samples were taken into EDTA-tubes, centrifuged immediately and stored at −20°C until analysis. Triglyceride and cholesterol values were determined by the Boehringer enzymatic test, while the colorimetric method of Zilversmit and Davis [14] was used for determining phospholipids. HDL-cholesterol was measured enzymatically after heparin-manganese precipitation [2]. LDL- and VLDL-cholesterol values were calculated from the formulas of Hardell and Carlson [8]. Statistical analysis was carried out by means of Student's $t$ test and linear regression analysis.

The newborns were classified into three groups on the basis of their gestational age and birth weight percentile position.

*Group I: 22 eutrophic neonates*

Gestational age: 37—42 weeks; birth weight: 10—90%. One of the newborns had been delivered by Caesarian section. The mothers of two babies had been treated because of late pregnancy toxae-

mia. One minute Apgar score was seven in both neonates.

*Group II: 16 true premature neonates*

Gestational age: <37 weeks; birth weight: 10–90%. The mothers of four babies had been treated with betamethasone prior to delivery. One of the latter was delivered at the 28th gestational week of a baby weighing 750 g. The child died after 27 h in consequence of IRDS. From the latter neonate we obtained only cord blood values. The baby of another mother treated with steroid was born with an Apgar score <7 and needed resuscitation. Among the neonates of mothers not treated with steroid, two were found to have Apgar scores <7 at birth.

*Group III: 22 small-for-gestational age neonates*

Gestational age: 37–42 weeks; birth weight <10%. One of the babies was born with an Apgar score 7, another scored 6.

All neonates were breast fed. Mean birth weight, gestational age, and sex ratio in each of the three groups of neonates are presented in Table I.

## Results

The concentrations found in cord blood samples of the three different groups of neonates are summarized in Table II. When the values were plotted against gestational age, a positive linear correlation was obtained (Fig. 1). Similar tendencies were observed in respect of triglyceride values but here the correlation was not significant ($r = 0.216$). At the same time, a close inverse correlation was found between HDL-cholesterol and gestational age (Fig. 1), but this

Table I

Mean gestational age, birth weight and sex ratio in the different groups of newborns

| | Gestational age, weeks mean±SD | Birth weight, g mean±SD | Sex ratio boys : girls |
|---|---|---|---|
| Eutrophic infants | 38.8±0.36 | 3230±100 | 11 : 11 |
| Premature infants | 34.6±0.62 | 2250±130 | 7 : 9 |
| SGA infants | 38.9±1.64 | 2415±259 | 8 : 14 |

Table II

Lipid-lipoprotein values measured in cord blood

| mmol/l | Eutrophic infants Group I mean±SD | p between I and II | Premature infants Group II mean±SD | p between II and III | SGA infants Group III mean±SD | p between I and III |
|---|---|---|---|---|---|---|
| Triglyceride | 1.089±0.62 | n.s. | 1.0 ±0.5 | 0.02 | 1.34±0.44 | n.s. |
| Total cholesterol | 1.97 ±0.52 | 0.05 | 2.68±0.83 | n.s. | 2.18±0.75 | n.s. |
| Phospholipid | 1.77 ±0.34 | 0.001 | 1.27±0.39 | n.s. | 1.62±0.49 | n.s. |
| HDL-cholesterol | 0.60 ±0.21 | 0.05 | 1.57±0.51 | 0.01 | 0.77±0.28 | 0.05 |
| VLDL-cholesterol | 0.21 ±0.13 | n.s. | 0.19±0.12 | 0.02 | 0.26±0.11 | n.s. |
| LDL-cholesterol | 1.08 ±0.59 | n.s. | 0.90±0.67 | n.s. | 1.14±0.47 | n.s. |

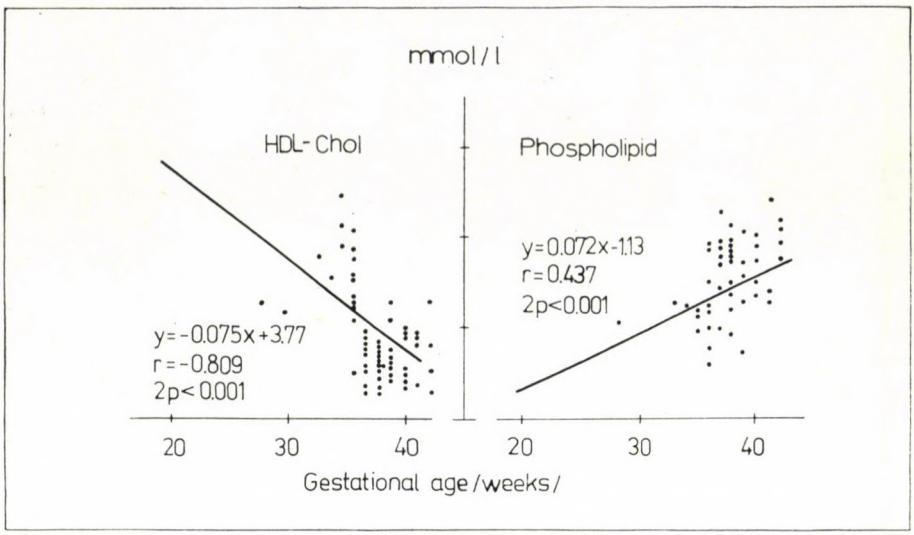


FIG. 1. Changes of HDL-cholesterol and phospholipid levels in dependence on gestational age

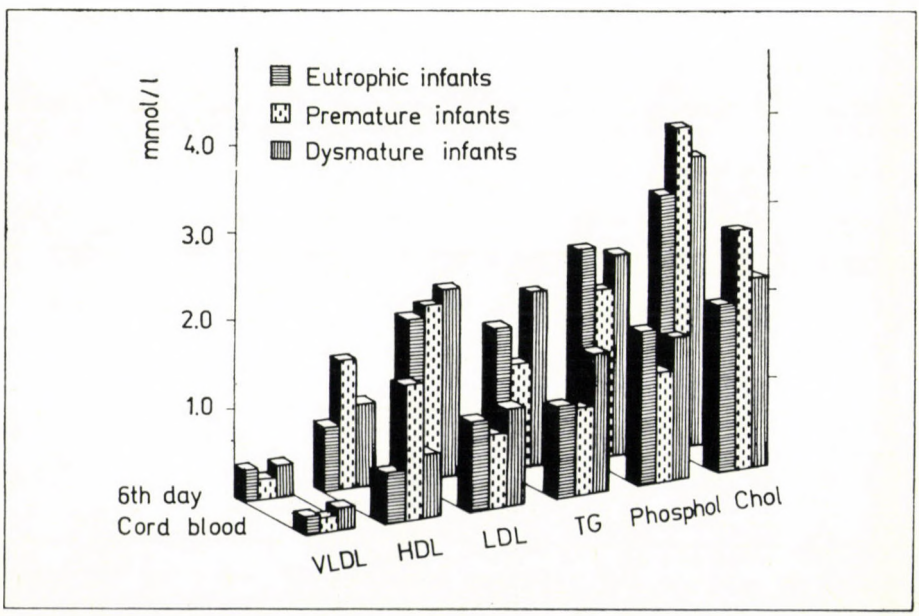


FIG. 2. Lipid and lipoprotein concentrations in cord blood and on the 6th postnatal day in babies of different maturity

TABLE III

Lipid-lipoprotein values measured on 6th postnatal day

| mmol/l | Eutrophic infants Group I mean±SD | p between I and II | Premature infants Group II mean±SD | p between II and III | SGA infants Group III mean±SD | p between I and III |
|---|---|---|---|---|---|---|
| Triglyceride | 1.63±0.73 | n.s. | 1.19±0.45 | 0.001 | 1.94±0.54 | n.s. |
| Total cholesterol | 2.95±0.44 | 0.01 | 3.66±0.82 | n.s. | 3.31±0.89 | n.s. |
| Phospholipid | 2.40±0.40 | 0.001 | 1.88±0.39 | 0.005 | 2.30±0.42 | n.s. |
| HDL-cholesterol | 0.73±0.42 | 0.001 | 1.45±0.56 | 0.005 | 0.84±0.56 | n.s. |
| VLDL-cholesterol | 0.32±0.16 | 0.05 | 0.23±0.11 | 0.001 | 0.38±0.13 | 0.05 |
| LDL-cholesterol | 1.86±0.84 | n.s. | 1.97±0.54 | n.s. | 2.08±0.92 | n.s. |

TABLE IV

Postnatal changes of lipid-lipoprotein levels

| mmol/l | Eutrophic infants | | |
|---|---|---|---|
| | Cord blood | 6th day | p< |
| TG | 1.09±0.62 | 1.63±0.73 | 0.01 |
| Total chol | 1.97±0.52 | 2.95±0.44 | 0.001 |
| PL | 1.77±0.34 | 2.40±0.40 | 0.001 |
| HDL-chol | 0.60±0.21 | 0.73±0.42 | n.s. |
| VLDL-chol | 0.21±0.13 | 0.32±0.16 | 0.01 |
| LDL-chol | 1.08±0.59 | 1.86±0.84 | 0.001 |

| mmol/l | Premature infants | | |
|---|---|---|---|
| | Cord blood | 6th day | p< |
| TG | 1.0 ±0.5 | 1.19±0.45 | n.s. |
| Total chol | 2.68±0.83 | 3.66±0.82 | 0.005 |
| PL | 1.27±0.39 | 1.88±0.39 | 0.005 |
| HDL-chol | 1.57±0.51 | 1.45±0.56 | n.s. |
| VLDL-chol | 0.19±0.12 | 0.23±0.11 | n.s. |
| LDL-chol | 0.90±0.67 | 1.97±0.54 | 0.001 |

| mmol/l | SGA infants | | |
|---|---|---|---|
| | Cord blood | 6th day | p< |
| TG | 1.34±0.44 | 1.94±0.54 | 0.001 |
| Total chol | 2.18±0.75 | 3.31±0.89 | 0.001 |
| PL | 1.62±0.49 | 2.30±0.42 | 0.001 |
| HDL-chol | 0.77±0.28 | 0.84±0.56 | n.s. |
| VLDL-chol | 0.26±0.11 | 0.38±0.13 | 0.005 |
| LDL-chol | 1.14±0.47 | 2.08±0.92 | 0.01 |

was not the case with total cholesterol values.

In Table III, the lipid-lipoprotein values of the 6th postnatal day are presented.

Table IV and Fig. 2 summarize the postnatal changes in lipid levels. Up to the 6th day, in all groups of neonates an increase of lipid levels was observed, with the exception of HDL-cholesterol. In comparison with cord blood values, significantly larger quantities of triglyceride, total cholesterol, phospholipid, VLDL-cholesterol and LDL-cholesterol were found in the full-term babies (Group I) on the 6th postnatal day, whereas the serum triglyceride and VLDL-cholesterol values of true premature neonates showed a non-significant slight increase in the course of the first six days of life.

## Discussion

Our data suggest that postnatal changes in cord blood lipid levels are influenced primarily by gestational age and not by the intrauterine nutritional state. The afore-mentioned changes occurred more slowly in premature than in mature infants.

Triglyceride and total cholesterol values measured by us were in accordance with the results of others [1, 4, 6, 9, 13]. The triglyceride levels were significantly higher in small-for-gestational-age neonates than in eutrophic and premature newborns. Still, the highest cholesterol and HDL-cholesterol concentrations were found in the prematures. In respect of LDL-cholesterol levels our findings differed from those obtained by Andersen and Friis-Hansen [1] as we did not find a raised LDL-cholesterol level in true premature infants either in cord blood or on the 6th postnatal day. In our study the highest postnatal increase in LDL-cholesterol was found in the group of premature infants, similarly to the data reported by Ginsburg and Zetterström [7].

As to the phospholipid levels of neonates we could not find any data in the available literature. The lowest values were observed in true premature newborns. The mean phospholipid values of small-for-gestational age babies were also lower than those of eutrophic neonates. During the first six postnatal days the increase in phospholipid concentration was considerable in all three groups, especially in that of small-for-gestational age newborns.

These observations may be explained as follows.

(a) Endogenous phospholipid synthesis is inadequate in premature infants due to the immaturity of hepatic functions. In small-for-gestational age babies chronic malnutrition may result in a similar effect.

(b) In premature infants placental transport is not yet sufficient, but one must reckon with placental insufficiency also in small-for-gestational age infants. The latter hypothesis seems to be supported by the fact that up to the 6th postnatal day, the phospholipid level of SGA-infants increases to the highest degree, approx-

imating the mean value for the eutrophic group.

Based on our findings, the lipidlipoprotein values of true premature newborns may be characterized as follows

(1) Triglyceride level is low in cord blood and increase up to the 6th postnatal day.

(2) Total cholesterol concentrations are high in cord blood and increase further in the postnatal period.

(3) Phospholipid values are low at birth but increase considerably up to the 6th day.

(4) HDL-cholesterol values are high in cord blood but tend to decrease up to the 6th day.

(5) In contrast to both groups of full-term neonates, VLDL-cholesterol levels of premature infants barely increase up to the 6th day.

(6) LDL-cholesterol values are at a medium level at birth but rise precipitously up to the 6th day.

As shown by these data, true premature infants differ from full-term ones in respect of all parameters involved in our study. This statement applies to cord blood values as well as to postnatal changes.

High triglyceride and low phospholipid levels are characteristic of SGA neonates. Both parameters increase postnatally. As compared with the eutrophic group, slightly higher total cholesterol and lipoprotein-cholesterol values were found in the group of SGA newborns, but this was due rather to the higher percentage of girls in the latter group than to dysmaturity.

Thus, according to our findings, SGA neonates differ from eutrophic ones in respect of two lipid fractions. Both deviations may be attributed to intrauterine malnutrition. High triglyceride levels are due to increased lipolysis caused by negative caloric balance [12] whereas low phospholipid values may be explained by insufficient placental transport of essential fatty acids [10, 11].

Beside sex differences [4, 9], the lipidlipoprotein metabolism of neonates is influenced most considerably by gestational age. Among newborns of the same gestational age, differences may result from intrauterine malnutrition. The differences established on the basis of our data were significant statistically, therefore it is desirable to take them into consideration in the course of hyperlipidaemia screenings.

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