Serum ferritin, iron levels and iron binding capacity in asymmetric SGA babies

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The concentration of serum ferritin reflects the extent of iron stores in premature infants. We aimed to determine serum ferritin levels and iron status in asymmetric small for gestational age (SGA) babies.

This study was performed on 21 SGA babies and 19 appropriate for gestational age (AGA) babies. Hemoglobin, iron, iron binding capacity and ferritin levels were inevestigated in the first six hours after the birth. Hemoglobin levels in the SGA and control groups were 20.9 ± 1.3 (19.4-23.4 g/dl) and 19.6 ± 0.8 (18.5-21.5 g/dl), respectively ($p = 0.001$). Serum ferritin levels in the SGA and AGA groups were 58.36 ± 20.1 ng/ml and 90.46 ± 30.5 ng/ml, respectively. Ferritin levels were found lower in the SGA group ($p < 0.001$). In the SGA group, decreased serum iron and increased iron binding capacity were found but the difference was not significant ($p > 0.05$).

Decreased ferritin levels may result from either impaired iron transport associated with uteroplacental vascular insufficiency or increased iron utilization during enhanced erythropoiesis in conditions characterized by chronic fetal hypoxia. Our results stress the significance of iron supplementation and careful anemia follow-up in term SGA babies. Because anemia progress early, beginning iron therapy as soon as possible is a necessity in SGA babies as in prematures.

Key words: small for gestational age, SGA, serum ferritin, iron stores.

Fetal growth is affected by fetal growth potential in the first half of the pregnancy and by maternal environment and uteroplacental functions in the second half[1]. Various criterions are used in defining babies as small for gestational age (SGA). SGA may be defined as birth weight below the 10th percentile for gestational age or as more than 2 standard deviations below the mean for gestational age[2]. The ponderal index can be used to identify infants whose soft tissue mass is below normal for the stage of skeletal development. Thus, a pondreal index below the 10th percentile may be used to identify SGA infants. Ponderal index is the most commonly used parameter[3,4]. Since it is not affected by gestational age, race or sex, it is preferred to define SGA.

The concentration of serum ferritin reflects the extent of iron stores in infants[5,6]. For this reason serum ferritin level is useful in the evaluation of iron status.

In this study, iron, iron binding capacity and ferritin levels were searched in the sera of term SGA babies that are thought to be the result of intrauterine chronic hypoxia.

Material and Methods

All infants were examined during the first day after birth; gestational age was determined by Dubowitz score[7]. Forty term babies were between 38-42 weeks' gestational age according to the Dubowitz score. Twenty-one of 40 babies were SGA and 19 were appropriate for gestational age (AGA). In the determination of the babies with SGA, the ponderal index (PI) (body weight/length^3 x 100) was used. Babies having PI under 10 percent were considered as asymmetric SGA[3,4].

Reasons for growth retardation included severe preeclampsia (n = 4), chronic hypertension (n = 2), maternal smoking (n = 2) and chronic

heart disease (n = 1). No underlying disease which could have caused SGA was found in the other patients. All of these infants were asymmetrically growth retarded. Non was retarded on the basis of intrauterine infection, as determined by titers for congenital infectious agents. Infants whose mothers had hemoglobin concentrations < 9 g/dl were excluded as were mothers and infants with fever, bacteremia, or leukocytosis.

The sera of the venous blood samples were taken in the first six hours after birth, and hemoglobin, iron, iron binding capacity and ferritin levels were investgiated. Hemoglobin was determined on the Abbott Coulter Counter (Cell-Dyn 3500). The serum was separated by centrifugation and was frozen at -40 °C until analysis for ferritin. Serum ferritin levels were determined by immunoenzymatic assay (ELISA) in the Exim-Abbott automatic analyzer using Boehringer Mannheim system (Abbott Labarotories, USA, 1997). Iron and iron binding capacity were determined by deproteinization method in the Hitachi 704 automatic analyzer with Boehringer Mannheim system in heparinized plasma (Boehringer Mannheim Gmblt. Mannheim, Germany, 1994).

Values are mean ± SD. Student's t test and linear correlation analysis were used for statistical analysis. A $p < 0.05$ value was considered to represent a significant difference between the compared values (SPSS 5-0, 1992).

The study was approved by the Medical Ethics Committee of Pamukkale University Hospital.

Results

Hemoglobin, iron, iron binding capacity and ferritin levels were investigated in the first six hours after birth in the 21 SGA and 19 AGA babies. SGA infants included 11 females (52.4%) and 10 males (47.6%) and AGA infants included 10 females (52.6%) and 9 males (47.4%). The mean birth weights were 2370 ± 211 grams (1800-2600) in the SGA group and 3228 ± 295 grams (288-3700) in the control group. There was a significant difference between the birth weight of the two groups ($p < 0.001$). Hemoglobin levels in the SGA and control groups were 20.9 ± 1.3 (19.4-23.4 g/dl) and 19.6 ± 0.8 (18.5-21.5 g/dl), respectively. There was a significant difference between the hemoglobin levels of the two groups ($p = 0.001$).

Serum ferritin levels in the SGA and AGA groups were 58.4 ± 20.1 ng/ml and 90.5 ± 30.5 ng/ml, respectively. Ferritin levels were found lower in the SGA group ($p < 0.001$). Serum iron levels in the SGA and AGA groups were 10.1 ± 3.4 µmol/L and 10.6 ± 5.0 µmol/L, respectively. Serum iron binding capacities were 74.5 ± 11.8 µmol/L and 70.4 ± 10.0 µmol/L, respectively. In the SGA group, decreased serum iron and increased iron binding capacity were found, but the difference was not significant ($p > 0.05$) (Table I).

Table I. Perinatal Data of SGA and Control Groups (mean ± SD)

	SGA	Control	P
Birth weight	2370 ± 211	3228 ± 295	< 0.001
Gestational age (weeks)	39.7 ± 0.9	40.0 ± 0.5	> 0.05
Hemoglobin	20.9 ± 1.3	19.6 ± 0.8	= 0.001
Iron (µmol/L)	10.07 ± 3.4	10.6 ± 5.0	> 0.05
Iron binding capacity (µmol/L)	74.5 ± 11.8	70.4 ± 10.0	> 0.05
Ferritin (ng/ml)	58.4 ± 20.1	90.5 ± 30.5	< 0.001

SGA: small for gestational age.

Twelve (57.1%) of the infants in the study group had abnormally low serum ferritin levels, whereas only three (15%) of the control infants had such low values. An abnormally low serum ferritin level was accepted as lower than 60 ng/ml[8].

We found clear correlation between serum ferritin and birth weight (r: 0.50, $p < 0.001$).

Discussion

Since the fetus gains 85 percent of its body weight in the second half of pregnancy, any impaired uteroplacental blood flow in this period will definitely disturb food and oxygen transfer to the baby[9]. Length and head circumference are protected; however, because of inadequate weight gain, these babies have a lower ponderal index and are referred to as asymmetric SGA.

In 50 percent of asymmetric SGA babies, intrauterine chronic hypoxia risk is increased because of their impaired uteroplacental blood flow[9]. These babies, when compared with AGA babies, presented higher cord hemoglobin levels[10] and an increased incidence of neonatal polycythemia[11]. Usually hematocrit levels are ≥ 60 percent. Neonatal polycythemia is associated with impaired fetoplacental blood flow during fetal hypoxia episodes or with chronic fetal tissue hypoxia and a compensatory increase in erythropoietin levels[12].

Levels of serum ferritin reflecting the extent of iron stores in children have been reported in recent studies[5,6]. Serum ferritin levels were searched in premature babies[13-15]. Correlations were detected between maternal and fetal serum ferritin levels and gestational age[8,16,17]. However, sufficient studies in SGA babies have not been done.

Cord ferritin levels were found significantly lower in preterm babies in a study based on 22 term and 32 preterm infants[15]. Tekinalp et al.[18] determined serum ferritin levels in 76 neonates and showed the lowest levels in less than 34 weeks of gestational age prematures. In a similar study, Jansson and Holmberg[13] showed significantly lower serum ferritin levels in less than 34 weeks of gestational age prematures. There was a positive correlation between serum ferritin levels and birth weights. In this study, we found clear correlation between serum ferritin levels and birth weights.

The results of the limited number of studies on SGA babies are as follows: Olivares et al.[19] showed that serum ferritin levels were lower in term SGA babies than in preterm AGA babies. On the other hand, serum ferritin levels were higher in term SGA babies than in preterm SGA babies.

Abbas and Snijders[20] in 1994 found a small decrease in ferritin levels in SGA babies and an important increase in maternal serum ferritin concentration. They demonstrated that the decreased feto-maternal ferritin ratio could be the consequence of impaired placental perfusion.

Chockalingam et al.[21] studied 50 high-risk infants consisting of 16 SGA, 21 from preeclamptic mothers and 13 from diabetic mothers. They showed a significant inverse correlation between increasing serum transferrin and decreasing ferritin levels compared to the control group. The reason for the increased transferrin levels was unknown, but may reflect an increase in iron binding capacity compensating for low fetal iron stores.

In this study, serum transferrin and maternal ferritin levels were not measured. However, in the SGA group, decreased serum iron and increased iron binding capacity were found, but difference was not significant. There results could be evidence of increased iron requirement in SGA babies. Serum ferritin levels were determined to be significantly decreased in SGA babies. Decreased ferritin levels may result from either impaired iron transport associated with uteroplacental vascular insufficiency[22] or increased iron utilization during enhanced erythropoiesis in conditions characterized by chronic fetal hypoxia.

Chockalingam et al.[21] determined abnormally low ferritin levels (< 60 ng/ml) in 64 percent of the infants. Similarly, we found abnormally low ferritin levels in 57.1 percent of the study group.

This study demonstrated that newborn infants at risk for impaired uteroplacental blood flow or chronic fetal hypoxia had depressed ferritin levels and body iron stores. Decreased iron stores may result from either impaired iron transport associated with uteroplacental vascular insufficiency or increased iron utilization during enhanced erytrhopoiesis in conditions characterized by chronic fetal hypoxia.

Further studies are needed in order to determine the time to administer iron supplement in the event of iron deficiency anemia in SGA babies.

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