Antioxidant Levels in Cord Blood of Low Birth Weight Newborns

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ABSTRACT

We evaluated the antioxidant status of 82 healthy term low birth weight (LBW) newborns and equal number of gestation and sex matched controls weighing <2500 g by measuring vitamin A and E, superoxide dismutase, catalase and glutathione peroxidase in cord serum. Levels of vitamin A and E, superoxide dismutase and catalase were significantly lower and glutathione peroxidase significantly higher in LBW babies compared to controls, with the lowest levels found in babies showing more severe growth restriction (<2000 g). We conclude that LBW newborns are deficient in several important antioxidants which may predispose them to higher oxidative stress.

Key words: *Antioxidants, Catalase, Glutathione peroxidase, Low birth weight, Superoxide dismutase, Vitamin A, Vitamin E.*

INTRODUCTION

Free radicals are incriminated in the pathogenesis of tissue injury in many human diseases. They produce cellular injury by lipid peroxidation, enzyme inactivation, damage of DNA, and degradation of structural proteins(1). The body has evolved multiple defense mechanisms against free radicals. These include vitamins A and E, superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx), bilirubin, and uric acid(2). Under normal circumstances, there is a critical balance between prooxidant and antioxidant forces.

Newborns are more susceptible to oxidative stress due to increased production of free radicals at birth, and incompletely developed antioxidant mechanisms. Poor fetal growth may further compromise the development of antioxidant defenses of low birth weight (LBW) babies, predisposing them to higher oxidative stress which, in turn, may partly account for increased morbidity and mortality in these infants. The objective of the present study was to measure the levels of vitamins A and E, SOD, catalase and GPx in the cord blood of LBW babies delivered at term gestation.

METHODS

The study population comprised of 82 healthy term (gestation 37-41 weeks) LBW babies (birth weight <2500g) and an equal number of gestation-and sex-matched control newborns weighing >2500g. Study subjects were divided into different groups: Group I (birth weight 1500–<2000 g; *n*=28), Group II (birth weight 2000–2499g; *n*=54); Group III (Group I and Group II pooled together; *n*=82) and Group IV (birth weight ≥2500 g; *n*=82) served as controls. Gestational age was calculated from the first day of last menstrual period and confirmed by the New Ballard Score. Birth weight was recorded soon after birth on UNICEF balance to the nearest 20 g. Exclusion criteria were perinatal asphyxia, respiratory distress, infection, hemolytic disease and major malformations.

About 15 mL of cord blood was collected in sterilized glass tubes just after the second stage of labor. Serum was stored at –20ºC until analyzed. Standard methods were used to measure the levels of vitamin A(3), vitamin E(4), SOD(5), catalase(6) and GPx(7). Informed consent was obtained from the parents and study protocol was approved by Institute Ethics Committee. For normally distributed data

(vitamins A and E, SOD, and GPx) statistical analysis was done by one way analysis of variance (ANOVA), SNK test and *Z* test to see the significance of difference between groups. In case of catalase due to non-normal distribution of data but large sample size we used the *Z* (Normal) approximation to the Kruskal Wallis test and the Mann Whitney *U* test to know the significance of difference between groups.

RESULTS

***Table* I** shows the levels of various antioxidants in the cord blood of study infants. The levels of vitamin A, vitamin E and catalase decreased progressively with decreasing birth weight. On the other hand, SOD and GPx showed no such relationship. In comparison to controls, babies in Group I had lowest levels of various antioxidants while babies in Group II had intermediate levels. Overall, LBW babies had reduced levels of vitamin A and E, SOD and catalase compared with controls. However, in comparison to controls, GPx levels were elevated in LBW babies.

DISCUSSION

The present study suggests that LBW infants are deficient in several important antioxidants. Compared to controls, the levels of vitamin A and E, SOD and catalase were reduced in LBW newborns which might have significant implications, as diseases like infection and perinatal asphyxia are much more common in this group. Our findings are in broad agreement with an earlier study carried out on term small for gestational age neonates(8) which used erythrocytes to estimate various antioxidants. Many antioxidants are micronutrients or depend on micronutrients for their activity. These include vitamins A, C and E as well as β-carotene and trace elements copper, zinc, manganese and selenium which act as cofactors for antioxidant enzymes(9). Vitamin E is an important chain-braking antioxidant which acts by scavenging peroxyl radical to limit cell membrane peroxidation(2). Vitamin A has substantial singlet oxygen scavenging ability(10). We observed lowest values of vitamins A and E in newborns weighing <2000g. Thus these infants may be most vulnerable to oxidative stress. The levels of vitamin A and E observed in the present study are in agreement with other studies(11,12).

The present study showed that LBW infants are lacking in key antioxidant enzymes which act as the first line of defense against free radicals and reactive oxygen species. SOD efficiently removes superoxide radical by converting it to H_2O_2, which in turn is metabolized by GPx and catalase to molecular oxygen and water(2). With reduced antioxidant enzyme activities, the body is unable to dispose of superoxide radical and H_2O_2 which can attack all biological molecules with extensive tissue damage(13). Comparison of results with other studies(8) is not possible as antioxidant enzyme activities were measured in different body tissues. It is of interest to note that we found elevated GPx

TABLE I LEVELS OF VITAMINS A AND E, SUPEROXIDE DISMUTASE, CATALASE AND GLUTATHIONE PEROXIDASE IN RELATION TO BIRTH WEIGHT

Groups	Birth weight (g)	Vitamin A* (μg/dL)	Vitamin E† (mg/dL)	Superoxide dismutase^ mg protein/ mL serum	Catalase** μM H_2O_2 consumed/mg protein /min	Glutathione peroxidase± μmol DTNB conjugate/ mg protein
I (*n*=28)	1500-<2000	9.24 ± 5.11	0.44 ± 0.12	6.30 ± 3.82	11.84 ± 12.25	0.14 ± 0.06
II (*n*=54)	2000-2499	13.49 ± 5.36	0.63 ± 0.18	7.65 ± 3.51	20.85± 18.98	0.13 ± 0.05
III (I + II) (*n*=82)	<2500	12.04 ± 5.65	0.56 ± 0.17	7.19 ± 3.67	17.76± 17.51	0.13 ± 0.05
IV (*n*=82)	≥2500	14.93 ± 7.12	0.76 ± 0.15	8.26 ± 3.26	26.12 ± 16.61	0.12 ± 0.03
P value	<0.001	<0.001	>0.05	<0.01	>0.05	

** P<0.001 for I vs II, I vs IV; P <0.01 for III vs IV; † P <0.001 for I vs II, I vs IV, II vs IV, and III vs IV;*
*** P<0.01 for I vs IV, III vs IV; P<0.05 for I vs II;* ±P<0.01 for III vs IV; ^P<0.05 for III vs IV

WHAT THIS STUDY ADDS?

- Term low birth weight infants have inadequately developed antioxidant defenses.

activity in LBW babies. It may be speculated that intrauterine growth restriction exerted differential effects on different components of antioxidant defense system, with upregulation of synthesis of certain components in an attempt to restore the oxidant/antioxidant balance(2).

The present study had certain limitations. Antioxidant levels were not analyzed in relation to maternal nutritional status, medical and obstetrical complications, route of delivery and other perinatal factors which may influence antioxidant status in cord blood(3). We analyzed antioxidant levels in relation to birth weight but not with other parameters of neonatal anthropometry, which might have yielded important information. However, it is well known that in babies with poor fetal growth, birth weight remains the most important determinant of outcome. Antioxidant assays of body fluids such as total radical trapping antioxidant parameters assay are useful in understanding a global picture of antioxidant activities rather than assessing each component of the complex antioxidant defense system(2).

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