ANTIOXIDANT STATUS AND PEROXIDATIVE STRESS IN MOTHER AND NEWBORN – A PILOT STUDY

Chitra Upadhyaya*, Sandhya Mishra*, P.P. Singh** and Praveen Sharma*

*Department of Biochemistry, S.M.S. Medical College, Jaipur & **Darshan Dental College, Udaipur (India)

ABSTRACT

Serum antioxidant status and peroxidative stress was estimated in 30 pregnant women, their newborn infants and 25 non-pregnant women. Serum Ascorbic acid, α -tocopherol, retinol & β -carotene levels were found to be significantly reduced and peroxidative stress was significantly higher in mothers as compared to matched non-pregnant women. Newborn had significantly higher levels of ascorbic acid as compared to their mother but had significantly lower levels of lipid soluble vitamins. The peroxidative stress in newborn was found to be significantly less as compared to their mothers. A positive correlation of ascorbic acid and α -tocopherol levels between mother and newborn reflects that their status in mother does influence the newborn status.

KEY WORDS

Peroxidative stress, Ascorbic acid, α -Tocopherol, β -Carotene, Retinol, Newborn, Mother

INTRODUCTION

Pregnancy is confronted with aggressive episodes of progressive and periodic changes in metabolic and physiological profile. Consequently remarkable and dramatic events occur during this period for sustaining mother and fostering the growth and maintenance of fetus (1). Pregnancy while not a disease often accompanied by a high-energy demand of many bodily functions and an increased oxygen requirement. One of the adaptive changes in the respiratory physiology from 8th week onwards, where minute ventilation initially increased by 36% and ultimately reaches to the maximum of 50% or more to meet the increasing demands of oxygen by mother to meet the requirement of fetus, which could rise up to 30-35% (2, 3, 4). This triggered aerobic environment should primarily be responsible for raised oxidative stress in pregnancy. Further, over enthusiastic and uncontrolled iron supplementation and inclement environmental factors may further add to oxidative stress (5). Above all, the feeble antioxidant defense, as it is often visible in developing population, could lead to an undesirable level of oxidative stress which could become a discovering cause of many diseases due to oxidative damage of cellular and/or tissue components. Needless to say that pregnant women are more prone

to health problems especially in our family pattern. Naturally these observations call for determining the pattern of oxidative stress and antioxidant cascade in pregnancy.

MATERIALS & METHODS

The study is based on 30 pregnant women ranging in age from 22 to 30 years (mean 25.8 ± 3.7), their newborns and 25 age matched non-pregnant control. The subjects were selected amongst those attending the department of Obstetrics and Gynaecology of Zanana Hospital and Mahila Chikitsalaya of S.M.S. Medical College, Jaipur. Care was taken to ensure that all the subjects belonged to middle socioeconomic group (who were able to meet the basic necessities of life and some requirements of comforts). All the subjects were vegetarian, normotensive, not taking any drug, which could influence antioxidants level. Women with any obstetrical abnormality or disease complicating pregnancy were excluded. Age matched non-pregnant control subjects were randomly selected among the staff of S.M.S. Medical College, Jaipur. Blood samples were collected from antecubital vein of control and pregnant women. For the newborn cord venous blood samples were collected from the placental end of the cord. The weight of newborns and their mothers was also recorded at the time of delivery. Blood samples were analyzed for- Vitamin A, β -Carotene, ascorbic acid (6), α -tocopherol (7) and peroxidative stress was assessed by estimation of Malondialdehyde (MDA) using Thiobarbituric acid (TBA) assay method (8).

* Author for Correspondence

Prof . Praveen Sharma

Deptt. Of Biochemistry, SMS Medical College,
Jaipur - 302004

Email : drpsharma_in@hotmail.com

Statistical analysis was done using Students 't' test.

RESULTS

Table 1 shows comparison of peroxidative stress and antioxidant status of mother, newborn and non-pregnant women. Serum ascorbic acid level was found to be significantly low ($P<0.001$) in mothers as compared to non-pregnant women. Similarly other lipid soluble vitamin levels were also low in mothers where as peroxidative stress at the time of delivery was significantly high ($P<0.001$) and increase was almost two folds. The newborn had significantly higher levels ($P<0.001$) of ascorbic acid and significantly low peroxidative stress, which was half of the mother

oxidative stress. α -tocopherol, retinol and β -carotene levels of newborn were found to be low at the time of birth. The relationship was more impressive in the case of ascorbic acid and α -tocopherol, where the coefficient of correlation between mother and newborn was $r=+0.69$ ($P<0.001$) for ascorbic acid (figure 1), and $r=+0.87$ ($P<0.001$) for tocopherol (figure 2). A weak correlation was observed in retinol and β -carotene. Table II shows the influence of antioxidants and peroxidative stress on birth weight of newborn. As evident from the observation, low birth weight child (<2500 gm) suffers with greater oxidative stress as compared with normal birth weight newborn (>2500 gm) and they were found to be relatively deficient in their antioxidant status.

Table I. Lipid Peroxidation & Nutrient antioxidants in mother and newborn
(Values are mean $\pm$ SD & range)

	Non-Pregnant n=25	Mother n=30	Newborn n=30	Ratio newborn/mother
α -Tocopherol (mg/dl)	0.99 $\pm$ 0.40 (0.72-1.14)	0.80 $\pm$ 0.20* (0.60-1.07)	0.60 $\pm$ 0.17* (0.45-0.90)	0.75 $\pm$ 0.15
Ascorbic Acid (mg/dl)	0.96 $\pm$ 0.15 (0.75-1.14)	0.75 $\pm$ 0.10** (0.45-0.92)	1.23 $\pm$ 0.18** (0.98-1.45)	1.64 $\pm$ 0.17
Retinol (mg/dl)	26.53 $\pm$ 2.46 (22.75-31.4)	22.60 $\pm$ 3.86 (19.6-25.8)	20.01 $\pm$ 2.82 (18.74-25.62)	0.88 $\pm$ 0.012
β -Carotene (μ g/dl)	118.97 $\pm$ 5.34 (112.2-123.9)	111.90 $\pm$ 11.30 (105.2-125.6)	105.58 $\pm$ 15.79 (97.2-118.4)	0.94 $\pm$ 0.012
TBARS (nmol/ml)	1.41 $\pm$ 0.19 (1.20-1.63)	2.88 $\pm$ 0.31** (2.32-3.50)	1.22 $\pm$ 0.20** (0.88-1.53)	0.42 $\pm$ 0.011

Statistical comparison was done between non-pregnant and mothers; mother and newborn

** $P<0.001$; * $P<0.01$; rest not significant.

Table II (a). Nutrient Antioxidants level of mother and newborn weighing more than 2500 gms and less than 2500 gms. (Values are mean $\pm$ SD and range)

	<2500 gm (1740 $\pm$ 410 gm) n=20			>2500 gm (2850 $\pm$ 230 gm) n=10		
	Mother	Newborn	Newborn/ Mother	Mother	Newborn	Newborn/ Mother
α -Tocopherol (mg/dl)	0.74 $\pm$ 0.16 (0.60-0.88)	0.54 $\pm$ 0.11 (0.45-0.65)	0.73 $\pm$ 0.14	0.95 $\pm$ 0.17 (0.80-1.07)	0.72 $\pm$ 0.19 (0.62-0.90)	0.76 $\pm$ 0.15
Ascorbic Acid (mg/dl)	0.65 $\pm$ 0.11 (0.45-0.79)	1.10 $\pm$ 0.14 (0.98-1.25)	1.70 $\pm$ 0.18	0.85 $\pm$ 0.18 (0.65-1.02)	1.32 $\pm$ 0.22 (1.15-1.45)	1.55 $\pm$ 0.16
Retinol (mg/dl)	22.5 $\pm$ 3.85 (19.60-24.20)	19.56 $\pm$ 2.28 (18.74-23.82)	0.86 $\pm$ 0.10	22.80 $\pm$ 3.86 (19.8-25.8)	20.80 $\pm$ 3.46 (18.92-25.62)	0.91 $\pm$ 0.12
β -Carotene (μ g/dl)	108.0 $\pm$ 10.30 (105.2-116.32)	100.0 $\pm$ 13.78 (97.2-111.4)	0.93 $\pm$ 0.11	111.72 $\pm$ 12.94 (106.60-118.41)	108.78 $\pm$ 8.02 (102.6-118.2)	0.97 $\pm$ 0.13
TBARS (nmol/ml)	2.97 $\pm$ 0.32 (2.42-3.53)	1.29 $\pm$ 0.24 (0.96-1.53)	0.43 $\pm$ 0.11	2.71 $\pm$ 0.29 (2.32-3.22)	1.07 $\pm$ 0.10 (0.88-1.32)	0.39 $\pm$ 0.12

DISCUSSION

Pregnancy is a physiological state accompanied by a high-energy demand and an increased oxygen requirement (9). As a result various compensatory adaptive changes occur with advancing pregnancy to meet the increasing demands for proper bodily

functions of mother to fulfill the requirement of fetus (2, 3, 4) and the increased oxygen demand is met by increased ventilation (10). Such conditions may be responsible for raised oxidative stress in pregnancy. In present study oxidative stress was significantly higher ($P<0.001$) in mothers as compared to age

Table II (b). Statistical Comparison of Nutrient Antioxidants level of mother and newborn weighing more than 2500 gms and less than 2500 gms

Statistical Comparison Between	α -Tocopherol	Ascorbic Acid	Retinol	β -Carotene	TBARS
Mothers of Newborns Weighing <2500 gm and >2500gm	t=5.67 p<0.001	t=4.24 p<0.001	t=1.78 p>0.05	t=1.92 p>0.05	t=1.32 p>0.05
Newborns Weighing <2500 gm and >2500gm	t=4.28 p<0.001	t=2.92 p<0.01	t=1.11 p>0.05	t=1.55 p>0.05	t=4.23 p<0.001
Mothers and Newborns Weighing <2500 gm	t=7.33 p<0.001	t=6.76 p<0.001	t=1.98 p>0.05	t=1.79 p>0.05	t=10.67 p<0.001
Mothers and Newborns weighing >2500 gm	t=4.11 p<0.001	t=8.21 p<0.001	t=1.52 p>0.05	t=1.87 p>0.05 p<0.001	t=11.29
p>0.05 not significant.					

Fig:1 Correlation of ascorbic acid between Mother and Newborn
 $r=+0.69$ ($p<0.001$)

Fig :2 Correlation of alpha Tocopherol between Mother & Newborn
 $r=+0.87$ ($p<0.001$)

matched non-pregnant women and at the same time antioxidant levels were found to be significantly low. This decrement in antioxidants may be ascribed due to a transient imbalance between higher antioxidant requirement and intake (11), metabolic demand (12), hemodilution (13) or a combination of these. When antioxidant status of newborn was compared with their mothers, newborns were found to have significantly higher levels of ascorbic acid while the concentration of lipid soluble antioxidants – α -tocopherol, retinol and β -carotene were less than the mother. However, at the time of birth peroxidative stress was surprisingly lowest in the newborn. Ascorbic acid is transferred across the placenta from the maternal circulation as dehydro ascorbic acid and is retained by the fetus after reduction to ascorbic acid, resulting in elevated level of vitamin C in cord blood. The ratio of ascorbic acid in newborn to mother was 1.6 in this study (Table 1). On the contrary limited permeability of lipid soluble antioxidants across the placenta lowers their concentration in cord blood (14, 15, 16). A positive correlation between mother and newborn levels of ascorbic acid and tocopherol indicates that the nutritional status of mother does influence antioxidant status of the newborn (17). This is further clear from the finding that mother deficient in antioxidants tends to produce newborn with relatively low levels of these antioxidants, so also to some extent oxidative stress in mother is reflected in newborn (Table 2). It is elucidated from the study that birth weight of the newborn has effect on antioxidant status or vice versa, as poor antioxidant status is reflected in low

birth weight. Newborn with birth weight < 2500 gm showed relatively greater oxidative stress measured by their MDA levels. A similar increase in peroxidative stress in low birth child has also been reported by Baydas et al (18).

It can be surmised that the newborn begins life with abundant supply of vitamin C that is not merely an overflow from the mother under obstetrical stress, indicating a compensatory mechanism in fetus endangered by oxidative stress. Low oxidative stress at time of birth in the face of low fat-soluble antioxidants suggests that the newborn begins life with minimum oxidative stress, and ascorbic acidemia protects the newborn against oxidative stress. However, the precise mechanism and physiological significance of raised vitamin C level in newborn still remains to be elucidated.

BIBLIOGRAPHY

1. Quanungo, S. Mukherjea, M. (2000) Ontogenic profile of some antioxidants and lipid per-oxidation in human placental and fetal tissues. *Mol. Cell. Biochem.* Dec, 215, (1-2): 11-9.
2. Clapp, J.F. (1988) Maternal physiological adaptation during early human pregnancy. *Am.J. Obstet Gynaecol.*
3. Pernoll, M.L., Metcalfe, J., Kovac, P.A. et al (1975) ventilation during rest and exercise in in

pregnancy & Post partum Respir, Physiol 25, 295.

4. Alaily, A.B. and Carral, K.B. (1978) Pulmonary ventilation in pregnancy. *Br. J. Obstet Gynaecol* 85; 518.
5. Lachilli, B., Hininger, I., Faure, H., Arnaud, J., Richard, M.J., Favier, A., Roussel, A.M. (2001) Increased lipid per-oxidation in pregnant women after Iron and vitamin C supplementation. *Boil. Trace. Elem. Res. Nov*, 83(2): 103-10.
6. Natelson, S. (1971) *Techniques of clinical chemistry* Charles C Thomas Springfield, Illinois USA: 162-65.
7. Barker, H. and Frand, O. (1968) In: *Clinical vitaminology, methods and interpretation*, Interscience publishers. Joh wiley and sons. Inc. New York. P 172.
8. Barry Halliwell and susanna Chirico (1993) Lipid Per-oxidation: its mechanism, measurement and significance. *Am. J. clin. Nutr.* 57(1): 7, 15 S-25 S.
9. Gitto, E., Reiter, R.J., Karbownik, M., Tan, D.X., Gitto, P., Barberi, S., Barberi, I. (2002) Causes of oxidative stress in the pre and perinatal period. *Biol. Neonate.* 81(3) 146-57.
10. John, B. West. (1991) *Best in Taylor's Physiological Basis of Medical Practice*, 12th ed, P.P. 894
11. Alberti-Fidanza, A., Di Renzo, G.C., Burini, G. Antonelli, G., Perriello, G. (2002) Diet during pregnancy and total antioxidant capacity in maternal and umbilical cord blood. *J. Matern. Fetal. Neonatal. Med.* Jul, 12(1) 59-63.
12. Soni, N.D., Sharma, Praveen., Kiran, C., Pramod, J., Kothari, L.K. (1989) Leucocyte and Serum Ascorbic acid levels in mothers and their newborn in semi arid western India. *Indian. J. Physiol. Pharmac.* 33, (4). 239-242.
13. Pritchard, J.A. (1965) Changes in the blood volume during pregnancy and delivery. *Anesthesiology.* 26, 393-9.
14. Khattab, A.K. et al (1970) Foetal maternal ascorbic acid gradient in normal Egyptian subjects. *J. Trop. Pediatr.* 17, 16. 112-5.
15. Ibeziako, P.A., Ette, S.I. (1981) Plasma ascorbic acid levels in Nigerian mothers and newborn. *J. Trop. Pediatr.* 27. 263-6.
16. Bohles, H. (1997) Antioxidative vitamins in prematurely and maturely born infants. *Int. J. Vitam. Nutr. Res.* 67(5). 321-8.
17. Yehum, K.J., Ferland, G., Party, J., Russel, R.M. (1998) Relationship of plasma carotenoids, retinol and tocopherols in mothers and newborn infants. *J. Am. Coll. Nutr.* Oct, 17(5). 442-7
18. Baydas, G., Karatas, F., Gursu, M.F., Bozkurt, H.A., Ilhar, N., Yasar, A., Canatan, H. (2002) Antioxidant vitamin levels in term and preterm infants and their relation to maternal vitamin status. *Arch. Med. Res.* May-Jun, 33(3). 276-80.