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Original Research Article

Assessment of oxidative stress markers and level of antioxidant in preeclampsia

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ABSTRACT

Introduction: In pre-eclampsia the pathophysiology is still under investigation. Lipid peroxidation is important for the normal endothelial cell function. The antioxidant like Vitamin E and vitamin C play a role in preventing preeclampsia.

Materials and Methods: We compare between serum malondialdehyde (MDA) level, a product of lipid peroxide and the antioxidant (vitamin C and E) in pregnant women with or without preeclampsia. Patient are divided to two group; Group 1 (n=50): pregnant women between 28 and 40 weeks' gestation with preeclampsia and Group 2(n=50): the control group includes pregnant women without hypertension episode during their pregnancy.

Result: Serum MDA levels were raised in women with preeclampsia compared with normal pregnancy ($P < 0.001$*). A positive correlation was seen between MDA level and both systolic and diastolic blood pressure in preeclamptic and normal pregnancies ($r_s = 0.693$, $p<0.001$*), ($r_s = 0.467$, $p<0.001$*) respectively. Vitamin C, E level show s highly significant decrease in Pre-eclamptic women than normal one ($p<0.001$*). Significant negative correlation between vitamin C level (mg/dl) and both systolic blood pressure and diastolic blood pressure ($P<0.001$*, $p<0.018$*) respectively. Significant negative correlation between vitamin E level (mg/dl) and both systolic blood pressure and diastolic blood pressure ($P <0.05$), ($P <0.05$) respectively.

Conclusion: These results provide further evidence that excessive lipid peroxidation level and decreases in vitamin E and C levels (which are responsible from antioxidant activity) may contribute to the pathophysiology and pathogenesis of preeclampsia.

1. Introduction

Preeclampsia defined as onset of hypertension and either proteinuria or edema after 20 weeks of gestation in previously normotensive women. It is multi system progressive disorder, with an increased risk for maternal and/or fetal mortality or serious morbidity.[1,2] The main treatment of the pre-eclampsia is the termination of the pregnancy. The risk–benefit ratio of induced preterm delivery and maternal–fetal complications is important factor in decision of the termination. So the early diagnosis women at high risk of preeclampsia are key issues in the management of pre-eclampsia.[3]

Pre-eclampsia has unknown pa thophysiology, the primary definite mechanism being abnormal placentation. Abnormal invasion of cytotrophoblast cells into the spiral arteries is the main pathophysiology in pre-eclampsia.[4,5] This abnormal invasion will Increased uterine arterial resistance result in higher sensitivity to vasoconstriction and thus chronic placental ischemia and oxidative stress. This chronic placental ischemia causes fetal complications, including intrauterine growth retardation and intrauterine death.[3,6]

Previous studies shows that oxidative stress had an important role in the pathophysiology of preeclampsia.[7,8] Reduced perfusion and ischemic reperfusion in placenta result in placental ypoxia and raised synthesis of the free radical in placenta.[9] In non pre-eclamptic women

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this free radicals in endothelial cells is neutralized by antioxidant molecules. During pregnancy alterations in maternal and fetal metabolism due to changes in the levels of various enzymatic and non-enzymatic antioxidants will affect pregnancy outcome. The potential causes of oxidative stress may be ascribed to a series of physiological changes, mineral deficiencies and increased oxygen consumption during pregnancy.[9]

Oxidative stress result due to imbalance between prooxidants and antioxidants, which favors oxidation. In all cells and tissues Lipid peroxidation occurs normally at low levels.[10] But in preeclampsia, an uncontrolled lipid peroxidation may occur and impair normal endothelial cell function. Still the exact mechanisms of vascular endothelial damage in preeclampsia under investigation by the authors, increased lipid peroxidation may lead to endothelial cell dysfunction.[11] Lipid peroxide is highly reactive and very damaging compound, arising as a consequence of tissue damage.[12] Hence, extensive lipid peroxidation will cause vascular endothelial cell damage.[13]

Antioxidants can be enzymatic or nonenzymatic. The enzymatic antioxidants include enzymes like superoxide dismutase, thioredoxin reductase, and glutathione peroxidase. The non-enzymatic antioxidants can be lipid soluble such as vitamin E or water-soluble such as vitamin C. A recent report indicated maternal plasma levels of vitamins C and E to be significantly associated with birth weight and length of live-born infants.[14]

Under normal conditions the toxic actions of lipid peroxides are opposed by variety of antioxidant mechanisms (e.g. vitamin E, C) which is a free radical scavenger and thus prevents the formation of lipid peroxides so protects tissue lipids from free radical attack, that result in stabilizing cell membranes. However, the balance of oxidant-antioxidant systems may be impaired in women with preeclampsia.

Vitamin C is an antioxidant because, by donating its electrons, so prevents other compounds from being oxidized, it also interacts with the tocopheroxyl radical and regenerate reduced tocopherol.[15] So it act as a scavenger of free radicals. Vitamin E consider as lipid peroxidation chain. It result in breaking antioxidant that inhibits NAD(P)H oxidase in the placental tissues. Another mode of action of vitamins C and E is the interact with glutathione-related enzymes which will result in control the production of lipid peroxidation products.[15] So that the level of vitamins E and C is important to maintain oxidative balance and the decrease in their level will lead to oxidative stress.[16] So some authors suggested the antioxidants supplementation. They supposed that by their sublimation the oxidative stress will decrease and vascular endothelial function will improved, so affect the course of preeclampsia.[17,18]

Malondialdehyde (MDA) it is a biomarkers of lipid peroxidation. Previous study show that it elevated in the plasma of women with preeclampsia, a major metabolite of lipid peroxide breakdown.[19] Few markers of antioxidative stress are performed to in preeclamptic women including glutathione (GSH), vitamin E and C.

Although scientific evidence indicated that free radicals and oxidative stress might play a significant role in preeclampsia, not all studies have produced consistent results about antioxidant balance in preeclampsia. While some studies reported a decreased level of enzymatic and non-enzymatic antioxidant,[20] other studies reported an increased level or even no difference in values of antioxidants in preeclamptic women.

The aim of this study was to evaluate oxidative stress status in preeclamptic and normal pregnancies by measuring serum malondialdehyde (MDA) levels, an end product of lipid peroxide. The reinforcement of antioxidant capacity is the body attempt to overcome oxidative stress during pregnancy. In view of these facts, the present study was planned to measuring the plasma antioxidants (Vitamin C and E level) to investigate the antioxidants level in preeclamptic women.

2. Materials and Methods

2.1. Study Design

The study was done a total of 100 pregnant women admitted to Tanta University Hospital, Obstetric and Gynecology Department. It is case control study A-Study group (Preeclamptic group):- include 50 Patients suffer from preeclampsia. B-Control group (Normal group) : include 50 pregnant cases medically free. The study was approved by the Tanta University ethics committee. All participants provided their informed consent before their involvement in this study after being informed about the objectives of the study.

2.2. Inclusion Criteria

50 preeclamptic patients and 50 normotensive pregnant women, within the age range of 20-35 years. All the women were in their third trimester of pregnancy. As for the studying group Subjects with blood pressure $>$ 140/90mmHg, proteinuria and edema were included. Normal pregnant women, diagnosed on clinical and ultrasonography findings were taken as controls. Patients and controls were matched for gestational age and maternal age. The body mass index for both groups was less than 30 kg/m2.

2.3. Exclusion Criteria

Elderly primigravid subjects, gestational diabetics, renal diseases, liver diseases, cardiovascular disease, severe anemia, systemic or endocrine disorders, chronic hypertension and multiple gestations were excluded from the study.

Subjects also had to be nonsmokers, nonalcoholics, not suffering from any acute infections and none were taking aspirin or receiving vitamin E therapy.

2.4. Sample Collection

Ten mL of venous blood was collected in EDTA bottles using disposable syringes, after an overnight fast of 12 hours. Plasma was separated and analyzed for MDA, vitamin C and Vitamin E by calorimetric method as following:

2.5. Measurement of MDA

Thiobarbituric Acid (TBA) reacts with Malondialdhyde (MDA) in acidic medium at temperature of 95^0 C for 30 min to form thiobarbituric acid reactive product the absorbance of the resultant pink product can be measured at 534 nm.

Prepare three clean test tubes for Blank, Standard and Sample. Add 1.0 ml of Chromogen Reagent for all tubes. Then add 0.2 ml of Standard solution to the Standard tubes, 0.2 ml of Serum to the Sample tubes. Mix well, Cover the test tubes with glass bead, heat in boiling water bath for 30 min, Cool, then Add 0.2 ml of serum to the Blank tubes. Read the absorbance of sample against blank and standard against dist. Water at 534nm. Malondialdhyde (nmol /ml) = $A_{Specimen}$ / $A_{Standard}$ x 10.

2.6. Measurement of Vitamin C

Vitamin C assay quantifies the vitamin C in serum or plasma based on an enzymatic method. Ascorbate Oxidase catalyzes the oxidation of L-Ascorbate (vitamin C to generate hydrogen peroxide. Peroxidase catalyzes the hydrogen peroxide and the unique chromogen to form blue dye, which enables high sensitive measurement.

Prepare three clean test tubes for Blank, Standard and Sample. Add 0.3 ml of Chromogen Reagent (R1) for all tubes. Add 5 μl of Standard solution for Standard tubes and 5 μl of Serum for Sample tubes. Mix well, then Incubation at 37°C for 5 min, then add 150 μl of Enzyme Reagent (R2) to all tubes. Mix well, then Incubation at 37°C for 5 min, then measure at 2-endpoint, 660/700 nm. Assay Range: (0.5 – 5.0) mg/dl.

2.7. Measurement of Vitamin E

Vitamin E was determined by fluorometric measurement of tocopherol in serum. 1 mL of double-distilled water and 1.0 mL of ethanol were added to 0.2 mL serum and mixed thoroughly. 5 mL of n-hexane was added and the samples vigorously shaken for 1 min. Samples were centrifuged at 1000 rpm for 5 min, and the hexane phase was separated and analyzed for tocopherol with a fluoro-spectrophotometer at an excitation of 295 nm and an emission of 320 nm. DL-a-Tocopherol was used as standard and double-distilled water as control.

2.8. Statistics

Statistical analysis was performed using Student t test and linear regression analysis. Data were expressed as mean ± standard deviation (X ±+ S.D.). P value < 0.05 consider significant.

3. Results

3.1. Demographic Character

Patients and controls Women were similar regarding baseline demographic characteristics regarding to age, weight, BMI, and gestational age (Table 1). The mean gestational age at the time of sampling show no statically difference between two groups (p = 0.3) based on ultrasound results. The mean age of women between two groups s how insignificant difference (P=0.07). Also the mean BMI in both groups show insignificant deference (p = 0.07). Also there is no difference in parity in both groups.

3.2. Blood Pressure

Blood pressure, a diagnostic criterion for preeclampsia, was analyzed in both groups. Blood pressure was significant increase in pre eclampsia compared to controls. As regard to systolic BP the main systolic BP in pre eclampsia group was *143.7±5.25* and in control group 123.5±6.73 (P=0.001*). And for diastolic blood pressure in preeclampsia group it was *94.5 ±5.26* and in control group it was 73.45±4.33 (P <0.001*).

3.3. Serum MDA, Vitamin C, Vitamin E

Serum MDA levels were significantly greater in women with preeclampsia than in women with uncomplicated pregnancy (p<0.001*). Statistical analysis of the Mean ± SD of Vitamin C Acid level (mg/dl) in Normal pregnant female (2.77±1.07) and Pre-eclamptic female (0.32±0.10), Shows statistically highly significant decrease in Vitamin C level in Pre- eclamptic women (p<0.001*). Vitamin E levels were significantly increased in normotensive pregnant women (0.97±0.75 mg/dL) as compared with (0.33±0.40 mg/ dL) in preeclamptic women (P <0.001*) (Table 3)

3.4. Correlation Analysis

Pearson's correlation analysis was carried out between the results of serum level of (MDA -Vitamin C-Vitamin E) and (systolic –diastolic blood pressure) measurement. Results are summarized in Table 4 (Figures 1, 2, 3, 4, 5 and 6)

Significant positive correlation between MDA level (nmol/dl) and both systolic and diastolic blood pressure (r_s =0.693, p=0.001*), (r_s =0.467, p<0.001*) respectively.

Table 1: Demographic profile of subjects. Data are presented as mean ± standard deviation. BMI = body mass index

Mean ± SD	**Pre-Eclampsia (N=50)**	**Control (N=50)**	
Age (YS)	28.4±2.7	27.5±2.3	0.075
Parity	2± 1	2 ±1	
BMI (kg/m2)	31.2±3.4	29.3±2.2	0.07
Gestational age at the Sampling (WK)	33.3 ± 3.6	34.3 ± 0.8	0.3

Table 2: Blood pressure (BP) of subjects. *Data are presented as mean ± standard deviation; (p * < 0.05)*

	Pre-Eclampsia (N=50)	**Control (N=50)**	*p*
Systolic BP	143.7±5.25	123.5±6.73	0.001*
Diastolic BP	94.5±5.26	73.45±4.33	<0.001*

Table 3: Serum MDA, Vitamin C, Vitamin E in normal pregnancy and preeclampsia

	Pre-Eclampsia (N=50)	**Control (N=50)**	
MDA (nmol/ml)	12.38 ± 5.43	4.9± 1.18	<0.001*
Vitamin C (mg/dl)	0.32± 0.10	2.77± 1.07	<0.001*
Vitamin E(mg/dl)	0.33± 0.40	0.97± 0.75	<0.001*

Table 4: Correlation between Serum MDA, Vitamin C, Vitamin E and (systolic– diastolic) blood pressure in preeclamptic patient

	Systolic		Diastolic	
	r	P-value	r	P-value
MDA	0.693	<0.001*	0.467	<0.001*
Vitamin C	-0.517	<0.001*	-0.337	0.018*
Vitamin E	-0.303	<0.05*	-0.348	<0.05*

As for vitamin C Significant negative correlation between vitamin C level (mg/dl) and systolic blood pressure (P<0.001*), and diastolic blood pressure (p=0.01*).

Also Significant negative correlation between Vitamin E level (mg/dl) and both systolic and diastolic blood pressure (p=0.05*), (p<0.05*) respectively.

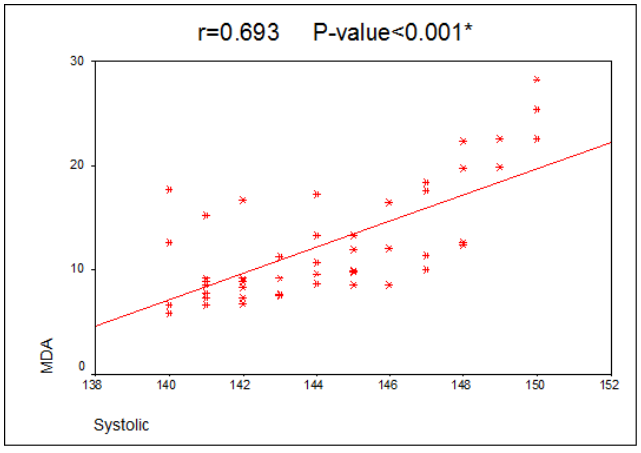

Fig. 1: Correlation between MDA level and systolic blood pressure measurement. It is positive correlation with P<0.001.

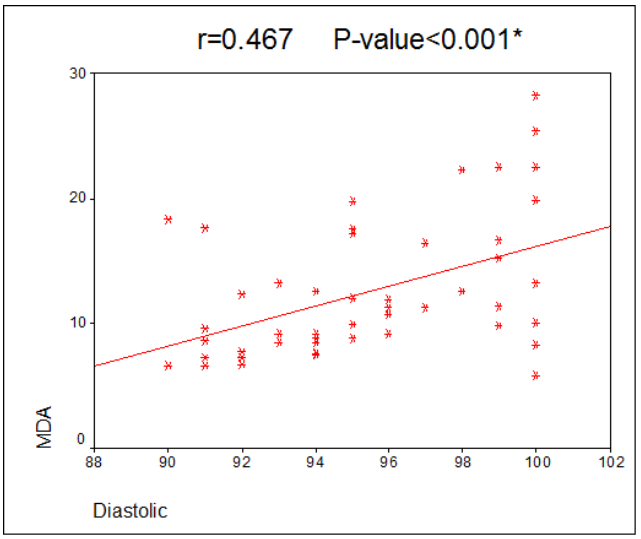

Fig. 2: Correlation between MDA level and diastolic blood pressure measurement. It is positive correlation with P<0.001.

4. Discussion

Preeclampsia is a hypertensive disorder of pregnancy.[21] A lot of effort was done to diagnose the exact mechanism of preeclampsia. The free-radicals play an important role in this pathophysiology. It has been suggested that this may be due to increased cell turn over or due to decreased

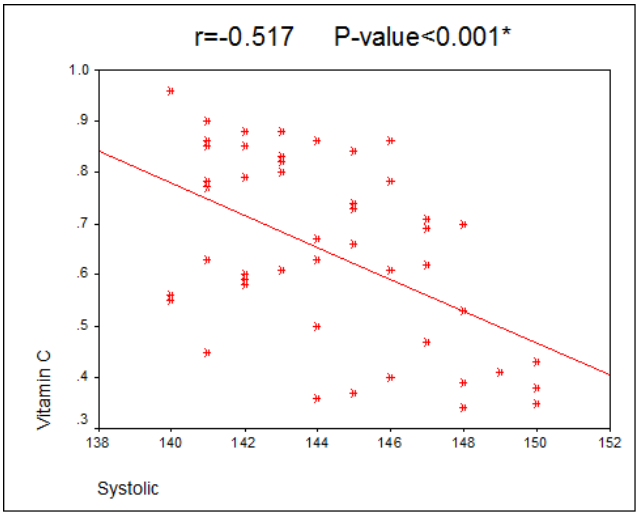

Fig. 3: Correlation between Vitamin C level and systolic blood pressure measurement. It is negative correlation with P<0.001.

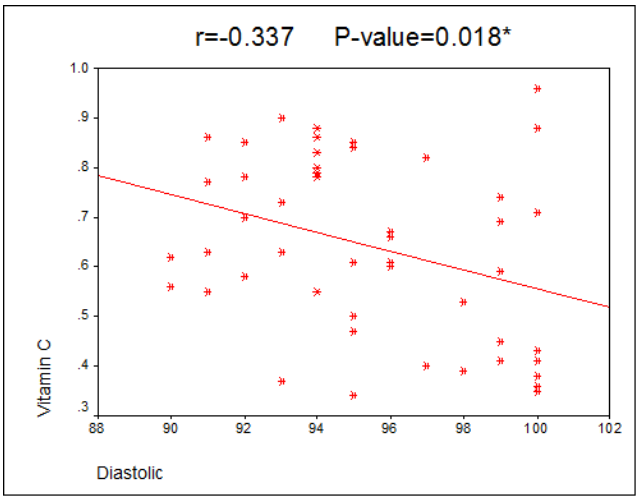

Fig. 4: Correlation between Vitamin C and diastolic blood pressure. It is a negative correlation with P<0.01

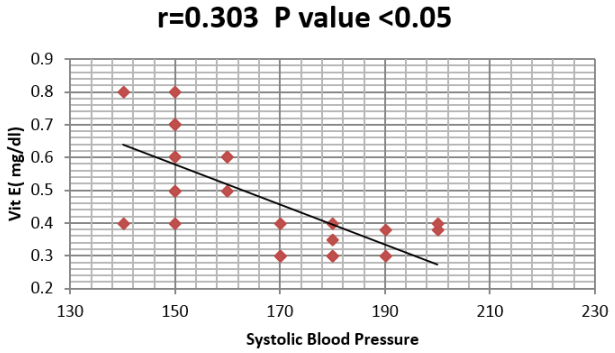

Fig. 5: Correlation between Vitamin E level and systolic blood pressure measurment. It is a negative correlation with P<0.05

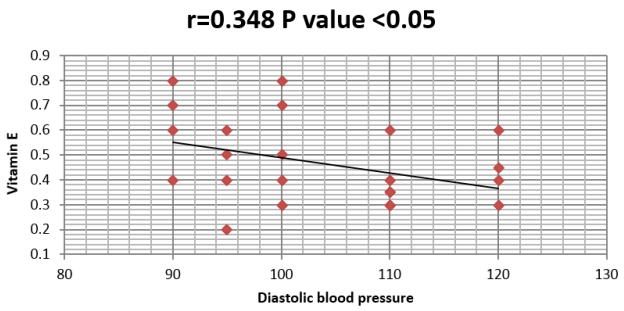

Fig. 6: Correlation between Vitamin E and diastolic blood pressure. is a negative correlation with P<0.05

antioxidant free-radical scavenging mechanisms.[22] It is not well clear whether oxidative stress and antioxidant insufficiency are the direct cause of preeclampsia or secondary consequence of preeclampsia. Determination of the level of various antioxidants or the oxidative stress end products offers guidelines for the diagnosis and management of preeclampsia. So will decrease maternal and fetal mortality.

Our study was carried on 100 cases 50 of them are normal pregnant women and 50 pre-eclamptic women with no statistical significant difference between the patient and control group as regard age, parity, gestational gage at time of sampling and body mass index ($P < 0.05$) As regard systolic and diastolic blood pressure there are significant difference between normal and pre-eclamptic group (P<0.001*).

The malondaialdehyde (MDA) in preeclamptic women is significantly increased as compared to control group ($p < 0.001$*). Also the association between MDA level and blood pressure was analyzed in pre-eclamtic women. Positive correlation was reported between MDA level and blood pressure (both the systole and the diastole). Based on previous reports, MDA is always more elevated in the blood of pregnant women who suffer from preeclampsia. MDA level might be a causative factor for pathogenesis of preeclampsia.

These finding come in agreement with other author as Sheena PS,[23] Kashinakunti SV),[24] xSahu S,[25] Jaweed SA,[26] Phalak[22] and Shikha.[27] All these found that there are significant increase MDA in preeclamptic women in comparison with normal one. However, increased lipid peroxidation products were reported in both normal pregnancy and preeclampsia as compared with nonpregnant women.[28,29] Furthermore, high statistic difference in MDA level was reported in pregnant women with sever and mild pregnancy-induced hypertension.[30]

Other study aim to determine the association of severity of PIH and serum malondialdehyde (MDA) and serum uric acid level. It shown that Serum MDA and uric acid level was significantly elevated (p<0.001) in PIH subjects than

normal one.[24]

In a new study done by Draganovic D, the correlation of a lipid peroxidation marker, with ultrasound and cardiotocography parameters were analyzed in pregnancy induced hypertension. It is supposed that MDA could be used for assessment of hypertensive pregnant women and decisions on pregnancy termination period.[31]

The antioxidant capacity in the body overcomes oxidative stress during pregnancy. In view of these facts, the present study also investigates the level of antioxidants in pre-eclamptic women. Antioxidant vitamins, especially vitamin E and C had been investigated in this study. Vitamin C hunts free radicals, and the vitamin E prevent the formation of lipid peroxides and thus protect cell membranes.

Vitamin C has been proposed as a first-line defense in the aqueous phase protecting lipoproteins from peroxidation by a wide spectrum of free radicals. In our study vitamin C show significant increase in normal pregnant women as compared to preeclamtic women (P<0.001*). Also our study showed negative correlation between Vitamin C level and systolic and diastolic blood pressure. As for Vitamin E, which is the most important chain breaking antioxidant, our study show increase in normal pregnant women as compared to preeclamtic women (P<0.001*). Also our study showed negative correlation between Vitamin E level and systolic and diastolic blood pressure. Increases in lipid peroxides in preeclampsia could increase consumption, resulting in the decreased vitamin E levels. Another possibility is decreased absorption of vitamin E from the gut as a result of the vasoconstriction of preeclampsia. The antioxidant vitamins level decrease supports the hypothesis that lipid peroxidation is an important causative factor in the pathogenesis of preeclampsia. Measurement of vitamin C and E concentration in plasma may be useful as a prognostic marker of pre-eclampsia.

These finding come in agreement with Mohantys,[32] RAO[33] and Bargale[34] who observed that level of antioxidant as vitamin C and vitamin E are decreased in serum of preeclamptic women. They also study the correlation between oxidative stress and initiation of pathogenesis of pregnancy induced hypertension (PIH). They also subgouped the cases as severe preeclampsia and mild pre-eclampsia. All of them were show the same result for serum malondialdehyde (MDA), Serum vitamin E and plasma vitamin C levels as in our study.

Other studies conducted with other author as Sheena,[23] Padalkar,[35] Howlader[36] and Sakar[37] who revealed that plasma ascorbate level decrease gradually through normal pregnancy and decrease more and more in preeclampsia as compared to normal pregnancy.

In the meta-analysis done on oxidative stress markers and antioxidants marker in preeclampsia, vitamin E level was significantly reduced in pre-eclamptic women as compared to normal pregnant women. Lower level of vitamin C was also found in pre- eclamptic women compared to normal pregnant women. Also an increased level of MDA was observed in this meta-analysis.[38] Another meta-analysis by Cohen JM et al. (2015), show that vitamins A, C, and E have negative association with overall analysis between pre-eclamptic women and control group.[39]

Oxidative stress will also affect preterm infants. These infant may suffer from intra-ventricular hemorrhage, the respiratory distress syndrome, chronic lung disease, anecrotizing enterocolitis and retinopathy of prematurity.[40] So prophylactic antioxidants may prevent oxidative stress so reduce the risk perinatal complications in their infants as well as decrease preeclampsia in their mothers. The study done by Scholl reported that vitamin C and vitamin E supplementation did not only associated with reduced risk for preeclampsia but also is associated with increased rate of low weight birth nascent.[41] Dehghan compare the incidence of the preeclampsia. He shown that pre-eclampsia is less in the group that received vitamin C and vitamin E, compared with the placebo group.[42] Spinnato,[43] who used multiple antioxidants such as Vitamin C, and other antioxidant as selenium, zinc, magnesium, coenzyme Q, and melatonin have been also used with encouraging results in decreasing the incidence of preeclampsia. A more recent study, not encourage the routine use of antioxidants against pre-eclampsia as they proposed the inefficiency of antioxidant therapy in the treatment of preeclampsia.[44] This may be probably because the condition was already too advanced.

5. Conclusion

In general, the combination of elevated lipid peroxidation markers and decreased antioxidant capacity provides a clear indication of the presence of oxidative stress. The oxidative stress might be a potential risk factor for initiation of preeclampsia because of inability of antioxidant like Vitamin C, E to neutralize free radicals and increased levels of oxidative stress products. We proved in our study the increased products of oxidative stress in preeclampsia and may be an underlying mechanism for endothelial dysfunction in pre-eclamptic women. The data of this study, however, support the hypothesis that the concentrations of oxidants are raised in preeclampsia compared with that of a normal pregnancy. The measurement of MDA and Vitamin E, C in the preeclamptic patient give an idea about severity of the disease and important in early detection of preeclampsia.

6. Abbreviation

- MDA Malondialdehyde
- PIH Pregnancy induced hypertension
- BMI Body Mass index

- GSH Glutathione
- TBA Thiobarbituric Acid

7. Source of funding

None.

8. Conflict of Interest

None.

References

1. Sibai BM, Caritis S, Hauth J. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. What we have learned about pre-eclampsia. *Semin Perinatol*. 2003;27:239–239.
2. Hutcheon JA, Lisonkova S, Joseph KS. Epidemiology of pre-eclampsia and the other hypertensive disorders of pregnancy. *Best Pract Res Clin Obstet Gynaecol*. 2011;25:391–391.
3. Osmond C, Kajantie E, Forsén TJ, Eriksson JG, Barker DJ. Infant growth and stroke in adult life: the Helsinki Birth Cohort Study. *Stroke*. 2007;38:264–270.
4. Genbacev O, Difederico E, Mcmaster M, Fisher SJ. Invasive cytotrophoblast apoptosis in pre-eclampsia. *Hum Reprod*. 1999;14:59–66.
5. Fisher SJ, Mcmaster M, Roberts M. Chesley's Hypertensive Disorders in Pregnancy, The placenta in normal pregnancy and pre-eclampsia. vol. 5. Amsterdam, the Netherlands: Academic Press Elsevier ; 2009,.
6. Kayem B, Deis G, Sibai S, BM. Are perinatal and maternal outcomes different during expectant management of severe pre-eclampsia in the presence of intrauterine growth restriction? *Am J Obstet Gynecol*. 2007;196:237–237.
7. Roberts JM, Gammill HS. Preeclampsia: recent insights. *Hypertens*. 2005;46:1243–1252.
8. Sibai B, Dekker G, Kupferminc M. Pre-eclampsia. *Lancet*. 2005;365:785–799.
9. Sikkema JM, Rijn BBV, Franx A, Bruinse HW, Roos RD, Stroes ES. Placental superoxide is increased in pre-eclampsia. *Placenta*. 2001;22:304–308.
10. Slater TF. Lipid peroxidation and intracellular messengers in relation to cell injury. *Agents Actions*. 1987;22:333–334.
11. Davidge ST, Signorella AP, Hubel CA. Distinct factors in plasma of pre-eclamptic women increase endothelial nitric oxide or prostacyclin. *Hypertens*. 1996;28:758–764.
12. Hennig B, Chow CK. Lipid peroxidation and endothelial cellinjury: implication in atherosclerosis. *Free Radic Biol Med*. 1989;4:99–106.
13. Hubel CA, Roberts JM, Taylor RN, Musci TJ, Rogers GM, Mclaughkin MK. Lipid peroxidation in pregnancy: new perspectives on preeclampsia. *Am J Obstet Gynecol*. 1989;161:1025–1034.
14. Lee BE, Hong YC, Lee KH. Influence of maternal serum levels of vitamins C and E during the second trimester on birth weight and length. *Eur J Clin Nutr*. 2004;58:1365–1371.
15. Hassan GI, Onu AB. Total serum vitamin C concentration in pregnant women: implications for a healthy pregnancy. *Rev Bras Saúde Matern Infant*. 2006;p. 293–296.
16. Rodrigo R. Pathophysiological basis for the prophylaxis of preeclampsia through early supplementation with antioxidant. *Pharmacol Ther*. 2005;107:177–197.
17. Gubory KH, Fowler PA, Garrel C. The roles of cellular reactive oxygen species, oxidative stress and antioxidants in pregnancy outcomes. *J Biochem Cell Biol*. 2010;42:1634–50.
18. Ghulmiyyah L, Sibai B, Semin P. Maternal mortality from preeclampsia/ eclampsia ; 2012,.
19. Patil SB, Kodliwadmath MV, Kodliwadmath SM. Study of oxidative stress and enzymatic antioxidants in normal pregnancy. *Indian J Clin Biochem*. 2007;22(1):135–137.
20. Jain SK, Wise R. Relationship between elevated lipid peroxides, vitamin e deficiency and hypertension in preeclampsia. *Mol Cell Biochem*. 1995;151:33–38.
21. Patil BS, Mallikarjun VK, Sheela MK, Mamatha BP. Lipid Peroxidation and Non Enzymatic Antioxidants Status in Preeclampsia and Postpartum Preeclamptic Women. *Natl J Basic Med Sci*. 2012;3(1):39–43.
22. Phalak P, Kulkarni J, Tilak M, Thorat AP. Role of lipid peroxidation and antioxidant status in pathogenesis of Pre-eclampsia. *Basic Appl Med Res*. 2013;6(2):536–539.
23. Sheena PS. Comparative study of oxidative stress in pregnancy induced hypertension preeclampsia and eclampsia. *Int J Biomed Adv Res*. 2012;3(11):810–814.
24. Kashinakunti SV, Sunitha H, Gurupadappa DS, Shankarprasad, Suryaprakash G, Ingin JB. Lipid peroxidation and antioxidant status in preeclampsia. *Al Ameen J Med Sci*. 2010;3(1):38–41.
25. Sahu S, Abraham R, Vedavalli R, Daniel M. Study of lipid profile, lipid peroxidation and vitamin E in pregnancy induced hypertension. *Indian J Physiol Pharmacol*. 2009;53(4):365–374.
26. Jaweed SA, Bhavthankar SS, Thorat AP. Increased lipid composition; increase lipid peroxidation and decrease antioxidant activity in pre-eclampsia. *Antiseptic*. 2008;105(7):326–338.
27. Shikha S, Prem C, Srivastava KV, Das BT, Mallick AK. Study of Serum Malondialdehyde and uric acid in Pregnancy Induced Hypertension and its medico-legal significance. *J Indian Acad Forensic Med*. 2014;36(1):55–60.
28. Wang YP, Walsh SW, Guo JD, Zhang JY. Maternal levels of prostacyclin, thromboxane, vitamin e, and lipid peroxides throughout normal pregnancy. *Am J Obstet Gynecol*. 1991;165:1690–1694.
29. St, Hubel CA, Brayden RD, Capeless EC, Mclaughlin MK. Sera antioxidant activity in uncomplicated and preeclamptic pregnancies. *Obstet Gynecol*. 1992;79:897–901.
30. Draganovic D, Lucic N, Jojic D. Oxidative stress marker and pregnancy induced hypertension. *Med Arch*. 2016;70:437–440.
31. Draganovic D, Lucic N, Jojic D, Milicevic S. Correlation of oxidative stress markers with ultrasound and cardiotocography parameters with hypertension induced pregnancy. *Acta Inf Med*. 2017;25:19–23.
32. Mohanty S, Sahu PK, Mandal MK, Mohapatra PC, Panda A. Evaluation of oxidative stress in pregnancy induced hypertension. *Indian J Clin Biochem*. 2006;21(1):101–105.
33. Rao GM, Sumita P, Roshni M, Ashtagimatt MN. Plasma antioxidant vitamins and lipid peroxidation products in pregnancy induced hypertension. *Indian J Clin Biochem*. 2005;20(1):198–200.
34. Bargale A, Ganu J, Trivedi D, Nagane N, Mudaraddi R, Sagare A. Serum Hs-CRP and uric acid as indicator of severity in Preeclampsia. *IJPBS*. 2011;2(3):340–345.
35. Padalkar RK, Suryakar AN, Kambale PS, Zende PD, Patil SM, Pandhare VR. Oxidative stress and antioxidant status in pre-eclampsia and eclampsia: an application to forensic significance. *Indian J Forensic Med Pathol*. 2009;2(1):13–15.
36. Howlader ZH, Tamanna S, Parveen S, Shekhar HU, Alauddin M, Begum F. Superoxide dismutase activity and the changes of some micronutrients in preeclampsia. *BJMS*. 2009;15(2):107–113.
37. Sarkar P, Jayaram S. Estimation of primary enzymatic antioxidants in pregnancy induced hypertension. *J Krishna Inst Med Sci Univ*. 2013;55:77–86.
38. Taravati FF, Tohidi. Comprehensive analysis of oxidative stress markers and antioxidants status in preeclampsia. *Taiwanese J Obstet Gynecol*. 2018;57:779–90.
39. Cohen JM, Beddaoui M, Kramer MS, Platt RW, Basso O, Kahn SR. Maternal antioxidant levels in pregnancy and risk of preeclampsia and small for gestational age birth: A systematic review and meta-analysis. *PloS One*. 2015;10:135192–135192.
40. Rumbold AR. Vitamins C and E and the Risks of Preeclampsia and Perinatal Complications. *New Engl J Med*. 2006;354:17–17.
41. Scholl TO, Chen X, Sims M, Stein TP. Vitamin e: maternal concentrations are associated with fetal growth. *Am J Clin Nutr*. 2006;84:1442.
42. Dehghan MH, Dehghan R. Plasma level of vitamin C in women with preeclampsia in Ardabil, Iran. *Iranian J Reprod Med*. 2006;4(1):35–39.

43. Sharma JB, Kumar A, Kumar A, Malhotra M, Arora R, et al. Effect of lycopene on pre-eclampsia and intrauterine growth retardation in primigravidas. *Int J Gynaecol Obstet*. 2003;81(3):257–262.
44. Williamson RD, Mccarthy C, Mccarthy FP, Kenny LC. Oxidative stress in preeclampsia; have we been looking in the wrong place? *Pregnancy Hypertens*. 2017;8:1–5.

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