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Original Article

Biochemistry Section

Serum Lipid Profile Parameters as Markers of Oxidative Stress in Preeclampsia- A Case-control Study

APURVA SAKARDE[1], JYOTI JOHN[2], ASHOK KUMAR AHIRWAR[3], VAIJAYANTI HARDAS[4]

ABSTRACT

Introduction: Many hypotheses have been postulated in the pathogenesis of preeclampsia. Among these, the theory of placental ischaemia giving rise to Reactive Oxygen Species (ROS) and thus causing oxidative stress is still being explored. This oxidative stress by the ROS may be further accentuated in the presence of hyperlipidaemia via the production of various lipid peroxidation products.

Aim: To assess the serum lipid profile parameters and serum Malondialdehyde (MDA) levels in normotensive pregnant and preeclamptic patients and to study the association of deranged lipid profile with oxidative stress in patients of preeclampsia. Also, to correlate these parameters with the severity of preeclampsia.

Materials and Methods: The present study was a case-control study carried out in the Department of Biochemistry, Government Medical College and Hospital, Aurangabad, Maharashtra, India, from January 2014 to October 2015. The study included 50 normotensive pregnant women (control group) and 100 preeclamptic women further grouped into 50 cases of mild preeclampsia and 50 cases of severe preeclampsia with >20 weeks of gestation. Serum lipid profile, along with markers of oxidative stress viz., serum MDA were estimated in all groups. Data were analysed applying unpaired t-test and Pearson's correlation test among various lipid profile parameters and serum MDA levels in the two groups of cases.

Results: There was no significant difference in age and Period Of Gestation (POG) at the time of sample collection between all three groups. There was a significant rise in serum Total Cholesterol (TC) (210±20 and 240±41 mg/dL in group II and group III), Triacylglycerol (TAG) (180±22 and 190±24 mg/dL in group II and group III), Low Density Lipoprotein-Cholesterol (LDL-C) (140±20 and 170±40 mg/dL in group II and group III), Very Low Density Lipoprotein-Cholesterol (VLDL-C) (35±4.4 and 38±4.8 mg/dL in group II and group III) in the study group as compared to controls. Also, the serum levels of MDA were found to be significantly increased in the study groups as compared to controls.

Conclusion: Deranged lipid profile status was found to be significantly associated with oxidative stress in preeclampsia.

Keywords: Dyslipidaemia, Hypertensive disorders of pregnancy, Lipid mperoxidation, Malondialdehyde, Reactive oxygen species

INTRODUCTION

The preeclampsia is a disease of pregnancy complicating about 5-10% of all pregnancies across the world [1]. The World Health Organisation (WHO) states that preeclampsia is the direct cause of 70,000 maternal deaths and 500,000 infant deaths annually worldwide [2].

Oxidative stress, inflammatory changes, immunological intolerance between maternal and foetal tissues are some of the postulated theories regarding preeclampsia. Although, many hypotheses have been stated in relation to the pathophysiology and aetiology of preeclampsia, the exact cause still remains an enigma and is incompletely understood. Of the many hypotheses postulated, the theories of placental ischaemia along with its secondary outcome of production of ROS and various lipid peroxidation products which is accentuated in the presence of hyperlipidaemia is still being explored [3].

Many studies have although found an association between lipid profile parameters and markers of oxidative stress [4,5], however, there is still a gap in terms of estimating the severity of preeclampsia with the amount of oxidative stress. Hence, the present study was conducted to check the correlation of the marker of oxidative stress i.e., MDA and the serum lipid profile status in patients with mild and severe preeclampsia, such that the severity of preeclampsia and its propensity to land into eclampsia can be predicted.

MATERIALS AND METHODS

The present case-control study conducted in the Department of Biochemistry, Government Medical College and Hospital, Maharashtra, India, from January 2014 to October 2015. Permission of the Institutional Ethical Committee (IEC) was sought prior to the study (IEC No. Pharma/IEC-GMCA/79/2014).

Inclusion criteria: Cases were selected from the already diagnosed cases of preeclampsia, who were previously normotensive and non proteinuric subjects were included in this study.

Exclusion criteria: Patients with preeclampsia in previous pregnancy, family history of preeclampsia/eclampsia, multiple (twin, triplet etc.,) pregnancy, molar pregnancy, pre-existing hypertension, renal or hepatic disease, diabetes mellitus, any autoimmune or thyroid disorder, any haemolytic disease or haemoglobinopathy, on lipid lowering drug therapy or history of smoking, alcoholism. Subjects with a history of oral contraceptive pill use and those developing hypertension at any time during the Antenatal Care (ANC) follow-up were excluded.

Sample size calculation: Sample size was calculated using Open EPI software. The mean of serum MDA was predicted as 3.15 nmol/mL and SD=0.28 nmol/mL in mild preeclampsia group and mean serum MDA as 1.85 nmol/mL and SD= 0.18 nmol/mL in healthy pregnant control group. The power of study was taken as 80%, confidence interval as 95% and chance of error as 5% [6]. The total sample size on calculation was 50 in each arm. Total sample size was taken 150-50 controls (group I) and 100 cases. Cases were

further subdivided into two groups- mild preeclampsia (50 cases) and severe Preeclampsia (50 cases).

Study Procedure

The diagnostic criteria employed for the classification of the cases into mild and severe preeclampsia was based on the guidelines given by National High Blood Pressure Education Programme (NHBPEP) working group on high Blood Pressure (BP) in pregnancy [7].

Group I (controls): A 50 normotensive and non proteinuric healthy pregnant women in the age group of 18-35 years, attending the Outpatient Department (OPD) of Obstetrics, Government Medical College for regular ANC check-up were included as controls.

Group II (cases of mild preeclampsia PE): Consisted of preeclamptic women in the age group of 18-35 years, with a single gestation of >20 weeks, having a systolic BP of >140 but ≥160 mmHg and a diastolic BP of >90 but ≥110 mmHg evident on atleast two occasions atleast six hours apart and a 24 hours urinary protein excretion of 0.3 gm corresponding to 1+ dipstick or greater in two random samples collected four or more hours apart [7].

Group III (cases of severe preeclampsia): Consisted of preeclamptic women in the age group of 18-35 years, with a single gestation of >20 weeks, having a systolic BP of 160 mmHg and a diastolic BP of 110 mm Hg on two occasions six or more hours apart and 24 hours urinary protein excretion of 5 gm or more or 3+ dipstick or greater on two random samples collected four or more hours apart. Other signs and symptoms of multiorgan involvement such as vision disturbances, headache, epigastric pain etc., may be present [7].

All cases and controls were matched for age and POG. While recording BP the subject was given a left lateral position at 45° to the horizontal and BP was measured in the right arm. In case of OPD patients, BP was measured in sitting position with the occluded brachial artery coming at the level of the heart. Korotkoff phase V was used to define diastolic pressure [7]. History was taken regarding parity, any significant past or present illness, history of medications and family history. Age and POG at the time of sampling was recorded.

Blood collection: After obtaining a written informed consent and taking all aseptic precautions, 5 mL of fasting venous blood sample was collected from all participants in plain vacutainers. Serum was separated after half an hour by centrifugation at 3000 Revolution Per Minute (RPM) for 10 minutes.

After obtaining all the daily internal quality control results within range, all samples were tested on Erba Chem-5 semiautomatic analyser for serum lipid profile parameters i.e., serum TC, Serum TAG and serum High Density Lipoprotein (HDL-C). Serum VLDL-C was estimated by Friedewald's equation [8] i.e.,

VLDL (mg/dL)=TAG (mg/dL)/5 and

LDL-C by the formula- LDL (mg/dL)=TC-(HDL+VLDL)

Wherever serum TAG was >400 mg/dL, direct LDL-C was estimated in serum [8]. All reagent kits used belonged to Agappe Diagnostics Diagnostics, India. The reference ranges taken into account for all the parameters as per the kit inserts [9-11] are detailed in [Table/Fig-1].

Parameter	Method	Reference range
Serum total cholesterol	Cholesterol oxidase-peroxidase	<200 mg/dL
Serum TAG	Glycerol phosphate oxidase-trinder	<150 mg/dL
Serum HDL-C	Cholesterol oxidase-peroxidase	42-88 mg/dL
Serum VLDL-C	Friedewald's equation	2-30 mg/dL
Serum LDL-C	Friedewald's equation	<130 mg/dL

[Table/Fig-1]: Methods and reference ranges for lipid profile parameters.

Serum MDA was estimated by manual method developed by Satoh K, which employs the principle of auto-oxidation of unsaturated fatty acids [12]. The semi stable peroxides formed in the process produce MDA on going through a series of reaction. The MDA formed reacts with thiobarbituric acid of the reagent to form a pink coloured chromogen which is extracted with 4 mL of n-butyl alcohol and the absorbance measured at 530 nm. Standard curve was plotted and the test values obtained were expressed in nmol/mL. Normal range of serum MDA was taken as 2-8 nmols/ mL.

STATISTICAL ANALYSIS

Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) software, 21st version (IBM, USA) and GraphPad Prism (USA). The data obtained were showing normal distribution on the basis of histogram. Demographic and biochemical characteristics of all the participants were analysed as mean±Standard Deviation (SD). Unpaired t-test was applied to analyse the differences of studied characters in study groups. The p-value was obtained from the unpaired t-test and interpreted as: >0.05 not significant, <0.05 significant and <0.001 highly significant. Correlation co-efficient (r) were calculated by applying Pearson's correlation test among various parameters of mild and severe preeclampsia groups. Positive and negative r values were interpreted as: r=0 (no correlation), r=0 to 0.3 (poor correlation), r=0.3 to 0.7 (considerable correlation) and r=0.8 or more (strong correlation).

RESULTS

No significant difference existed in the age and POG between all the three groups. A statistically significant difference in the systolic and diastolic BP was seen with a p-value of <0.001 among all groups [Table/Fig-2].

Variables	Group I (Controls) n=50	Group II (Mild preeclampsia) n=50	p value*	Group III (Severe preeclampsia) n=50	p^a-value*	p^b-value*
	Mean±SD			Mean±SD		
	Range			Range		
Age (years)	23.18±3.9	24.16±2.6	0.96	24.5±3.7	0.66	0.64
	18-34	18-32		18-33		
POG (weeks)	29.9±3.0	30.2±2.7	0.06	31±2.3	0.05	0.9
	24-36	22-36		25-36		
Systolic BP (mmHg)	120±10	148±6	<0.001	188±25	<0.001	<0.001
	98-140	140-160		160-300		
Diastolic BP (mmHg)	72±8	102±6	<0.001	118± 9	<0.001	<0.001
	60-88	84-110		100-130		
Urinary protein	Nil	1+		3+		

[Table/Fig-2]: Comparison of demographic parameters in study groups.
*unpaired t-test. p-comparison between group I and II; p^a-comparison between group I and III; p^b-comparison between group II and III

The [Table/Fig-3] shows the serum levels (mean±SD) of TC, TAG, VLDL-C, LDL-C, HDL-C and the various lipoprotein ratios in groups I, II and III along with their corresponding p-values. There was statistically significant increase in the serum levels of TC, TG, VLDL-C and LDL-C and the lipoprotein ratios of TC/HDL, TG/HDL and LDL/HDL in group II and group III subjects as compared to the group I. Also, the increase in these serum parameters in group III was statistically significant as compared to group II. Also, there was statistically significant decrease in the serum levels of HDL-C and the HDL/VLDL ratio in group II and group III as compared to group I. Similarly, this decrease was statistically significant in group III as compared to group II.

The observations in [Table/Fig-4] shows that the mean concentration of MDA was higher in groups II and III when compared with group I and was statistically significant (p<0.001). The increase in MDA concentration in group III as compared to group II was also statistically significant (p<0.001).

Parameters	Group I (Controls) n=50	Group II (Mild preeclampsia) n=50	p-value*	Group III (Severe preeclampsia) n=50	p^a-value*	p^b-value*
	Mean±SD			Mean±SD		
	Range			Range		
Serum TC (mg/dL)	190±25	210±20	0.001	240±41	<0.001	<0.001
	130-250	170-260		170-330		
Serum LDL-C (mg/dL)	120±26	140±20	<0.001	170±40	<0.001	<0.001
	64-190	98-190		110-270		
Serum TAG (mg/dL)	160±24	180±22	0.003	190±24	<0.001	0.002
	110-210	110-230		120-280		
Serum VLDL-C (mg/dL)	32±4.8	35±4.4	0.003	38±4.8	<0.001	0.002
	21-43	23-45		25-55		
Serum HDL-C (mg/dL)	39±5.9	33±4.6	<0.001	30±4.8	<0.001	<0.001
	25-53	24-44		23-43		
TC/HDL	5.1±1.1	6.4±1.4	<0.001	8.4±2.2	<0.001	<0.001
	3.2-8.2	3.8-11		4.1-14		
TAG/HDL	4.3±0.98	5.4±1.4	<0.001	6.6±1.5	<0.001	<0.001
	2.7-6.8	2.6-9.3		2.9-12		
LDL/HDL	3.2±0.95	4.3±1.1	<0.001	6.1±1.9	<0.001	<0.001
	1.5-5.8	2.3-7.7		2.6-11		
HDL/VLDL	1.2±0.29	0.98±0.2	<0.001	0.8±0.23	<0.001	<0.001
	0.7-1.9	0.5-1.9		0.4-1.7		

[Table/Fig-3]: Comparison of lipid profile parameters in the study groups.
*unpaired t-test. p-comparison between group I and II; p^a-comparison between group I and III; p^b-comparison between group II and III

Parameters	Group I (Controls) n=50	Group II (Mild preeclampsia) n=50	p-value*	Group III (Severe preeclampsia) n=50	p^a-value*	p^b-value*
	Mean±SD			Mean±SD		
	Range			Range		
Serum MDA (nmol/mL)	2.5±0.9	6.4±2.0	<0.001	9.9±1.6	<0.001	<0.001
	1.2-4.5	1.5-9.9		5.8-13		

[Table/Fig-4]: Comparison of serum levels of Malondialdehyde (MDA) between the study groups.
*unpaired t-test. p-comparison between group I and II; p^a-comparison between group I and III; p^b-comparison between group II and III

The [Table/Fig-5] exhibits the Pearson's correlation analysis to find the correlation of serum levels of MDA with serum TC, TAG, VLDL-C, LDL-C and HDL-C in group II. There was considerable positive correlation between serum levels of MDA with serum TC, TAG, VLDL-C and LDL-C. The correlation was highly statistically significant (p<0.001). Also, statistically significant negative correlation was found between serum levels of MDA with serum HDL-C (p<0.001).

Pearson's correlation analysis was used to find the correlation of serum levels of MDA with serum TC, TG, VLDL-C, LDL-C and HDL-C in group III. The [Table/Fig-6] shows that there was considerable positive correlation between serum levels of MDA with serum TC, TAG, VLDL-C and LDL-C. The correlation was highly statistically significant (p<0.001). Also highly statistically significant negative correlation was found between serum levels of MDA with serum HDL-C (p<0.001).

Parameters	Serum MDA	
	r-value*	p-value#
Total cholesterol	0.56	<0.001
Triacylglycerol (TAG)	0.45	0.001
VLDL-C	0.45	0.001
LDL-C	0.58	<0.001
HDL-C	-0.51	<0.001

[Table/Fig-5]: Correlation of serum MDA with serum lipid profile parameters in mild preeclampsia group (group II).
*Pearson's correlation test; #unpaired t-test

Parameters	Serum MDA	
	r-value*	p-value#
Total cholesterol	0.64	<0.001
Triacylglycerol (TAG)	0.69	<0.001
VLDL-C	0.69	<0.001
LDL-C	0.63	<0.001
HDL-C	-0.53	<0.001

[Table/Fig-6]: Correlation of serum MDA with serum lipid profile parameters in severe Preeclampsia (PE) group (group III).
*Pearson's correlation test; #unpaired t-test

DISCUSSION

The results of the present study suggest that women with preeclampsia are prone to dyslipidaemia and increased lipid peroxidation. Lipid profile findings from other studies which are similar to that in this study [Table/Fig-7] [13-18].

Misra MK et al., in their study additionally estimated the lipid profile levels in post-partum preeclampsia women and found that the levels of all the lipid profile parameters gradually decreased in these women when compared to the preeclamptic group with a significant p-value of <0.001 [19]. Siddiqui Ia and Mittal M et al., in their studies, did not find any significant difference in serum levels of TC, LDL-C and HDL-C in normal healthy pregnant controls and preeclamptic cases. Both the studies found significant differences in serum levels of triglycerides only in both the study groups [4,20].

An important cause for hypertriglyceridaemia in pregnancy could be oestrogen as pregnancy is a hypoestrogenic state. This hypertriglyceridaemia may also be linked to hypercoagulability [20]. Another reason postulated for increased serum triglycerides concentration is the increased hepatic lipase activity and a decreased lipoprotein lipase activity, respectively causing the increased synthesis of TAG in liver and decreased catabolism of

S. No.	Authors, year of publication	Place of study	Sample size	TC (mg/dL±SD) p-value	TAG (mg/dL±SD) p-value	HDL (mg/dL ±SD) p-value	VLDL (mg/dL±SD) p-value	LDL (mg/dL±SD) p-value
1	Ahmed AA et al., 2018 [13]	Eygpt	Total-100 NP-40 MPE-30 SPE-30	NP-176.13±8.09 MPE-217.00±10.49 SPE-229.47±12.61 p<0.001	NP-152.30±9.22 MPE-195.33±14.38 SPE-210.57±14.09 p<0.001	NP-43.28±4.03 MPE-40.10±5.39 SPE-36.33±6.21 p<0.001	NP-30.53±1.91 MPE-39.60±3.07 SPE-41.83±2.87 p<0.001	NP-102.13±9.78 MPE-138.93±12.23 SPE-152.13±11.03 p<0.001
2	Avidime AR et al., 2018 [14]	Nigeria	Total-140 NP-70 PE-70	NP- 239± 47.95 PE-251.35± 62.65 P-0.180	NP- 160.32±48.72 PE- 243.6±110.72 p<0.001	NP-68±18.18 PE-49.88±13.15 P-0.028	NP-13.92±4.25 PE-21.27±9.67 p<0.001	NP-106.34±36.35 PE-143.85±40.6 p<0.001
3	Olalere FDH et al., 2020 [15]	Nigeria	Total-240 NP-120 PE-120	NP-237±74.49 PE-309.9±113.92 p<0.001	NP-157.5±77.77 PE-203.3±120.49 p<0.001	NP-55.4±19.72 PE-63.2±27.39 p<0.001	NP-31.5±15.33 PE-39.5±21.91 p<0.001	NP-109.7±82.48 PE-156.5±120.49 p<0.001
4	Vani I et al., 2015 [16]	India	Total-100 NP-50 PE-50	NP-187.66±31.87 PE-227±31 p<0.001	NP- 196.62±35.06 PE-219±58 p<0.001	NP-53.77±10.45 PE-51±5 p<0.001	NP-39.31±7.01 PE-43±10 p<0.001	NP-94.61±28.23 PE-132±34 p<0.001
5	Deshpande H et al., 2016 [17]	India	Total-60 NP-30 PE-30	NP-163.8±8.83 PE-208.8±12.64 p<0.001	NP-158.8±9.96 PE-201.06±10.67 p<0.001	NP-49.56±4.08 PE-38.06±3.01 p<0.001	NP-35.4±3.62 PE-52.76±4.96 p<0.001	PE-140.36±10.8 NP-120.2±7.98 p<0.001
6	Yadav S et al., 2018 [18]	India	Total-200 NP-100 PE-100	NP-149.94±34.54 PE-221.92±34.54 p<0.01	NP- 151.61±28.23 PE- 255.68±65.17 p<0.001	NP- 59.32±13.01 PE- 32.93±5.79 p<0.01	NP- 30.70±5.73 PE- 51.19±13.12 p<0.001	NP- 59.92±37.29 PE- 137.10±29.05 p<0.01
7	Present study, 2022	India	Total-150 NP-50 MPE-50 SPE-50	NP-190±25 MPE-210±20 p-0.001 SPE-240±41 p<0.001	NP-160±24 MPE-180±22 p<0.01 SPE-190±24 p<0.001	NP-39±5.9 MPE-33±4.6 p<0.001 SPE-30±4.8 p<0.001	NP-32±4.8 MPE-35±4.4 p<0.01 SPE-38±4.8 p<0.001	NP-120±26 MPE-140±20 p<0.001 SPE-170±40 p<0.001

[Table/Fig-7]: Comparison of lipid profile parameters from other studies [13-18].
TC: Total cholesterol; TAG: Triglyceride; HDL: High density lipoprotein; VLDL: Very low density lipoprotein; LDL: Low density lipoprotein; mg/dL: Milligram per deciliter; SD: Standard deviation; NP: Normal pregnant; PE: Preeclampsia; MPE: Mild preeclampsia; SPE: Severe preeclampsia

TAG at the tissue level. There is delayed uptake of the remnant in the liver resulting in increased serum TAG concentration. This causes an increase in the Cholesterol Ester Transfer Protein (CETP) activity which leads to HDL becoming enriched with triglycerides and VLDL with cholesterol. The TAG rich HDL is rapidly catabolised by hepatic lipase, thus reducing its concentration. Thus, the reverse cholesterol transport to liver is impaired, leading to its reduced excretion and increased levels of TC [19,21]. Also, VLDL rich cholesterol causes increased formation of more atherogenic variant of LDL particle referred to small dense LDL [22].

Increased LDL in the circulation is protected from oxidation by the robust antioxidant defences of the body. Preeclampsia is characterised by impaired trophoblastic invasion leading to placental ischaemia and oxidative stress [23]. The oxygen free radicals cause the LDL infiltrates in the arterial intimal spaces to be oxidised. There is increased uptake of the oxidised LDL by macrophages through scavenger receptors. This leads to an increased accumulation of cholesterol in the macrophages causing them to change into foam cells leading to atherogenesis and vascular endothelial damage. The oxidised LDL causes impairment of endothelial cells by bringing about stimulation of the Vascular Cell Adhesion Molecule-1 (VCAM-1), neutrophil adhesion receptors and endothelin production; and inhibition of nitric oxide synthesis and endothelial prostacyclins. Thus, the oxidatively modified LDL is responsible for the vascular endothelial cell dysfunction [24].

Various lipoprotein ratios were calculated in the study groups such as TC/HDL, TG/HDL, LDL/HDL and HDL/VLDL. Results similar to this study were observed by De J et al., [25]. Herrera-Villalobos JE et al., in their study reported that an increase in the TC/HDL ratio to four suggests an increase in the risk for atherosclerosis and coronary heart disease [26]. Several studies studying the long-term implications on health in preeclamptic women have reported a higher risk of developing hypertension, coronary heart disease and stroke in later life. Also, studies have reported an increased risk of stroke and hypertension as a long-term effect on the offsprings of preeclamptic women [26].

The present study reported increased levels of serum MDA in preeclamptic women and also found a significant correlation between serum MDA and serum lipid profile parameters, corresponding to the severity of PE. These findings were in accordance with studies carried out by Wu JJ and Kashinakunti SV et al., [27,28]. Sahu S et al., in their study found serum levels of MDA in preeclamptic cases to be twice as much in normal pregnant women (p<0.0001). However, they did not find statistically significant correlations between serum MDA and serum lipid profile in the study groups (p>0.05) [29]. Dhananjaya BS et al., have found normal levels of MDA in patients of preeclampsia in their study [30]. The present study does not corroborate with their findings.

Oxidative stress in preeclampsia is due to placental hypoxia and increased oxygen demand with a concomitant reduction in antioxidant levels which scavenge the free radicals. Hypoxia/re-oxygenation are known to be potent stimuli for xanthine oxidase and Nicotinamide Adenine Dinucleotide Phosphate (NADPH) oxidase activation in neutrophils and monocytes causing increased synthesis of superoxide anion. The increased formation of free radicals causes excessive lipid peroxidation, reflected by elevated levels of MDA. These lipid peroxide products cause vascular endothelial damage and subsequently endothelial dysfunction [31]. There is production of cytokines such as Tumour Necrosis Factor alpha (TNF alpha), Interleukin 6 (IL-6) and Vascular Cell Adhesion Molecule 1 (VCAM-1) by the activated neutrophils indicating the attachment and activation of leucocytes to endothelium [32]. Lipid peroxidation products such as MDA play a major role in LDL modification leading to formation of oxidised-LDL. The oxidatively modified LDL is uptaken by macrophages via scavenger receptors and forms foam cells, resulting in atherogenesis which clinically presents as hypertension. Hyperlipidaemia causing excessive lipid peroxidation in turn causes increased consumption of antioxidants leading to imbalance between pro oxidants and anti-oxidants leading to oxidative stress in preeclampsia [33].

Limitation(s)

The study subjects included in this study came from a single centre. An ideal approach would be to verify the findings with larger multicentric studies with a prospective approach.

CONCLUSION(S)

Deranged lipid profile status is associated with oxidative stress in PE. The magnitude of derangement can help to assess the severity of preeclampsia and to predict the propensity of the patient to land

into eclampsia. Large scale prospective studies can be carried out taking women in early gestation as study subjects. Those with dyslipidaemia and deranged serum iron status parameters can be followed-up for the occurrence and progression of the disease. Other parameters such as markers of endothelial dysfunction can also be included in the study.

REFERENCES

[1] Hoffman B, Horsager R, Roberts S. Williams Obstetrics 23rd Edition. Hypertension in pregnancy, New York, USA: McGraw-Hill Professional Publishing; 2011;709-715.
[2] WHO. Make every mother and child count. In: World health report. Geneva, Switzerland. 2005. Accessed on 7th June 2016.
[3] Dey M, Arora D, Narayan N, Kumar R. Serum cholesterol and ceruloplasmin levels in second trimester can predict development of pre-eclampsia. N Am J Med Sci. 2013;5(1):41-46. Doi: 10.4103/1947-2714.106198. PMID: 23378955; PMCID: PMC3560138.
[4] Siddiqui Ia. Maternal serum lipids in women with pre-eclampsia. Ann Med Health Sci Res. 2014;4(4):638-41.
[5] Tesfa E, Nibret E, Munshea A. Maternal lipid profile and risk of pre-eclampsia in African pregnant women: A systematic review and meta-analysis. PLoS One. 2020;15(12):e0243538. Doi: 10.1371/journal.pone.0243538. PMID: 33362205; PMCID: PMC7757810.
[6] Noyan T, Güler A, Sekeroğlu MR, Kamaci M. Serum advanced oxidation protein products, myeloperoxidase and ascorbic acid in pre-eclampsia and eclampsia. Aust N Z J Obstet Gynaecol. 2006;46(6):486-91. Doi: 10.1111/j.1479-828X.2006.00647.x. PMID: 17116052.
[7] Report of the National High Blood Pressure Education Program Working Group on High Blood Pressure in Pregnancy. Am J Obstet Gynecol. 2000;183(1):S1-S22.
[8] Burtis CA, Ashwood ER, Bruns DE. Tietz textbook of Clinical Chemistry and Molecular Diagnostics. Missouri: Elsevier Saunders; 2006, 948-949.
[9] Cholesterol [package insert]. Brno (CZ): Erba Lachema s.r.o; 2014.
[10] Triglycerides [package insert]. Brno (CZ): Erba Lachema s.r.o; 2014.
[11] HDL Direct [package insert]. Brno (CZ): Erba Lachema s.r.o; 2014.
[12] Satoh K. Estimation of serum malondialdehyde. Clin Chim Acta. 1978;90(1):37-43.
[13] Ahmed AA, El Omda FA, Mousa MS. Maternal lipid profile as a risk factor for preeclampsia. The Egyptian Journal of Hospital Medicine. 2018;71(6):3434-38.
[14] Avidime AR, Tella MA, Hadiza G, Abiodun OO. A comparative study of serum lipid levels in pre-eclamptic and normotensive pregnant women in a tertiary hospital, Northwest Nigeria. Biomedical Journal of Scientific & Technical Research. 2018;3(1):3003-11.
[15] Olalere FDH, Okusanya BO, Oye-Adeniran BA. Maternal serum lipid in women with preeclampsia in Lagos: A case control study. J Matern Fetal Neonatal Med. 2020;33(5):794-98. Doi: 10.1080/14767058.2018.1505851. Epub 2018 Sep 3. PMID: 30176753.
[16] Vani I, Gayathri A, Nagamani T. Lipid profile parameters in normal and preeclampsia complicating pregnancies-A prospective observational study. The Ame J Sci & Med Res. 2015;1(1):61-66.
[17] Deshpande H, Madkar C, Vishnoi P. Study of serum lipid profile in pregnancy induced hypertension. Indian Journal of Applied Research. 2016;6:546-48.
[18] Yadav S, Agrawal M, Hariharan C, Dewani D, Vadera K, Krishna N. A comparative study of serum lipid profile of women with preeclampsia and normotensive pregnancy. J Datta Meghe Inst Med Sci Univ. 2018;13:83-86.
[19] Misra MK, Tiu DN, Sharma R. Lipid profile in pre-eclampsia in comparison with normal subjects. Int J Med Res Rev. 2016;4(10):1859-62. Doi: 10.17511/ijmrr.2016.i10.24.
[20] Mittal M, Kulkarni CV, Panchonia A, Mittal RK. Evaluation of serum lipid profile in cases of pre-eclampsia and eclampsia. Int J Reprod Contracept Obstet Gynecol. 2014;3:732-34.
[21] Bhat PV, Vinod V, Priyanka AN, Kamath A. Maternal serum lipid levels, oxidative stress and antioxidant activity in pre-eclampsia patients from Southwest India. Pregnancy Hypertens. 2019;15:130-33.
[22] Herrera E, Ortega-Senovilla H. Maternal lipid metabolism during normal pregnancy and its implications to fetal development. Clinical Lipidology. 2010;5(6):899-911.
[23] Roberts JM, Escudero C. The placenta in preeclampsia. Pregnancy Hypertens. 2012;2(2):72-83. Doi: 10.1016/j.preghy.2012.01.001.
[24] León-Reyes G, Maida-Claros RF, Urrutia-Medina AX, Jorge-Galarza E, Guzmán-Grenfell AM, Fuentes-García S, et al. Oxidative profiles of LDL and HDL isolated from women with preeclampsia. Lipids in Health and Disease. 2017;16(1):01-09.
[25] De J, Mukhopadhyay A, Saha PK. Study of serum lipid profile in pregnancy induced hypertension. Indian J Clin Biochem. 2006;21(2):165-68. Doi: 10.1007/BF02912935. PMID: 23105637; PMCID: PMC3453987.
[26] Herrera-Villalobos JE, Jaimes PA, González FM, Alanís AG, Benhumea AM, Villalpando JP. Atherogenic index as a risk factor for preeclampsia syndrome. CorSalud (Revista de Enfermedades Cardiovasculares). 2012;4(4):261-65.
[27] Wu JJ. Lipid peroxidation in preeclamptic and eclamptic pregnancies. European Journal of Obstetrics & Gynecology and Reproductive Biology. 1996;64(1):51-54.
[28] Kashinakunti SV, Sunitha H, Gurupadappa K, Shankarprasad DS, Suryaprakash G, Ingin JB. Lipid peroxidation and antioxidant status in preeclampsia. Al Ameen J Med Sci. 2010;3(1):38-41.
[29] 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):365-69. PMID: 20509330.
[30] Dhananjaya BS, Venkatesh G, SendilKumadan D. Study of correlation between oxidative stress parameters and severity of pre-eclampsia. Int J Biol Med Res. 2012;3(1):1260-62.
[31] Gomez ABZ. Obesity and oxidative stress: A direct link to pre-eclampsia? Arch Gyn Obstet. 2011;283:415-22.
[32] Wakatsuki A, Ikenoue N, Okatani Y, Shinohara K, Fukaya T. Lipoprotein particles in preeclampsia: Susceptibility to oxidative modification. Obstetrics & Gynecology. 2000;96(1):55-59.
[33] Adiga U, D'souza V, Kamath A, Mangalore N. Antioxidant activity and lipid peroxidation in preeclampsia. Journal of the Chinese Medical Association. 2007;70(10):435-38.

PARTICULARS OF CONTRIBUTORS:
1. Senior Resident, Department of Biochemistry, All India Institute of Medical Sciences, Nagpur, Maharashtra, India.
2. Additional Professor, Department of Biochemistry, All India Institute of Medical Sciences, Nagpur, Maharashtra, India.
3. Assistant Professor, Department of Biochemistry, University College of Medical Sciences and Associated Guru Teg Bahadur Hospital, New Delhi, India.
4. Associate Professor, Department of Biochemistry, Government Medical College, Aurangabad, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Vaijayanti Hardas,
Associate Professor, Department of Biochemistry, Government Medical College,
Aurangabad-431001, Maharashtra, India.
E-mail: aforapurva@gmail.com

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