RESEARCH PAPER

Serum Homocysteine and Lipid Profile Alterations in Preeclampsia: A Case Control Study

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ABSTRACT

Background: Preeclampsia is a multisystem disorder of pregnancy characterized by hypertension and proteinuria after 20 weeks of gestation. Endothelial dysfunction and metabolic disturbances play a central role in its pathogenesis. Dyslipidemia and elevated serum homocysteine levels are considered important contributors to vascular injury in preeclampsia. Therefore, the present study aims to evaluate and correlate serum homocysteine levels with lipid profile parameters in patients with preeclampsia.

Methods: This case–control study was conducted in MMIMSR, Mullana, Ambala. A total of 76 pregnant women were enrolled, including 51 preeclamptic cases (Group A) and 25 age-matched normotensive controls (Group B). Preeclampsia was diagnosed according to ACOG criteria (BP ≥140/90 mmHg after 20 weeks with proteinuria). Serum homocysteine and lipid profile were estimated using standard biochemical methods. Statistical analysis was performed using independent t-test, chi-square test, and Pearson correlation.

Results: Mean serum homocysteine levels were significantly higher in preeclamptic women (39.87 ± 15.88 µmol/L) compared to controls (17.43 ± 9.98 µmol/L) ($p < 0.001$). Among lipid parameters, triglycerides (319.96 ± 106.47 mg/dL vs 211.75 ± 86.20 mg/dL) and VLDL (63.99 ± 21.29 mg/dL vs 42.35 ± 17.24 mg/dL) were significantly elevated in the test group ($p = 0.001$). No significant differences were observed in LDL, HDL, total cholesterol, and non-HDL cholesterol levels ($p > 0.05$).

Conclusion: Preeclamptic women exhibit significantly elevated homocysteine and abnormal lipid levels contribute to endothelial dysfunction, and may serve as useful biomarkers for early detection and risk assessment.

Keywords: Preeclampsia; Homocysteine; Lipid profile; Triglycerides; VLDL; Endothelial dysfunction;Dyslipidemia; Pregnancy.

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INTRODUCTION

Preeclampsia is a pregnancy-specific hypertensive disorder characterized by the onset of hypertension with proteinuria or organ dysfunction after 20 weeks of gestation. It remains a leading cause of maternal and perinatal morbidity and mortality worldwide, affecting nearly 4–5% of pregnancies (1). The condition is multifactorial in origin, primarily involving abnormal placentation and systemic endothelial dysfunction. Impaired trophoblastic invasion and inadequate remodeling of uterine spiral arteries result in placental ischemia, oxidative stress, and release of antiangiogenic factors, which ultimately lead to widespread endothelial damage and clinical manifestations (2).

Recent studies have highlighted the role of biochemical markers such as homocysteine and lipid profile in the pathogenesis of preeclampsia. Elevated homocysteine levels may contribute to endothelial dysfunction, oxidative stress, and a prothrombotic state (3–5). Similarly, dyslipidemia, characterized by increased triglycerides and altered lipoprotein levels, may aggravate vascular injury and placental insufficiency (4–8). Therefore, this study aims to evaluate and correlate

serum homocysteine levels with lipid profile parameters in preeclampsia.

METHODOLOGY

Study Design and Setting

The current study was carried out in the Department of Biochemistry at MMIMSR, Maharishi Markandeshwar Deemed to be University, Mullana, Ambala, Haryana, in collaboration with the Department of Obstetrics and Gynecology, M.M. Super speciality Hospital.

ETHICAL CONSIDERATION

Prior to the collection of data and blood samples, each patient provided written, informed consent. Only those who offered to take part in the study were included. The institutional ethical committee duly approved the project(IEC-3280).

Study population

A total 76 pregnant women with 51 females in Group A and 25 females in Group B were recruited for our study.

• Group A- Cases of preeclampsia (51)- According to American College of Obstetricians and Gynecologists, hypertension in pregnancy is defined as systolic ≥140 mmHg or diastolic ≥90 mmHg on two readings taken at least 4 hours apart after 20 weeks of gestation

• Group B- Controls (25): Age matched normotensive pregnant women.

INCLUSION CRITERIA:

1. Persistently high blood pressure (>140/90 mmHg) with proteinuria.
2. Primigravida with singleton pregnancy and gestational age >20 weeks of gestation.

EXCLUSION CRITERIA:

1. A history of persistent hypertension prior to pregnancy.
2. Women with gestational hypertension.
3. Had a history of diabetes or were already using insulin or hypoglycemic medications.
4. Obese women who had a pre-pregnancy BMI of more than 25 kg/m².
5. Those on anti-hypertensive or hypolipidemic medications.
6. Those who had been diagnosed with hepatic, heart, or renal disease, or any other serious condition.
7. Malpresentation.
8. .Multiple pregnancy.

COLLECTION AND LABORATORY ANALYSIS OF BLOOD SAMPLE

Following written informed consent, 5 ml venous blood was collected from the antecubital vein under aseptic conditions and transferred to a sterile, dry, acid-washed vial for analysis.Serum homocysteine was estimated by Competitive ELISA (5). Total cholesterol was measured by the CHOD-PAP method (6), triglycerides by the GPO–Trinder method (7), and HDL-C by the precipitation method (8). LDL-C was calculated using the Friedewald formula [LDL-C = TC − (HDL-C + TG/5)] (9), Non-HDL-C (TC − HDL-C) and VLDL-C (TG/5) were also calculated

RESULTS

The present study demonstrated a significant difference in serum homocysteine levels between the test and control groups. The mean serum homocysteine (HCY) level in the test group was markedly higher (39.86 ± 15.88 µmol/L) compared to the control group (17.42 ± 9.98 µmol/L), and this difference was found to be highly statistically significant ($t = 6.453$, $p < 0.001$),as shown in table no.1

Table 1: Comparison of Mean Homocysteine (HCY) Levels Between Test and Control Groups.

Group	N	Mean	± SD	SEm	't' value	P value
Test	51	39.867	15.887	2.225	6.453	<0.001**
Control	25	17.428	9.981	1.996		

With respect to the lipid profile parameters, serum triglyceride (TG) levels were significantly elevated in the test group (319.96 ± 106.47 mg/dL) compared to controls (211.75 ± 86.20 mg/dL), showing statistical significance ($t = 4.45$, $p = 0.001$). Similarly, very low-density lipoprotein (VLDL) levels were significantly higher in the test group (63.99 ± 21.29 mg/dL) than in the control group (42.35 ± 17.24 mg/dL), which was also statistically significant ($t = 4.36$, $p = 0.001$),as shown in table no.2

Table 2: Comparison of Mean Lipid Profile Parameters Between Test and Control Groups Using Independent t-Test.

Parameter	Group	N	Mean	SD	SEM	"t" value	"p" value
TG	Test	51	319.96	106.47	14.91	4.45	0.001*
	Control	25	211.75	86.2	17.24		
LDL	Test	51	116.28	40.11	5.62	1.28	0.20
	Control	25	131.0	52.45	10.49		
HDL	Test	51	51.71	12.6	1.76	0.19	0.85
	Control	25	52.29	13.64	2.73		
VLDL	Test	51	63.99	21.29	2.98	4.36	0.001*
	Control	25	42.35	17.24	3.45		
Non-HDL Chol	Test	51	180.27	42.19	5.91	0.52	
	Control	25	173.35	62.43	12.49		0.60
Total Cholesterol	Test	51	231.98	45.19	6.33	0.46	0.65
	Control	25	225.64	65.37	13.07		

However, no statistically significant differences were observed in other lipid parameters. Low-density lipoprotein (LDL) levels were lower in the test group (116.28 ± 40.11 mg/dL) compared to controls (131.0 ± 52.45 mg/dL), but this difference was not significant ($t = 1.28$, $p = 0.20$). High-density lipoprotein (HDL) levels were nearly similar between the test (51.71 ± 12.60 mg/dL) and control groups (52.29 ± 13.64 mg/dL), with no significant difference ($t = 0.19$, $p = 0.85$). Additionally, non-HDL cholesterol and total cholesterol levels did not differ significantly between the two groups ($p = 0.60$ and $p = 0.65$, respectively).

Overall, the findings indicate that elevated homocysteine, triglycerides, and VLDL levels are significantly associated with the test group, while other lipid parameters did not show significant variation.

DISCUSSION

Preeclampsia is a common pregnancy complication associated with significant maternal and fetal morbidity and mortality, especially in developing countries. Although its exact etiology remains unclear, endothelial dysfunction and vasospasm are considered central to its pathogenesis. Homocysteine, an amino acid derived from methionine metabolism, has been identified as an important risk factor for preeclampsia and eclampsia (10).

In the present study, a highly significant increase ($p < 0.001$) in mean homocysteine levels was observed in the test group compared to controls, suggesting its crucial role in the pathophysiology of preeclampsia. These findings are consistent with earlier studies by Ahmed M. Maged et al. (2024), Halima Akter et al. (2024) and Kumar and Jain et al.(2024), all of which reported significantly elevated homocysteine levels in preeclamptic women (11–13). The strong statistical significance further supports the involvement of homocysteine in disease progression.

Elevated homocysteine contributes to endothelial dysfunction through multiple mechanisms, including increased oxidative stress, reduced nitric oxide availability, and vascular smooth muscle proliferation. It promotes the generation of reactive oxygen species, leading to lipid peroxidation and endothelial injury. This results in impaired vasodilation, increased vascular resistance, and enhanced sensitivity to vasoconstrictors. Additionally, homocysteine promotes platelet aggregation and coagulation, contributing to microvascular thrombosis and placental ischemia (14).

Hyperhomocysteinemia may arise due to genetic factors or nutritional deficiencies, particularly folate deficiency.

In preeclampsia, reduced folate levels and altered activity of enzymes such as methylenetetrahydrofolate reductase (MTHFR) contribute to elevated homocysteine levels. Other factors such as metabolic syndrome, inflammation, oxidative stress, and tissue injury may further aggravate endothelial dysfunction (15).

Recent evidence also suggests a synergistic interaction between hyperhomocysteinemia and dyslipidemia. Elevated homocysteine enhances LDL oxidation, increasing its atherogenic potential and worsening endothelial damage. This combined effect may lead to placental hypoperfusion and systemic inflammation, accelerating the progression of preeclampsia (16).

In addition to homocysteine, significant alterations in lipid profile were observed, particularly elevated triglycerides (TG) and VLDL levels in the test group ($p < 0.001$). These findings indicate a strong association between dyslipidemia and preeclampsia. Similar results have been reported by Yu Huang et al. (2024), P. Kumari et al. (2023), and Yadav S. et al. (2018), (17–19). However, unlike some studies, only TG and VLDL showed significant elevation in the present study, which may be attributed to differences in sample size and gestational age.

Hypertriglyceridemia in preeclampsia is likely due to increased hepatic lipoprotein synthesis induced by estrogen and reduced lipoprotein lipase activity, leading to impaired clearance of triglyceride-rich lipoproteins. Elevated VLDL undergoes oxidative modification, producing lipid peroxides that damage vascular endothelium. This contributes to increased vascular permeability, vasoconstriction, and placental dysfunction. The findings suggest that TG and VLDL may play a more prominent role than other lipid parameters in the development of preeclampsia (20).

Currently, there are no reliable screening tools for early detection of preeclampsia. However, altered lipid metabolism and reduced PGI2:TXA2 ratio have been implicated in pregnancy-induced hypertension. Early pregnancy dyslipidemia may increase the risk of developing preeclampsia (21).

CONCLUSION

The study shows that preeclampsia is linked to significant biochemical changes, including elevated homocysteine, triglycerides, and VLDL levels. Increased homocysteine may contribute to endothelial dysfunction, oxidative stress, and vascular injury, while hypertriglyceridemia may promote lipid peroxidation and disease progression. These findings suggest that homocysteine and lipid profile parameters could serve as useful markers for early detection and risk assessment of preeclampsia. Identifying these changes early may help enable timely management and reduce associated maternal and fetal complications.

Disclosure of conflict of interest: None

REFERENCES

1. Karrar SA, Martingano DJ, Hong PL. Preeclampsia. [Updated 2024 Feb 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-.
2. Kutllovci Hasani K, Ajeti N, Goswami N. Understanding Preeclampsia: Cardiovascular Pathophysiology, Histopathological Insights and Molecular Biomarkers. Med Sci (Basel). 2025 Aug 25;13(3):154. doi: 10.3390/medsci13030154. PMID: 40981151; PMCID: PMC12452302.
3. Oluwole AA, Nwogu CM, Sekumade A, Ajepe A, Okunade KS. Association between Serum Homocysteine Levels in Preeclampsia and its Severity among Women in Lagos, South-West Nigeria. West Afr J Med. 2020 Jan-Mar;37(1):246-252. PMID: 32030711; PMCID: PMC7065046.
4. Sharami SH, Tangestani A, Faraji R, Zahiri Z, Amiri A. Role of dyslipidemia in preeclamptic overweight pregnant women. Iran J Reprod Med. 2012 Mar;10(2):105-12. PMID: 25242982; PMCID: PMC4163271.
5. Paprotny Ł, Wianowska D, Izdebska M, Celejewska A, Szewczak D, Solski J. Analysis of serum homocysteine in the laboratory practice - comparison of the direct chemiluminescence immunoassay and high performance liquid chromatography coupled with fluorescent detection. Biochem Med (Zagreb). 2020 Oct 15;30(3):030703. doi: 10.11613/BM.2020.030703. Epub 2020 Aug 5. PMID: 32774125; PMCID: PMC7394257.
6. Beckman Coulter. Total Cholesterol Reagent, CHOD-PAP Enzymatic Method. AU
System Chemistry Manual. Brea (CA): Beckman Coulter Inc.; 2022.
7. Penumarthy S, Penmetsa GS, Mannem S. Assessment of serum levels of triglycerides, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol in periodontitis patients. J Indian Soc Periodontol. 2013 Jan;17(1):30-5. doi: 10.4103/0972-124X.107471. PMID: 23633769; PMCID: PMC3636940.
8. Beckman Coulter. Triglycerides Reagent by Glycerol Phosphate Oxidase-Peroxidase
Method and HDL Cholesterol Reagent Manual. AU System Chemistry Manual. Brea

(CA): Beckman Coulter Inc.; 2022.
9.Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-
density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge.
Clin Chem. 1972;18(6):499-502.
10. Sanlikan F, Kocyigit Y, Sanlikan A, Celik M, Guzel AI, Dansuk R. Maternal
serum homocysteine, folate and vitamin B12 levels in severe preeclampsia and
eclampsia. J Obstet Gynaecol Res. 2015;41(5):687-94.
11. Maged AM, Saad H, Meshaal H, Salah E, Abdelaziz S, Omran E, Deeb WS, Katta M. Expression of Concern: Maternal serum homocysteine and uterine artery Doppler as predictors of preeclampsia and poor placentation. Arch Gynecol Obstet. 2024 Jun;309(6):2953. doi: 10.1007/s00404-024-07491-5. PMID: 38619554.
12. Akter H, Hossain MT, Shabnam S. The role of maternal serum homocysteine level in early onset preeclampsia for prediction of severity of disease. Int J Reprod Contracept Obstet Gynecol [Internet]. 2024 Sep. 26
13.Kumar S, Jain N. Maternal serum homocysteine and vitamin B12 levels in
preeclampsia: a case-control study. Int J Reprod Contracept Obstet Gynecol.
2024;13(3):612-7.
14. Pushpakumar S, Kundu S, Sen U. Endothelial dysfunction: the link between homocysteine and hydrogen sulfide. Curr Med Chem. 2014;21(32):3662-72. doi: 10.2174/0929867321666140706142335. PMID: 25005183; PMCID: PMC5539954.
15. Wu X, Yang K, Tang X, Sa Y, Zhou R, Liu J, Luo Y, Tang W. Folate metabolism gene polymorphisms MTHFR C677T and A1298C and risk for preeclampsia: a meta-analysis. J Assist Reprod Genet. 2015 May;32(5):797-805. doi: 10.1007/s10815-014-0408-8. Epub 2015 Mar 11. PMID: 25758986; PMCID: PMC4429450.
16. Thakur P, Bhalerao A. High Homocysteine Levels During Pregnancy and Its Association With Placenta-Mediated Complications: A Scoping Review. Cureus. 2023 Feb 20;15(2):e35244. doi: 10.7759/cureus.35244. PMID: 36968916; PMCID: PMC10034471.
17.Huang, Y., Sun, Q., Zhou, B. et al. Lipidomic signatures in patients with early-onset and late-onset Preeclampsia. Metabolomics 20, 65 (2024)
18. Kumari P, Chouhan M, Jakhar B, Sharma G. A comparative study of serum lipid profile in preeclampsia and normotensive pregnancy in third trimester and their fetomaternal outcome. Int J Reprod Contracept Obstet Gynecol [Internet]. 2023 Jun. 19 [cited 2026 Apr. 9];12(7):2177-84.
19. Yadav S, Agrawal S, Yadav S. A study of lipid profile in normal pregnancy and preeclampsia. Int J Reprod Contracept Obstet Gynecol. 2018;7(8):3216-3220.
20. Kleess LE, Janicic N. SEVERE HYPERTRIGLYCERIDEMIA IN PREGNANCY: A CASE REPORT AND REVIEW OF THE LITERATURE. AACE Clin Case Rep. 2018 Oct 5;5(2):e99-e103. doi: 10.4158/ACCR-2018-0168. PMID: 31967011; PMCID: PMC6873862.
21. Kaaja R, Laivuori H, Tikkanen MJ, Ylikorkala O. Serum lipids, lipoproteins, and lipid peroxides in preeclampsia. Obstet Gynecol. 1997;89(3):353-356.