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Original Article

The study of serum iron, total iron binding capacity in preeclamptic patients among erode populations

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ABSTRACT

Background: *Pre-eclampsia is a complex condition that affects multiple systems in the body. It is characterized by the sudden development of high blood pressure and the presence of protein in the urine, or the sudden development of high blood pressure together with severe malfunction in organs, with or without protein in the urine. Pre-eclampsia usually occurs after 20 weeks of pregnancy or after childbirth. The classic clinical symptoms include hypertension, proteinuria, abnormal weight increases, and oedema. Unsecured iron ions in storage or transport proteins pose a risk as they can trigger free radical reactions. The presence of oxidative stress in preeclampsia can lead to an increase in transferrin saturation and a decrease in unsaturated iron binding capacity. This, in turn, can further exacerbate oxidative stress by reducing the serum's ability to buffer against redox-active iron through antioxidants.*

Methodology: *The study was carried out at the department of Obstetrics and Gynecology and Biochemistry in Nandha Medical College and Hospital. The study will involve women who have been diagnosed with preeclampsia as cases, and normotensive healthy pregnant women as controls. Informed consent will be obtained from all participants. The systolic and diastolic blood pressure of all individuals will be observed. The spectrophotometer on the fully automated analyser AU680 (Beckman Coulter) will be used to measure the levels of serum iron and TIBC.*

Result: *The average (mean) value of Iron for patients is 126.39, with a standard deviation (SD) of 39.53. In contrast, for controls, the average value is 83.86, with an SD of 25.48. The average value of TIBC for patients is 354.59, with a standard deviation of 52.58. For Controls, the Mean value is 417.0 and the Standard Deviation (SD) is 59.16. The P valve for both Iron and TIBC is less than 0.001.*

Conclusion: *This study establishes that pregnant women with pre-eclampsia experience a notable increase in serum iron levels. Excessive iron could be considered a potential cause of oxidative stress, which may play a role in the development of preeclampsia.*

Keywords: *Pre-eclampsia; Hypertension; Iron; Total Iron Binding Capacity – TIBC.*

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Introduction

Pregnancy involves numerous physiological changes that would be considered abnormal in a non-pregnant individual. Pregnancy leads to various physiological changes, including alterations in hormones, blood flow, and blood composition. These physiological changes should be seen as natural adaptations [1].

Pre-eclampsia is a frequently encountered complication during pregnancy. On average, preeclampsia occurs in 3% - 5% of pregnancies. It is a significant factor contributing to high rates of prenatal and maternal mortality during pregnancy [2]. Infant mortality in preeclampsia is four times greater compared to normal pregnancies. Pre-eclampsia is a complex condition that affects multiple systems in the body. It is characterized by the sudden development of high blood pressure and the presence of protein in the urine, or high blood pressure accompanied by organ dysfunction, occurring after 20 weeks of pregnancy or after childbirth. The classic clinical manifestations include hypertension, proteinuria, excessive weight gains, and edema [3].

Iron and hematin proteins have significant roles as catalysts of lipid peroxidation in tissues. Iron plays a role in promoting lipid peroxidation, which may be facilitated by the increase in lipid mobilization that occurs during the later stages of human gestation.

This may exacerbate the cycle by raising levels of circulating peroxide. Iron ions that are not properly sequestered in storage or transport proteins can be hazardous, as they have the potential to stimulate free radical reactions [4,5].

Transitional metals, such as iron, are highly prevalent in the placenta and play a crucial role in the generation of free radicals. Lipid peroxidation of membrane phospholipids is stimulated by alkoxyl radicals generated by the Fenton reaction in the presence of Fe and lipid peroxides. The presence of oxidative stress in the placenta may be attributed to factors such as hyperlipidemia, elevated iron levels in the maternal compartment, and the occurrence of pre-eclampsia [6].

The transferrin saturation levels tend to rise while the unsaturated iron binding capacity decreases in cases of preeclampsia. This can be attributed to the presence of oxidative stress, which in turn exacerbates the oxidative stress by reducing the serum's ability to counteract the effects of redox-active iron through antioxidants. The transferrin saturation in predelivery sera of women with preeclampsia is approximately doubled compared to controls. This is due to both an increase in serum iron and a decrease in total transferrin concentration. Although there is currently no alternative treatment for preeclampsia aside from delivery, the timely identification of pregnant women at high risk could enable prompt interventions to reduce the likelihood of complications. It is crucial to diagnose or predict pre-eclampsia in order to minimize maternal morbidity and mortality [7].

It is not recommended to administer iron supplements to pregnant women at high risk for preeclampsia unless there is evidence of iron deficiency [8]. Thus, the efficacy of routine iron supplementation in preeclampsia is uncertain. Changes in different blood and chemical measurements are commonly seen in individuals with pre-eclampsia, and these are often seen as indicators of the disease's progression. The primary objective of this study was to examine and compare the serum Iron and S. TIBC levels in individuals with preeclampsia and normotensive pregnant controls.

Materials and Methods

The study was conducted at Nandha Medical College and Hospital in the departments of Obstetrics and Gynecology and Biochemistry. Women diagnosed with preeclampsia will be chosen as cases, while normotensive healthy pregnant women will be selected as controls. Informed consent will be obtained from all participants included in the study. A comprehensive history will be obtained from all participants and a meticulous clinical examination will be conducted to assess their suitability for inclusion in the study. We will closely monitor the systolic and diastolic blood pressure of all the cases. Upon admission, venous serum samples will be obtained from the patient's ante-cubital vein using plain vials, prior to initiating any treatment. The levels of serum iron and TIBC will be measured using a spectrophotometer on the fully automated analyser AU680 (Beckman Coulter).

Inclusion criteria

A total number of 64 pregnant women were selected, 32 pregnant women in each group.

For study group:

- Pregnant women aged between 18-35 years
- Gestation period of >20 weeks of singleton pregnancy.
- Diagnosed cases of preeclampsia (newly and previously diagnosed):
- Blood Pressure = 140/90 mmHg or more on 2 occasions 4 hours apart after 20 weeks of gestation.

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- Women receiving oral iron supplement as prophylaxis for iron deficiency anaemia during pregnancy.

For control group:

- Women receiving oral iron supplement as prophylaxis for iron deficiency anaemia during pregnancy.
- Females with uncomplicated course during pregnancy.
- Pregnant women giving informed consent.

Exclusion criteria for study and control group:

- Pregnant females with known eclampsia.
- Females having Gestational hypertension.
- Subjects with co-existing conditions like:
  - -Anemia
  - -Liver disease
  - -Chronic renal disease
  - -Chronic hypertension
  - -Diabetes mellitus
  - -UTI
  - -History of repeated blood transfusions
  - -Tuberculosis, Rheumatoid arthritis and malignancy will be excluded from the study.
  - -and those who were on medications (such as diuretics, corticosteroids which could alter serum iron profile).

Result

Table 1: Comparison of Mean & SD of Preeclamptic patients (Study group) with Control group (healthy control).

S. No.	Parameters	Mean		SD		
		Patients	Controls	Patients	Controls	'P' value
1.	Iron (µg/dl)	126.39	83.86	39.53	25.48	<0.001*
2.	TIBC (µg/dl)	354.59	417.0	52.58	59.16	<0.001*

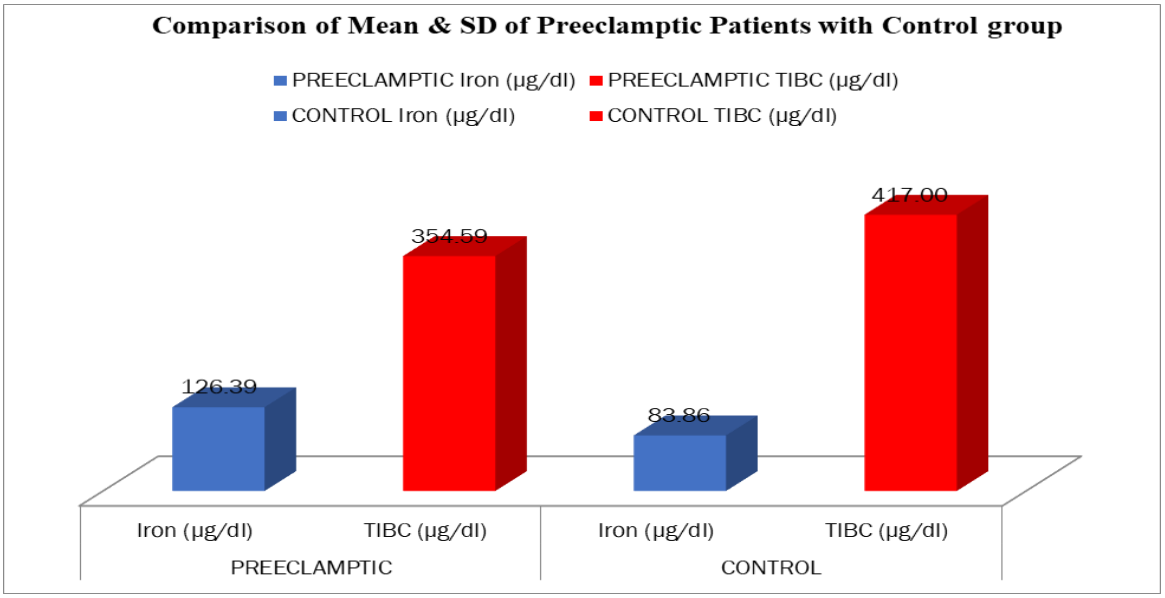

Figure 1: Comparison of mean and standard deviation of preeclamptic patients with control group.

Discussion

Preeclampsia remains a prominent factor contributing to both maternal and foetal illness and death. Despite extensive investigation over many decades, the cause of this condition still remains a mystery. Women with preeclampsia exhibit aberrant metabolism of blood iron and iron-binding proteins, specifically ferritin and transferrin. The cause of the elevated blood ferritin levels in preeclampsia is still not fully understood. Despite much research, the exact cause of preeclampsia has not been completely understood. Preeclampsia is sometimes referred to as the 'disease of theories' because to the numerous ideas that have been put up to explain its occurrence [9]. The precise pathophysiology of this illness remains unclear. The

precise mechanisms underlying the metabolic alterations in this condition have not yet been fully investigated. The present study aimed to assess the levels of serum iron, TIBC, and ferritin and their potential contribution to pre-eclampsia. Normotensive women experience a reduction in the levels of serum iron and ferritin throughout the third trimester of pregnancy. This occurs because their iron reserves are exhausted due to the increased demand from the fetus and the necessary growth of red blood cell volume [10,11]. Nevertheless, a higher concentration of serum iron has been detected in women with preeclampsia in comparison to pregnant women without the condition. Elevated levels of iron and the resulting oxidative stress have been observed in the intestinal mucosa, liver, spleen, bone marrow, and placenta. The generation of hydroxyl and methoxyl radicals in both the luminal and mucosal contents of the gastrointestinal tract confirm the involvement of iron in causing damage by free radicals [12,13]. These findings suggest that the release of iron free radicals from an ischemic placenta may contribute to the development of pre-eclampsia. The pre-eclamptic group showed higher levels of serum ferritin, which is consistent with the findings of the study conducted by Hubel et al. [14]. Conversely, there has been a recent association between taking iron supplements and having higher levels of iron in the body and maternal problems such as gestational diabetes and increased oxidative stress during pregnancy. Therefore, although iron supplements can enhance pregnancy results in cases where the mother lacks iron, there is also a possibility that preventive supplementation may raise the risk when the mother does not suffer from iron deficiency. Current estimates of gestational iron requirements and the proportion of iron absorbed from various iron supplements indicate that under existing supplementation schemes, the cells lining the intestinal mucosa are consistently exposed to excessive amounts of unabsorbed iron and oxidative stress [15,16].

Nevertheless, a study has shown that preeclamptic women have higher levels of serum iron compared to normal pregnant women. This study also supports the idea that there is an excess of iron and oxidative stress in various organs such as the intestinal mucosa, liver, spleen, bone marrow, and placenta. Additionally, the production of hydroxyl and methoxyl radicals in the gastrointestinal tract confirms the role of iron in causing damage through free radicals [17]. The preeclamptic group exhibits a lower total iron binding capacity (TIBC) compared to the control group. Similarly, the unsaturated iron binding capacity, which measures the amount of iron that can be bound by serum, is much lower in women with pre-eclampsia compared to those with a normal pregnancy [18]. Comparable results were noted in relation to the Total Iron Binding Capacity (TIBC) and Unsaturated Iron Binding Capacity (UIBC) [19]. The findings suggest that the release of iron free radicals from an ischemic placenta may potentially contribute to the development of pre-eclampsia. Preeclamptic individuals typically exhibit high levels of serum ferritin [20].

Conclusion

Based on the findings of this study, it is possible to draw the conclusion that pregnant women who have pre-eclampsia have considerably elevated levels of serum iron. A possible causal element in the oxidative stress that may be involved in the pathogenesis of preeclampsia is an excess of iron, which may be proposed as a potential cause. It is possible to employ serum iron and total ionized blood coagulation (TIBC) levels as a screening test that is both cost-effective and early marker for assessing the development of preeclampsia. Additionally, this test assists in gaining an understanding of the severity of preeclampsia. Having said that, additional research is necessary in order to fully support the same. Given this, it is imperative that the iron status of pregnant women who are experiencing pre-eclamptic toxaemia be evaluated before to administering iron supplements.

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Conflict of Interest

None declared.

References

1. Abu-Saad K, Fraser D. Maternal nutrition and birth outcomes. Epidemiologic reviews. 2010 Apr 1;32(1):5-25.
2. Shirin BS, Tasnim S, Haque MA, Kabir N, Begum K, Al-Azad MN. A Comparative Study on Serum Iron and Tibc among the Preeclamptic Patients and Normotensive Group. IOSR J Dental and Medical Sciences 19(11): 33-36.
3. Maitra S, Mukthapuram A, Huligol G, Sreelatha G, Vishwanath H. Increased serum ferritin and iron levels in preeclampsia. IOSR. 2019;5(2):50-2.
4. Akhter A, Nahar K, Jahan S, Akter H. A Comparative Study of Serum Calcium Level between Preeclampsia and Normal Pregnancy in a Tertiary Level Hospital. SSNI Med Col J. 2016;39–44.
5. Eslami B, Moeini A, Hosseini R, Sedaghat M. Comparison of Serum Uric Acid, Iron and Total Iron Binding Capacity (TIBC) Levels in Pre-eclamptic and Normal Pregnant Women.

Citation: *Ayyappan S, Vigneshwaran G, Paul JK, et. al. The study of serum iron, total iron binding capacity in preeclamptic patients among erode populations. Front Multidiscip Res Stud 2024; 1(1):105. doi: 10.31531/fmrs.1000105*

6. Siddiqui IA, Jaleel A, Kadri HM, Saeed WA, Tamimi W. Iron status parameters in preeclamptic women. Am J Obstet Gynocol.2010;187(2):412-8.
7. Ghosh L, Afrooz R, Chowdhury SB, Gani O, Khatun R. Association between Serum Ferritin and Iron Parameters with Preeclampsia and its Association with Perinatal Outcome. Ibrahim Card Med J. 2017;7(1–2):64–9.
8. Mudher HHASN, Hasan AHMA. The association of serum iron, zinc, and copper levels with preeclampsia. Med J Babylon. 2015;12(4):1027–36.
9. Maitra S, Mukthapuram A, Huligol G, Sreelatha G, Vishwanath H. Increased serum ferritin and iron levels in preeclampsia. IOSR. 2019;5(2):50–2.
10. Halliwell B and Chirico S. Lipid peroxidation. Its mechanism, measurement and significance. Am J Clin Nutri. 1993;57(suppl): 715S-725S.
11. Scholl TO. Iron status during pregnancy: Setting the stage for mother and infant. Am J Clin Nutr 2005; 81:1218S-22.
12. Hubel CA, Kozov AV, Kagan EV, Evans RW, Davidge ST, McLaughin MK et al. Decreased transferrin and increased transferrin saturation in sera of women with pre-eclampsia. Implications for oxidative stress. Am J Obstet Gynecol 1996; 175: 692-700
13. Sanni OB, Chambers T, Li JH, et al. A systematic review and meta-analysis of the correlation between maternal and neonatal iron status and hematologic indices. E Clinical Medicine. 2020 Oct1; 27:100555.
14. Quezada-Pinedo HG, Cassel F, Duijts L, et al. Maternal Iron Status in Pregnancy and Child Health Outcomes after Birth: A Systematic Review and Meta-Analysis. Nutrients. 2021 Jul;13(7):2221.
15. Goonewardene M, Shehata M, Hamad A. Anaemia in pregnancy. Best practice & research Clinical obstetrics& gynaecology. 2012 Feb 1;26(1):3-24.
16. Chandra S, Tripathi AK, Mishra S, et al. Physiological changes in haematological parameters during pregnancy. Indian journal of haematology and blood transfusion. 2012 Sep;28(3):144-6.
17. Trinder D, Fox C, Vautier G, et al. Molecular pathogenesis of iron overload. Gut. 2002 Aug 1;51(2):290-5.
18. Cerami C. Iron nutrition of the fetus, neonate, infant, and child. Annals of Nutrition and Metabolism.2017;71(Suppl. 3):8-14.
19. Quezada-Pinedo HG, Cassel F, Duijts L, et al. Maternal Iron Status in Pregnancy and Child Health Outcomes after Birth: A Systematic Review and Meta-Analysis. Nutrients. 2021 Jul;13(7):2221.
20. Åsberg A, Thorstensen K, Hov GG, et al. Diagnosing empty iron stores in women: unbound iron binding capacity (UIBC) versus soluble transferrin receptor (sTFR). Scandinavian J Clinical and Laboratory Investigation. 2021 Apr 1;81(2):137-41.