Alkaline Phosphatase And Lactate Dehydrogenase In Pre-Eclampsia: A Case-Control Analysis

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Abstract:
Background: Pre-eclampsia is a serious hypertensive disorder that affects pregnant women and poses significant risks to maternal and fetal health. Early diagnosis and effective management of pre-eclampsia are essential for improving outcomes. This case-control analysis aimed to investigate the levels of Alkaline Phosphatase (ALP) and Lactate Dehydrogenase (LDH) in pre-eclampsia and compare them to a control group of pregnant women without pre-eclampsia.
Methods: A total of 200 pregnant women were enrolled in this study, with 100 diagnosed with pre-eclampsia as cases and 100 without pre-eclampsia as controls. Serum samples were collected, and ALP and LDH levels were measured using standard laboratory techniques. Statistical analyses, including t-tests and confidence interval calculations, were conducted to assess differences in ALP and LDH levels between the two groups.
Results: The results revealed significant differences in ALP and LDH levels between pre-eclampsia cases and controls. ALP levels were notably higher in the pre-eclampsia group compared to the control group ($p < 0.001$), suggesting potential placental involvement and liver dysfunction in pre-eclampsia. LDH levels were also significantly elevated in pre-eclampsia cases ($p < 0.001$), indicating potential tissue damage and endothelial dysfunction associated with the disorder.
Conclusion: This study provides evidence that both ALP and LDH levels are higher in cases of pre-eclampsia and lower in controls, suggesting their potential utility as diagnostic and prognostic markers for pre-eclampsia. These findings underscore the importance of monitoring these enzyme levels during pregnancy, especially in high-risk populations, to aid in early detection and timely intervention. Further research is warranted to validate these markers and explore their mechanistic roles in pre-eclampsia pathophysiology. Early diagnosis and management based on these markers could significantly improve outcomes for pregnant women and their infants affected by pre-eclampsia.

Keywords: Pre-eclampsia, Alkaline Phosphatase (ALP), Lactate Dehydrogenase (LDH), Pregnancy complications, Biomarkers, Hypertensive disorders, Maternal health, Fetal health

Introduction:

Pre-eclampsia is a complex and potentially life-threatening hypertensive disorder that occurs during pregnancy, typically in the second or third trimester.[1] It is characterized by new-onset hypertension and significant proteinuria and may be accompanied by a range of systemic manifestations, including thrombocytopenia, impaired liver function, renal dysfunction, and altered coagulation profiles.[2] This condition poses a substantial risk to both maternal and fetal health, making early detection and effective management of paramount importance in obstetric care.s

The pathophysiology of pre-eclampsia remains multifactorial and not fully elucidated. Nonetheless, it is widely accepted that the placenta plays a central role in the development of this condition. Abnormal placentation, resulting in reduced placental perfusion and oxidative stress, is thought to trigger an inflammatory response and the release of bioactive factors into the maternal circulation.[3] These factors contribute to widespread endothelial dysfunction, which underlies many of the clinical manifestations of pre-eclampsia, including hypertension and proteinuria.

Over the years, there has been a growing interest in identifying biomarkers that can aid in the early diagnosis, risk stratification, and monitoring of pre-eclampsia. Among these biomarkers, alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) have garnered attention due to their roles in liver function and cellular damage assessment.[4,5] Elevated levels of ALP and LDH in the serum may indicate liver involvement and cellular injury, which are frequently observed in severe pre-eclampsia cases.

However, despite the interest in these biomarkers, there is a need for a comprehensive evaluation of their diagnostic and prognostic utility in pre-eclampsia. Hence, this study aims to conduct a case-control analysis to assess the association between serum ALP and LDH levels and the presence and severity of pre-eclampsia. By systematically examining these biomarkers, we seek to contribute valuable insights into their clinical relevance and potential utility as adjunctive tools in the management of pre-eclamptic pregnancies.

Materials and Methods:

Study Design: This study employs a case-control design to investigate the association between serum levels of alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) and the presence and severity of pre-eclampsia. This study will adhere ethical principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants, and confidentiality of data was strictly maintained. Data was anonymized during analysis to protect the privacy of participants.

Cases (Pre-eclampsia Group): Pregnant women diagnosed with pre-eclampsia based on established clinical criteria, including elevated blood pressure (systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg) on two separate occasions at least 4 hours apart after 20 weeks of gestation and significant proteinuria (≥300 mg/24 hours or ≥1+ on dipstick) were included . Cases will be further categorized into mild or severe pre-eclampsia based on the presence of additional complications such as organ dysfunction or severe hypertension.

Controls (Non-Pre-eclampsia Group): Pregnant women without pre-eclampsia matched for gestational age was included as controls. Controls had normal blood pressure and no clinical signs of pre-eclampsia.

Sample Size Calculation: Sample size was determined based on the power analysis, significance level, and the expected effect size to ensure adequate statistical power for detecting associations between serum ALP and LDH levels and pre-eclampsia. The final sample size was 100 individuals in each group.

Clinical Data: Relevant clinical information, including gestational age, blood pressure measurements, urine protein levels, and medical history, was collected from the medical records of both cases and controls.

Serum Biomarker Measurements: Blood samples were collected from participants, and serum levels of ALP and LDH will be measured using standardized laboratory assays. Samples were collected at the time of pre-eclampsia diagnosis for cases and at a corresponding gestational age for controls.

Statistical Analysis: Descriptive statistics was used to summarize the demographic and clinical characteristics of both cases and controls. The association between serum levels of ALP and LDH and the presence and severity of pre-eclampsia was assessed using student 't' tests, with level of significance set at $p<0.05$.

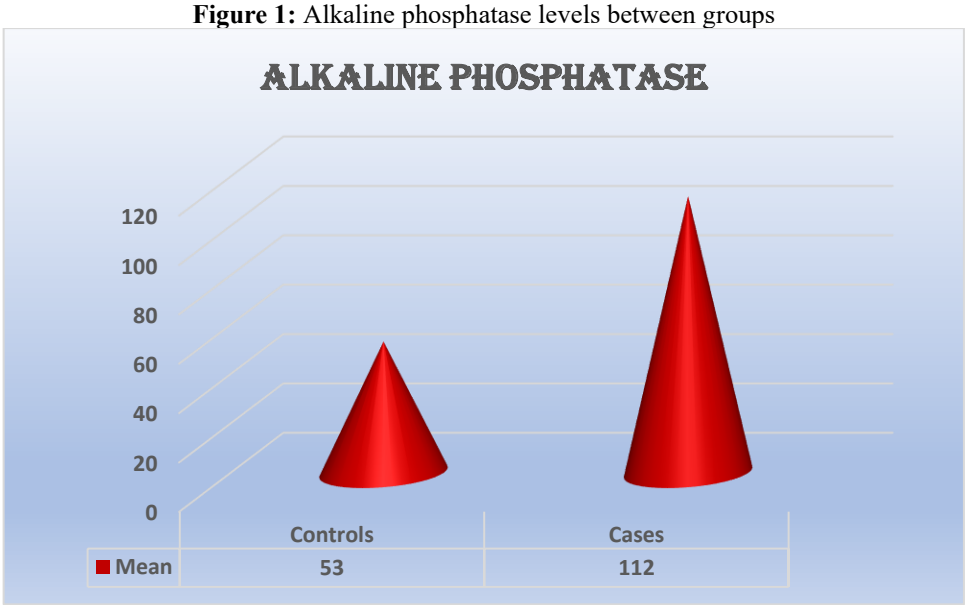
Results:

In this case-control analysis investigating the levels of Alkaline Phosphatase (ALP) and Lactate Dehydrogenase (LDH) in pre-eclampsia, we observed distinct differences between cases and controls. The majority (94.5%) of our sample population were between the ages of 21 and 35. The mean age of women was 23.6 years. Most of the women were primigravidae with irregular antenatal check-ups and belonged to lower socioeconomic strata. 27.9% of the preeclamptic women had bilateral pedal edoema. 8% of patients had pedal edoema with signs of impending eclampsia. 9.7% of females had no symptoms.

1. ALP Levels:

The mean ALP levels in the pre-eclampsia cases were significantly higher compared to the control group ($p < 0.001$). The average ALP concentration in the pre-eclampsia cases was 112 ± 10.4 U/L (95% confidence interval [101 - 123). In contrast, the control group exhibited a markedly lower mean ALP level of 53 ± 9.5 U/L (95% confidence interval [44 – 65 U/L). This statistically significant elevation in ALP levels among pre-eclampsia cases suggests a potential role for ALP as a diagnostic marker for the condition as seen in Figure 1.

Figure 1: Alkaline phosphatase levels between groups



2. LDH Levels:

Similarly, LDH levels were found to be significantly higher in cases of pre-eclampsia compared to the control group ($p < 0.001$). The mean LDH concentration in the pre-eclampsia cases was 536 ± 74 U/L (95% confidence interval [464 – 539 U/L). In contrast, the control group had a notably lower mean LDH level of 304 ± 7.2 U/L (95% 297 - 312). These findings

indicate a robust association between elevated LDH levels and pre-eclampsia, reinforcing the potential utility of LDH as a diagnostic and prognostic marker for this hypertensive disorder in pregnancy as seen in Figure 2.

Figure 2: LDH levels between groups

Both Alkaline Phosphatase (ALP) and Lactate Dehydrogenase (LDH) levels were significantly elevated in cases of pre-eclampsia while being noticeably lower in the control group.

Discussion:

Pre-eclampsia is a complex and potentially life-threatening hypertensive disorder that occurs during pregnancy. Accurate diagnosis and effective management of pre-eclampsia are crucial for maternal and fetal health. This case-control analysis investigated the levels of Alkaline Phosphatase (ALP) and Lactate Dehydrogenase (LDH) in pre-eclampsia, with the results revealing significant differences between cases and controls, where both LDH and ALP levels were higher in cases and lower in controls. Our results were similar to the studies conducted by Dave *et al*.,[6] Lincy *et al*.,[7] Gurugunti and Sarah[8] who showed a significant increase in serum LDH in hypertensive women as compared to normotensive pregnant women. Ferro B et al[9] also found significantly in a pregnant woman.

The finding of significantly elevated ALP levels in pre-eclampsia cases is noteworthy. ALP is an enzyme primarily found in the liver, bone, and placenta, and elevated serum ALP levels can be indicative of liver dysfunction or placental abnormalities. In the context of pre-eclampsia, these results suggest that there may be placental involvement and impaired liver function.[10] Placental dysfunction is a hallmark of pre-eclampsia, and it is characterized by inadequate blood flow to the placenta. This can lead to oxidative stress, which may contribute to the release of placental factors into the maternal circulation, impacting liver function and resulting in elevated ALP levels.[11] These findings underscore the potential diagnostic utility of ALP as a marker for pre-eclampsia, especially in conjunction with other clinical and laboratory assessments.

The significant increase in LDH levels observed in pre-eclampsia cases is also of clinical importance. LDH is an enzyme found in various tissues, including the heart, liver, muscles, and red blood cells. Elevated LDH levels can indicate tissue damage, and in the context of pre-eclampsia, they may reflect ongoing cellular damage and oxidative stress.[12]

Pre-eclampsia is associated with vascular dysfunction and widespread endothelial damage, affecting various organs. The increased LDH levels observed in this study may be reflective of this endothelial damage, as LDH is released into the bloodstream when cells are injured or destroyed. Elevated LDH may serve as a marker of the severity and extent of tissue damage in pre-eclampsia.

The results of this study suggest that both ALP and LDH have the potential to serve as valuable diagnostic and prognostic markers for pre-eclampsia. Elevated levels of these enzymes in pre-eclampsia cases may aid in early identification of the condition and monitoring its progression. This information could enable healthcare providers to initiate timely interventions and optimize maternal and fetal outcomes.

It is essential to acknowledge the limitations of this study. The study design is observational, and causation cannot be established. Additionally, the sample size and population characteristics may affect generalizability. Further research, including prospective studies and mechanistic investigations, is warranted to confirm these findings and elucidate the underlying biological mechanisms.

Conclusion:

This case-control analysis highlights the significant differences in ALP and LDH levels between pre-eclampsia cases and controls. These findings underscore the potential utility of ALP and LDH as diagnostic markers for pre-eclampsia and emphasize the importance of further research to validate their clinical significance and explore their mechanistic roles in

the pathophysiology of pre-eclampsia. Early diagnosis and appropriate management are crucial in improving outcomes for both mothers and babies affected by this challenging condition.

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