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ORIGINAL ARTICLE

Evaluate the Association of Various Electrolyte Abnormalities with Preeclampsia

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ABSTRACT

Introduction: Preeclampsia is a complex hypertensive disorder of pregnancy characterized by new-onset hypertension and proteinuria or significant end-organ dysfunction after 20 weeks of gestation.

Objective: The main objective of the study is to find the association of various electrolyte abnormalities with preeclampsia.

Methodology: This cross-sectional study was conducted at Department of Gynecology DHQ Hospital Killa saifullah during December 2021 to October 2022. A study was conducted on 165 patients diagnosed with preeclampsia. Patients were selected based on clinical and laboratory criteria, including blood pressure measurements, proteinuria, and relevant electrolyte profiles.

Results: Women with severe preeclampsia were diagnosed at an earlier gestational age (31.3 ± 2.9 weeks) compared to those with mild preeclampsia (33.2 ± 2.7 weeks) ($p = 0.013$). Systolic and diastolic blood pressures were significantly higher in the severe preeclampsia group (161.3 ± 9.7 mmHg and 106.5 ± 8.4 mmHg, respectively) compared to mild cases (145.8 ± 8.5 mmHg and 93.6 ± 7.1 mmHg) ($p < 0.001$). Additionally, proteinuria levels were markedly elevated in severe preeclampsia (2.1 ± 0.7 g/day) compared to mild cases (0.8 ± 0.3 g/day) ($p < 0.001$).

Conclusion: It is concluded that electrolyte imbalances, particularly reduced levels of calcium, magnesium, and potassium, along with elevated phosphate levels, are significantly associated with the severity of preeclampsia.

Keywords: Preeclampsia, Calcium, Magnesium, Potassium

INTRODUCTION

Preeclampsia is a complex hypertensive disorder of pregnancy characterized by new-onset hypertension and proteinuria or significant end-organ dysfunction after 20 weeks of gestation. It remains a major cause of increased maternal and fetal morbidities, and maternal deaths worldwide[1]. The basic Doctor Knight outlines and discusses five pathophysiologic categories that are important in preeclampsia: electrolyte abnormalities, endothelial dysfunction, coagulation abnormalities, renal dysfunction, and hypertension. Abnormalities of Na, K, Ca, Mg, and many other electrolytes can affect the tone of the blood vessels, the functioning of endothelium, and the balance of fluids, all of which are bound to worsen the situation[2]. For this purpose, the present study aimed to determine the relationship of different electrolyte derangements to preeclampsia to shed light on its cause, detection, and treatment. This review aims to disentangle the links between electrolyte imbalances and preeclampsia to establish why they are important in clinical practice[3].

We know that electrolytes are critical for cell operation, blood vessel integrity, and regular body functioning. Several mechanisms for the development of electrolyte imbalance can occur in preeclampsia such as impaired renal function, hormonal changes, oxidant stress and endothelial dysfunction, and an increased production of cytokines and inflammatory markers[4]. These changes participate in preeclampsia pathophysiology and include hypertension, increased proteinuria and edema. Hyponatremia or hypernatremia might result from the disease effects on the renal sodium and water metabolism. Hypervolemia is seen as a result of sodium retention that results from increase aldosterone and ADH levels which in turn causes hypertension and edema. On the other hand, severe presentations may involve hyponatremia on account of fluid overload or inappropiate secretion of the antidiuretic hormone[5].

Hypokalemia is common in preeclampsia and is usually related to higher aldosterone levels, which cause potassium loss in urine[6]. Potassium is also involved in smooth muscle relaxation and endothelial health, and low levels of it may contribute to worse vascular function, researchers found. The effects of potassium include hyperkalemia although rare because of a poor renal profile seen with severe preeclampsia[7]. Supervising the potassium levels is vital in patients experiencing cardiovascular and renal issues in MM survive. Calcium metabolism is said to be closely related to preeclampsia process and development. Low calcium level has been linked with preeclampsia, possibly because of reduced responsiveness of vascular smooth muscle to calcium and also changes in calcium regulation. Intakes of calcium have also been suspected to have benefits in decreasing the risk of preeclampsia, especially among ladies consuming low levels of dietary calcium[8].

The mineral also helps in the vasodilation process and blood pressure lowering. ,low serum magnesium levels are found in preeclampsia and could be involved in elevated vascular tone and endothelium dysfunction. This drug which is commonly used to manage severe preeclampsia and eclampsia shows a role for magnesium in lessening the severity of the disease and preventing seizures[9]. Regarding other electrolyte perturbations, presence of hypophosphatemia, and hypoclaemia with choreiform movements is unlikely, since the phosphate and bicarbonate abnormalities are also described in preeclampsia. These imbalances can also arise from other metabolic disorders, such as acid or base imbalance that may also be deep-seated, and contribute to further clinical complexity. The effect of chloride in pregnancy, albeit having received less attention, it could impact on acid base status and vascular responsiveness in preeclampsia[10]. The authors identified some mechanisms connecting electrolyte disturbances and preeclampsia. Renal dysfunction in preeclampsia leads to the disturbance of the uptake of Sodium and Potassium in the filtrate hence the disturbance of the overall ratios. In addition, there are hormonal imbalances with increased aldosterone, ADH and activation of the renin-angiotensin-aldosterone system (RAAS) in diabetes and hypertension disease in patients is associated with impaired regulation of fluid and electrolyte balance. Increased endothelial permeability and oxidative stress impair the normal physiology of ion exchange across the endothelial barrier, while systemic inflammation that occurs in preeclampsia may affect the function of cellular ion channels and transport systems, increasing the risk of electrolyte disorders[11]. Imbalance in electrolyte levels is part of the preeclampsia disease process and clinical symptoms. Knowledge of these dysregulations is critical in disease processes and interventions targets. The current study should be followed by other studies with aim in understanding the exact relation between electrolyte disturbances and preeclampsia in order to curtail the issue with prevention strategies[12].

Objective: The main objective of the study is to find the association of various electrolyte abnormalities with preeclampsia.

METHODOLOGY

This cross-sectional study was conducted at Department of Gynecology DHQ Hospital Killa saifullah during December 2021 to October 2022. Study was conducted on 165 patients diagnosed with preeclampsia. Patients were selected based on clinical and laboratory criteria, including blood pressure measurements, proteinuria, and relevant electrolyte profiles.

Inclusion Criteria

- Pregnant women diagnosed with preeclampsia after 20 weeks of gestation.
- Patients with documented blood pressure readings and proteinuria.
- Availability of complete biochemical profiles for electrolyte analysis.

Exclusion Criteria

- Patients with pre-existing chronic hypertension, renal disease, or diabetes mellitus.
- Cases of eclampsia or HELLP syndrome at the time of enrollment.
- Incomplete or missing clinical and laboratory data.

Data Collection: Data collection was carried out systematically. Patient demographics, clinical history, and pregnancy-related details were recorded. Blood samples were taken to measure serum electrolyte levels, including sodium, potassium, calcium, magnesium, phosphate, and bicarbonate. Blood pressure and urine protein levels were monitored throughout the study period. All laboratory tests were conducted using standardized equipment and protocols to ensure accuracy and consistency.

Data Analysis: Data were analyzed using SPSS v 26. Descriptive statistics were used to summarize the data, while inferential tests, such as Pearson correlation and regression analysis, were applied to identify significant associations. A p-value of <0.05 was considered statistically significant. Subgroup analyses were conducted to explore potential variations in electrolyte abnormalities based on gestational age and the severity of preeclampsia.

RESULTS

Data were collected from 165 patients. Women with severe preeclampsia were diagnosed at an earlier gestational age (31.3 ± 2.9 weeks) compared to those with mild preeclampsia (33.2 ± 2.7 weeks) ($p = 0.013$). Systolic and diastolic blood pressures were significantly higher in the severe preeclampsia group (161.3 ± 9.7 mmHg and 106.5 ± 8.4 mmHg, respectively) compared to mild cases (145.8 ± 8.5 mmHg and 93.6 ± 7.1 mmHg) ($p < 0.001$). Additionally, proteinuria levels were markedly elevated in severe preeclampsia (2.1 ± 0.7 g/day) compared to mild cases (0.8 ± 0.3 g/day) ($p < 0.001$).

Table 1: Patient Demographics and Clinical Characteristics

Characteristic	Mild Preeclampsia (n=92)	Severe Preeclampsia (n=73)	Total (n=165)	p-value
Age (years, mean ± SD)	28.3 ± 4.1	29.2 ± 4.5	28.7 ± 4.2	0.215
Gestational Age at Diagnosis (weeks)	33.2 ± 2.7	31.3 ± 2.9	32.4 ± 2.8	0.013*
BMI (kg/m², mean ± SD)	26.4 ± 2.8	27.1 ± 3.1	26.7 ± 3.0	0.102
Systolic BP (mmHg, mean ± SD)	145.8 ± 8.5	161.3 ± 9.7	152.6 ± 11.6	<0.001*
Diastolic BP (mmHg, mean ± SD)	93.6 ± 7.1	106.5 ± 8.4	99.2 ± 9.8	<0.001*
Proteinuria (g/day, mean ± SD)	0.8 ± 0.3	2.1 ± 0.7	1.4 ± 0.9	<0.001*
Primigravida (%)	58 (63%)	38 (52%)	96 (58%)	0.158
Multiparous (%)	34 (37%)	35 (48%)	69 (42%)	0.178

*Significant at $p < 0.05$.

Women with severe preeclampsia had lower serum sodium (135.4 ± 2.9 mEq/L), potassium (3.8 ± 0.3 mEq/L), calcium (8.4 ± 0.5 mg/dL), and magnesium (1.7 ± 0.2 mg/dL) levels compared to those with mild preeclampsia (137.8 ± 3.2 mEq/L, 4.2 ± 0.4 mEq/L, 9.1 ± 0.6 mg/dL, and 2.0 ± 0.3 mg/dL, respectively), with all differences being statistically significant ($p < 0.05$). Phosphate levels were significantly higher in severe preeclampsia (4.1 ± 0.5 mg/dL) compared to mild preeclampsia (3.7 ± 0.4 mg/dL) ($p = 0.033$). Additionally, bicarbonate levels were significantly lower in severe cases (20.4 ± 2.1 mEq/L) compared to mild cases (22.1 ± 1.8 mEq/L) ($p = 0.027$).

Table 2: Serum Electrolyte Levels

Electrolyte	Mild Preeclampsia (n=92)	Severe Preeclampsia (n=73)	p-value
Sodium (mEq/L)	137.8 ± 3.2	135.4 ± 2.9	0.021*
Potassium (mEq/L)	4.2 ± 0.4	3.8 ± 0.3	0.017*
Calcium (mg/dL)	9.1 ± 0.6	8.4 ± 0.5	0.002*
Magnesium (mg/dL)	2.0 ± 0.3	1.7 ± 0.2	0.011*
Phosphate (mg/dL)	3.7 ± 0.4	4.1 ± 0.5	0.033*
Bicarbonate (mEq/L)	22.1 ± 1.8	20.4 ± 2.1	0.027*

*Significant at $p < 0.05$.

Sodium demonstrated a significant negative correlation with both SBP ($r = -0.34$) and DBP ($r = -0.28$), as well as a moderate negative correlation with proteinuria ($r = -0.22$) ($p = 0.012$). Potassium had a positive correlation with proteinuria ($r = +0.28$) and moderate positive correlations with both SBP ($r = +0.14$) and DBP ($r = +0.18$) ($p = 0.019$). Calcium levels were negatively correlated with SBP ($r = -0.21$), DBP ($r = -0.41$), and proteinuria ($r = -0.26$), with the strongest correlation seen with DBP ($p = 0.003$). Magnesium also showed significant negative correlations with both SBP ($r = -0.32$) and DBP ($r = -0.36$), as well as a weaker negative correlation with proteinuria ($r = -0.19$) ($p = 0.009$).

Table 3: Correlation of Electrolyte Levels with Clinical Parameters

Electrolyte	Correlation with SBP (r)	Correlation with DBP (r)	Correlation with Proteinuria (r)	p-value
Sodium	-0.34	-0.28	-0.22	0.012*
Potassium	+0.14	+0.18	+0.28	0.019*
Calcium	-0.21	-0.41	-0.26	0.003*
Magnesium	-0.32	-0.36	-0.19	0.009*
Phosphate	+0.18	+0.11	+0.33	0.015*

Women diagnosed before 34 weeks had lower serum sodium (134.8 ± 3.1 mEq/L) compared to those diagnosed later (136.9 ± 2.8 mEq/L) ($p = 0.018$). Potassium levels were also lower in the ≤34 weeks group (3.9 ± 0.3 mEq/L) than in the >34 weeks group (4.1 ± 0.4 mEq/L) ($p = 0.025$). Similarly, calcium levels were significantly lower in the ≤34 weeks group (8.2 ± 0.4 mg/dL) compared to the >34 weeks group (8.7 ± 0.5 mg/dL) ($p = 0.007$). Magnesium levels were lower in the ≤34 weeks group (1.6 ± 0.3 mg/dL) compared to those diagnosed later (1.9 ± 0.2 mg/dL) ($p = 0.014$).

Table 4: Subgroup Analysis by Gestational Age

Electrolyte	≤34 weeks (n=78)	>34 weeks (n=87)	p-value
Sodium (mEq/L)	134.8 ± 3.1	136.9 ± 2.8	0.018*
Potassium (mEq/L)	3.9 ± 0.3	4.1 ± 0.4	0.025*
Calcium (mg/dL)	8.2 ± 0.4	8.7 ± 0.5	0.007*
Magnesium (mg/dL)	1.6 ± 0.3	1.9 ± 0.2	0.014*

Magnesium levels were reduced in severe cases (1.7 ± 0.2 mg/dL), compared to mild cases (2.0 ± 0.3 mg/dL). Phosphate

levels were notably higher in severe cases (4.1 ± 0.5 mg/dL) than in mild cases (3.7 ± 0.4 mg/dL), while bicarbonate levels were lower in severe cases (20.4 ± 2.1 mEq/L) compared to mild cases (22.1 ± 1.8 mEq/L), suggesting an imbalance of electrolytes associated with the severity of the condition.

Table 5: Electrolyte Abnormalities by Severity of Preeclampsia

Electrolyte	Normal Range	Observed in Mild Cases	Observed in Severe Cases
Sodium (mEq/L)	135–145	137.8 ± 3.2	135.4 ± 2.9
Potassium (mEq/L)	3.5–5.0	4.2 ± 0.4	3.8 ± 0.3
Calcium (mg/dL)	8.5–10.5	9.1 ± 0.6	8.4 ± 0.5
Magnesium (mg/dL)	1.7–2.3	2.0 ± 0.3	1.7 ± 0.2
Phosphate (mg/dL)	2.5–4.5	3.7 ± 0.4	4.1 ± 0.5
Bicarbonate (mEq/L)	22–28	22.1 ± 1.8	20.4 ± 2.1

DISCUSSION

This study highlights the significant role of electrolyte abnormalities in the pathophysiology and severity of preeclampsia. Accordingly, this study has established highly significant changes in serum sodium, potassium, calcium, magnesium, phosphate, and bicarbonate in Covid-19 patients as compared to normal values. Most importantly, both the original study and replication of this work showed that low calcium and magnesium intakes were significantly linked to higher blood pressure, and disease progression implications for vascular and endothelial functions were established[13]. Likewise, the seen hypokalemia and slightly reduced sodium are believed to be much more dynamics hormonal imbalance and renal involvement. Abnormal levels of phosphate and decreased bicarbonate can also indicate metabolic and renal changes and worsening of the vascular damage is preeclampsia. These electrolyte disturbances also bore some relation with clinical features namely the blood pressure nargin and the degree of proteinuria[14]. For example, calcium and magnesium levels decreased in blood pressure, and phosphate levels increased in proteinuria. Analysis of the patient data carried out using the regression analysis method found low serum calcium and magnesium and high phosphate as having association with severe preeclampsia. These findings affirm the value of electrolyte profiles as indicators of disease state severity, and identify novel therapeutic targets[15]. In comparison with the previous literature, this investigation substantiates other investigations pinpointing hypocalcemia and hypomagnesemia to preeclampsia. However, the study design makes it possible for analysis of several electrolytes of the same type and their correlation with clinical markers. The study results are also supportive of findings of favorable effect of calcium and magnesium supplementation in decreasing the risk of preeclampsia but with a need to combat hyperphosphatemia in severe presentation[16]. From the clinical point of view, the present investigation underscores the need for periodic evaluation of electrolyte concentrations in pregnant women—especially in those with a prospect of preeclampsia[17]. Such monitoring is useful in early diagnosis and staging of the disease that is useful when developing a care plan. In addition to maternal calcium and magnesium supplementation and the management of phosphate levels, aspects of potential therapeutic impact have been identified that may enhance maternal and fetal care[18]. Nevertheless, dependence on the survey means that there are some fundamental drawbacks, including the inability to establish cause-effect relationships because of cross-sectional analysis and the exclusion of patients with eclampsia or reduce generalizability to the most severe cases. We require future longitudinal and multicentre research to replicate these conclusions, implement mediational models, and investigate the effectiveness of tailored therapeutic approaches. Thus, this study emphasizes the possibility of correcting the electrolyte disturbances in the course of preeclampsia and contributes to the better understanding of the question, concerning the treatment of the described pathology in order to ensure better outcomes of the pregnancy for the women affected and their newborns.

CONCLUSION

It is concluded that electrolyte imbalances, particularly reduced levels of calcium, magnesium, and potassium, along with elevated phosphate levels, are significantly associated with the severity of preeclampsia. These abnormalities may serve as valuable biomarkers for early detection and disease monitoring. Addressing these imbalances through targeted interventions could improve maternal and fetal outcomes in preeclampsia.

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