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Renal Function in Preeclamptics versus Normal Pregnant Women

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Abstract

Background: Pregnancy is implicated in notable physiological changes and the extraordinary kidney physiology during pregnancy is believed to have an effect on kidney functions. However, during pregnancy the glomerular filtration rate (GFR) increases its work rate up to 50%, on the contrary, in preeclampsia the GFR turns back to decline. **Objectives:** This study aims to measure and compare kidney function between preeclamptic and normal pregnant women. **Materials and Methods:** A cross-sectional hospital-based study was conducted in the period from March to May 2021 in Wad Medani Obstetrics and Gynecology Teaching Hospital. A total of 100 pregnant women, 50 apparently healthy pregnant women and 50 pregnant ladies proved to have preeclamptic toxemia, their ages ranged from 18 to 44 years old and at the third trimester of pregnancy. Blood samples were taken and serum was separated, then urea, creatinine, uric acid, sodium and potassium were determined. Data were analyzed using Statistical Package for Social Science (SPSS). **Results:** The results of this study revealed that 92% of preeclamptic pregnant women had the first time of the incidence and 8% were family inherited preeclampsia and injured multiple times. The preeclamptic pregnant women showed elevation in both systolic and diastolic blood pressure compared to the normal pregnant women. Although the creatinine values of all study subjects were in the normal range, the mean of its serum level was found to be higher in normal pregnant women than that in preeclamptic women. The study also showed urea level was elevated in the preeclampsia group in comparison to the normal one, while all values were in the normal range. In addition to the significant difference that observed in the uric acid mean between preeclamptic (higher) and normal pregnant groups, abnormal values were only noticed with many preeclamptic patients. The levels of electrolytes (sodium and potassium) were elevated in the preeclampsia women group, whe-

reas all values were in the normal range. **Conclusion:** This study concluded that preeclamptics showed significant elevation in the urea, uric acid, sodium and potassium levels and a significant decrease in creatinine level compared to normal pregnant women, although all parameters values for both groups were in the reference values for non-pregnancy.

Keywords

Preeclampsia, Pregnant Women, Renal Function, Gezira State, Sudan

1. Introduction

Hypertensive disorders remain the most common medical complication during pregnancy. It affects about 5.2% to 8.2% of all pregnancies [1]. Gestational hypertension represents around 70% of hypertensive disorders in pregnancy while 30% are caused by chronic hypertension. Hypertension is defined as an elevated blood pressure (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg). The measurements should be taken at least twice times within one week, but not less than 6 hours apart [2].

Gestational hypertension is defined as a new onset of high blood pressure (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg), in a woman that was previously normotensive up to 20 weeks of gestation. The incidence of gestational hypertension ranges from 6% to 17% in healthy nulliparous women and from 2% to 4% in multiparous women. About 25% of women with gestational hypertension may possibly progress into preeclampsia [3].

Preeclampsia is defined as gestational hypertension accompanied by proteinuria of (≥300 mg/24hours). It is a multisystem disorder that affects 0.2% - 9.2% of pregnancies, resulting in a poor outcome in the health of the mother/fetus and constitutes a major cause of morbidity and mortality in the world [1]. In Sudan, preeclampsia is implicated in high maternal morbidity and mortality, representing about 4.2% of all obstetric complications and 20% of maternal deaths [4] [5]. Pregnancy is implicated in notable physiological changes and the extraordinary kidney physiology during pregnancy is believed to have an effect on kidney functions. However, during pregnancy the GFR increases its work rate up to 50%, which leads to increased urea, creatinine and uric acid clearance and consequently decreases plasma level. On the contrary, in preeclampsia the GFR turns back to decline, eventually may lead to damage to the kidneys [6] [7] [8] [9]. Endotheliosis is the major marked renal change in preeclampsia characterized by cellular swelling of the glomerular endothelium, which leads to the glomerular basement membrane damage, resulting in hypoperfusion of the glomeruli and proteinuria, eventually reduced glomerular filtration rate. Renal adaptations to these changes may manifest as elevated blood pressure [10]. Understanding the disease progression and the influence of hypertensive disorders on pregnancy is of extreme importance as it remains a major cause of maternal

and perinatal morbidity and mortality worldwide. Therefore, this study might be helpful in finding a way to test the efficiency of the kidneys in preeclamptic pregnant women.

2. Materials and Methods

2.1. Study Design

A cross-sectional hospital-based study was conducted on normal and preeclamptic pregnant women in the period from March to May 2021.

2.2. Study Population

The study recruited 100 pregnant women who attended to Wed Medani Obstetrics and Gynecology Teaching Hospital during the study period, 50 pregnant women diagnosed with preeclampsia and another 50 normal pregnant women taken as control group.

2.3. Blood Sample

Five ml of venous blood samples were taken for each pregnant woman and collected into heparin tubes, then separated by centrifugation at 1000 rpm for 15 minutes, and the serum was taken to measure the studied parameters. Ceatinine was measured by colorimetric reaction (Jaffe reaction) with alkaline picrate, measured kinetically at 490 nm [11]. Uric acid is oxidized by uricase to allantoine and hydrogen peroxide ($2H_2O_2$), which under the influence of POD, 4–aminophenazone (4-AP) and 2 - 4 Dichlorophenol sulfonate (DCPS) forms a red quinoneimine compound. The absorbance measured at 505 nm is proportional to the amount of uric acid in the specimen [12]. Blood urea nitrogen was estimated by urease method [13]. Sodium and potassium were estimated by AFT- 300 Cornley Electrolytes Analyzer.

2.4. Inclusion/Exclusion Criteria

Preeclampsia and normal pregnant women in the third trimester with all ages were included in this study, while pregnant women with other medical conditions such as hepatitis, diabetes mellitus, renal failure, autoimmune diseases, tuberculosis, chronic hypertension, heart diseases and myeloproliferative disorders were excluded.

2.5. Ethical Consideration

The study was approved by the Ethics Committee of Faculty of Medicine, University of Gezira as well as the Ethics Committee of Ministry of Health, Gezira State. A written consent was taken from all study participants.

2.6. Statistical Analysis

The data were analyzed using Statistical Package for Social Science (SPSS) Version.20.0. Independent samples t-test was used to compare the means of all

study parameters between preeclamptic and normal pregnant women. The results were presented as mean ± SD and $P \leq 0.05$ was considered as significant at 95% confidence interval.

3. Results

3.1. Study Population

A total of 100 pregnant women in the third trimester were recruited in this study, 50 of them were clinically diagnosed with preeclampsia while the other 50 were apparently healthy pregnant women. All these study subjects attended to Wed Medani Obstetrics and Gynecology Teaching Hospital during the period of the study. About 92% of preeclamptic pregnant women had the first time of the incidence and 8% were family inherited of preeclampsia and injured multiple times. Sixty eight of the study subjects (37 preeclamptic and 31 normal pregnant women) were outside Medani town while 32 (13 preeclamptic and 19 normal pregnant women) from Medani.

3.2. Age of the Study Subjects

There was no difference in the age mean between the two groups of the study subjects, moreover, most women in both groups were in the age range of 25- 34 years old (Table 1).

3.3. Gestational Age of the Study Subjects

About 80% of the study subjects were beyond 30 weeks of pregnancy, however, as can be seen in Table 2, 50% of the preeclamptic pregnant women had gestational age of (31 - 35) weeks, whereas, 46% of the normal pregnant women were in (36 - 40) weeks.

3.4. Parity of the Study Subject Groups

Table 3 presents parity distribution of the study subjects, revealing that more than 80% of the all pregnant women in this study were had (0 - 3) parity.

3.5. Blood Pressure of the Study Subject Groups

The peeclamptic pregnant women showed a high elevation in the blood pressure compared to normal women. The differences between the two study groups in the systolic and diastolic blood pressure were found to be significant as (*P*-value = 0.00) for both systolic and diastolic blood pressure (Table 4).

3.6. Renal Function in the Study Subjects

3.6.1. Creatinine, Urea and Uric Acid Levels in the Study Subjects

Although the means of the all studied renal function parameters were found to be lied within the normal range, the mean differences between the preelamptic and normal pregnant women in the creatinine (*P*-value = 0.00), urea (*P*-value = 0.01) and uric acid (*P*-value = 0.00) were noticed (Table 5). On the other hand,

Table 1. Distribution of the study subjects according to age.

Age group (year)	Group	Frequency	Percentage (%)
15 - 24	Preeclampsia	14	28
	Normal pregnant	13	26
25 - 34	Preeclampsia	27	54
	Normal pregnant	30	60
35 - 45	Preeclampsia	9	18
	Normal pregnant	7	14

Table 2. Distribution of the study subjects according to gestational age.

Gestational age (weak)	Group	Frequency	Percentage (%)
25 - 30	Preeclampsia	10	20
	Normal pregnant	10	20
31 - 35	Preeclampsia	25	50
	Normal pregnant	17	34
36 - 40	Preeclampsia	15	30
	Normal pregnant	23	46

Table 3. Distribution of the study subjects according to parity.

Parity	Group	Frequency	Percentage (%)
0 - 3	Preeclampsia	40	80
	Normal pregnant	42	84
4 - 6	Preeclampsia	8	16
	Normal pregnant	7	14
7 - 10	Preeclampsia	2	4
	Normal pregnant	1	2

Table 4. Comparison of blood pressure between preeclamptic and normal pregnant women.

Parameter	Group	Mean ± SD	*P-value*
Systolic blood pressure (mmHg)	Preeclampsia	164.80 ± 27.2	0.00
	Normal pregnant	110.80 ± 2.7	
Diastolic blood pressure (mmHg)	Preeclampsia	105.10 ± 14.5	0.00
	Normal pregnant	70.000 ± 0.0	

unlike urea and uric acid, creatinine mean was decreased in the preeclampsia group in comparison to normal pregnant group. Noteworthy, most values of creatinine in the preeclamptic pregnant women were accumulated in the range (0.26 - 0.5 mg/dl), whereas the normal pregnant women creatinine values were lied in the range from (0.51 - 0.75 mg/dl) (**Figure 1**).

Table 5. Comparison of creatinine, urea and uric acid means between preeclamptic and normal pregnant women.

Parameter	Group	Mean ± SD	*P*-value
Creatinine (mg/dl)	Preeclampsia	0.5446 ± 0.1	0.00
	Normal pregnant	0.6920 ± 0.1	
Urea (mg/dl)	Preeclampsia	18.9800 ± 6.3	0.01
	Normal pregnant	16.2400 ± 3.1	
Uric acid (mg/dl)	Preeclampsia	6.0880 ± 1.5	0.00
	Normal pregnant	4.0540 ± 0.5	

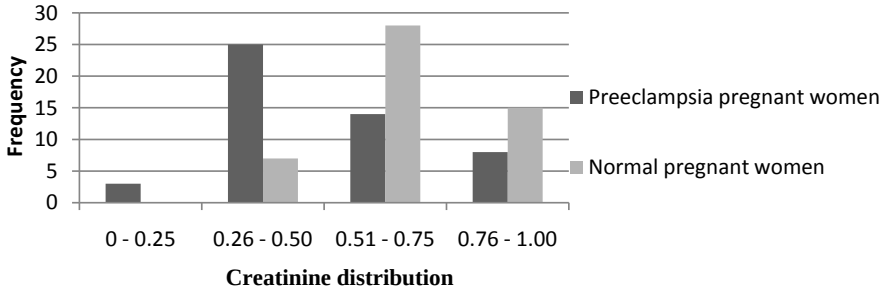

Figure 1. Distribution of creatinine in preeclamptic and normal pregnant women.

3.6.2. Electrolytes (Sodium and Potassium) Levels in the Study Subjects

Table 6 shows that there was a significant difference in the sodium (*P*-value = 0.00), and potassium (*P*-value = 0.00) means between preeclampsia and normal pregnant groups. Despite all values of both sodium and potassium were in the normal range, preeclamptic women showed elevation in the electrolytes levels compared to the normal women.

4. Discussion

In this study, the preeclampsia pregnant women showed elevation in both systolic (*P*-value = 0.00) and diastolic (*P*-value = 0.00) blood pressure compared to the normal pregnant women, this confirms the association of high blood pressure (systolic and/or diastolic) with the occurrence of the preeclampsia as reported earlier [14].

When concerned renal function, although the creatinine values of the all study subjects were in the normal range, the mean of its serum level was found to be higher in the normal pregnant women than that of preeclamptic women. Moreover, we noticed that most values of creatinine of preeclamptic women were accumulated in the range (0.26 - 0.5 mg/dl), whereas the normal women creatinine values were in the range (0.51 - 0.75 mg/dl). Thus, the creatinine mean of normal pregnant women was higher than that of preeclamptic women. This is a confusing result and disagrees with the assumption of GFR decreasing in preeclampsia [15]. In order to gain more insight, the correlation tests between serum creatinine and systolic blood pressure were made in both preeclampsia and normal

Table 6. Comparison of sodium and potassium means, between preeclamptic and normal pregnant women.

Parameter	Group	Mean ± SD	*P*-value
Sodium (mEq/l)	Preeclampsia	133.31 ± 3.5	0.00
	Normal pregnant	129.65 ± 0.8	
Potassium (mEq/l)	Preeclampsia	3.8418 ± 0.3	0.00
	Normal pregnant	3.6796 ± 0.1	

women groups. The preeclampsia group showed a positive correlation (r = 0.330, *P.* value = 0.02) between the serum creatinine and systolic blood pressure, indicating that creatinine clearance was decreasing reversely to increasing in systolic blood pressure (GFR decreased). On the other side in normal pregnant women, the serum creatinine correlated negatively with the systolic blood pressure, in other words, GFR was increasing proportional to the systolic blood pressure up to normal border value (120 mmHg), beyond this value, GFR turned back to decline as noted in preeclampsia. However, an important observation was noticed, the systolic blood pressure of the most normal pregnant women was accumulated closed to (110 mmHg), and this can explain why serum creatinine mean of this group was higher than that of preeclamptic women.

This study also showed urea level was elevated in the preeclampsia group in comparison to the normal one (*P*-value = 0.01), while all values were in the normal range. These results are in accordance with the study done earlier [16], showing higher urea level in preeclamptic patients compared to normotensive women. Increased urea level in preeclamptic patients may be to some extent explained by occurrence of microangiopathic haemolysis due to endothelium injury in preeclampsia which results in increasing urea synthesis in liver with kidney incapability to excrete urea from blood [17]. An alternative possible explanation is excretion of urea is dependent on renal blood flow (RBF) and glomerular filtration, with less tubular reabsorption. As a consequence of preeclampsia, hypovolemia leads to high angiotensin II and an angiotensin II hypersensitive state, efferent arteriolar resistance and filtration is increased. Thus, angiotensin II enhences direct tubular reabsorption of water as well as urea and this may explain the elevated levels observed in preeclampsia [18].

In addition to the significant difference that observed in the uric acid mean between preeclampsia (higher) and normal groups (*P*-value = 0.00), abnormal values were only noticed with preeclamptic patients. The increasing of uric acid level in preeclampsia was reported previously in different studies [16] [19] [20]. In spite of generation of high uric acid along with increased free radical formation and elevated oxidative stress in preeclampsia was attributed to tissue ischemia [21], the renal dysfunction which results in decreased renal clearance remains the most evidenced mechanism that can explain the elevation of uric acid in preeclampsia compared to normal pregnant women [22]. Moreover, uric acid, creatinine and to some extent urea were suggested to poses an antioxidant cha-

racteristics and act a scavenger of singlet oxygen and radicals [23] [24].

Despite the levels of electrolytes (Sodium and Potassium) values were elevated in the preeclampsia women group (P-value = 0.00 for each), value were found to be within the normal range, which is in agreement with a previous study [25] which showed normal plasma sodium and potassium values in preeclamptic and normal pregnant women. In preeclampsia, the volume of the circulating plasma is reduced, this may account for decreasing Na^+ delivery to the distal nephron and decreasing K^+ secretion [26].

5. Conclusion

This study concluded that preeclamptics showed significant elevation in the urea, uric acid, sodium, and potassium levels and a significant decrease in creatinine levels compared to normal pregnant women, although all parameters values for both groups were in the reference values for non-pregnancy. Thus, there is a need for close monitoring of preeclamptic pregnant women and establishing reference values of these parameters for Sudanese pregnant women.

Limitations of the Study

The main limitation of the present cross-sectional study was the small sample size of the comparative groups (50 preeclamptics and 50 normal pregnant women). A longitudinal study with large sample size regarding renal function parameters in normal pregnant women and preeclamptics (before/after preeclampsia and postpartum) would provide more insights. Data of protein creatinine ratio (PCR) was not present in this study.

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Conflicts of Interest

The authors declare that there was no any conflict of interests regarding this research.

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