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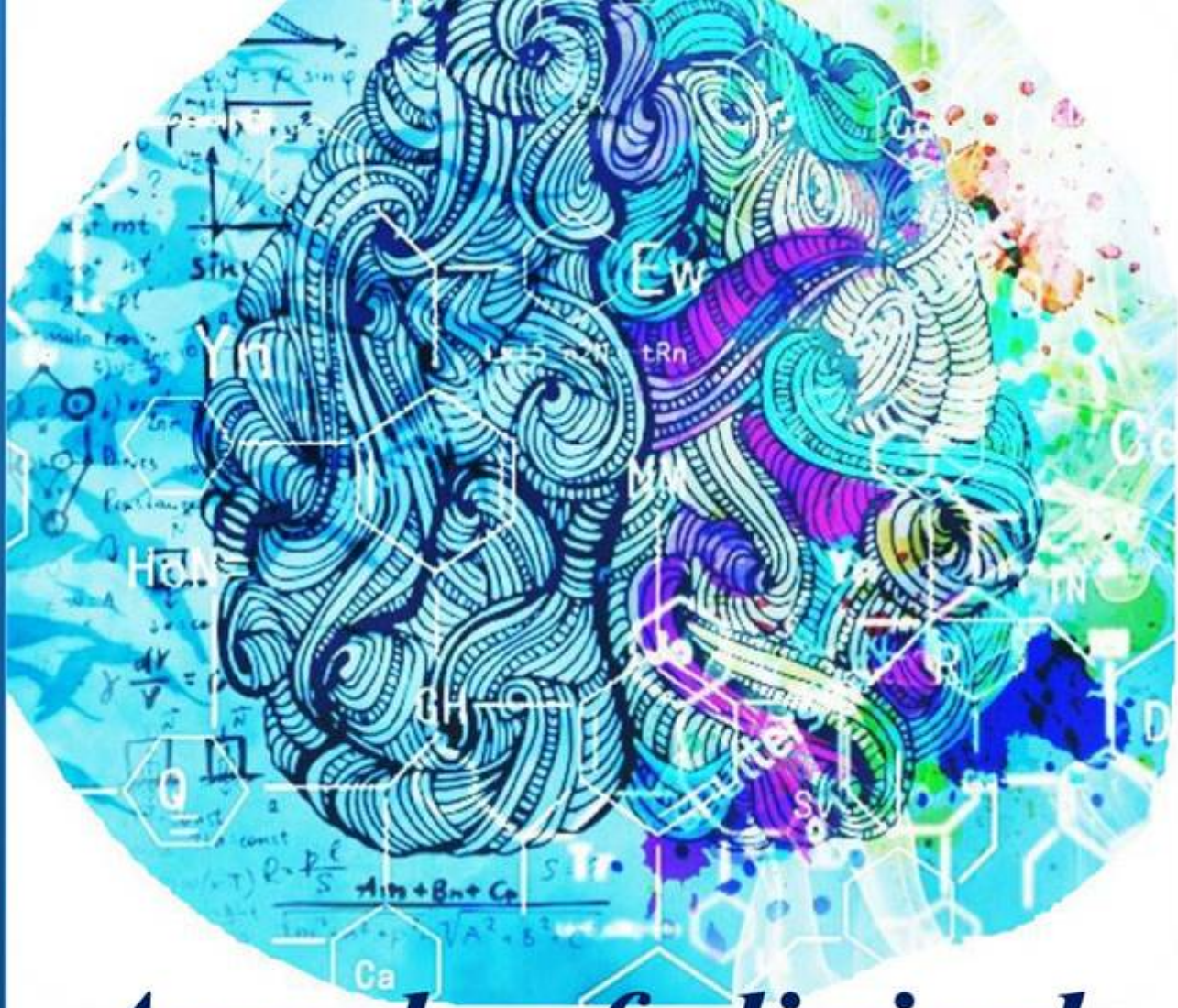

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CLINICAL AND BIOCHEMICAL CHARACTERISTICS OF BLOOD PARAMETERS IN PREGNANT WOMEN WITH PREECLAMPSIA ASSOCIATED WITH CHRONIC KIDNEY DISEASE

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Resume. Objective: To evaluate biochemical and acid-base blood parameters in pregnant women with preeclampsia complicated by chronic kidney disease (CKD), in order to determine the severity of multiple organ dysfunction and optimize individualized treatment strategies. Methods: A total of 93 pregnant women with moderate to severe preeclampsia were examined: 41 with CKD (main group) and 52 without CKD (comparison group). Blood biochemistry, protein spectrum, albumin functional activity, acid-base balance, and blood gas composition were evaluated. Results: Women with CKD showed pronounced lipid metabolism disorders, elevated creatinine, urea, cholesterol, and LDH levels. Total protein and albumin decreased, γ-globulins increased, and the albumin-globulin ratio was disrupted. Functional activity of albumin decreased, and the albumin toxicity index increased. Blood gas analysis revealed metabolic acidosis on a respiratory alkalosis background, reduced oxygen transport, and severe hypoxia.

Keywords: chronic kidney disease, preeclampsia, pregnancy, preeclampsia, blood biochemistry.

КЛИНИКО-БИОХИМИЧЕСКАЯ ХАРАКТЕРИСТИКА ПОКАЗАТЕЛЕЙ КРОВИ У БЕРЕМЕННЫХ С ПРЕЭКЛАМПСИЕЙ, АССОЦИРОВАННОЙ С ХРОНИЧЕСКОЙ БОЛЕЗНЬЮ ПОЧЕК

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Резюме. Цель: Анализ состояния биохимических и кислотно-основных параметров крови у беременных с преэклампсией на фоне хронической болезни почек (ХБП) с целью определения степени выраженности полиорганной дисфункции и выбора наиболее эффективной тактики лечения. Методы: В рамках исследования были проанализированы данные 93 беременных женщин, у которых диагностирована преэклампсия средней и тяжелой степени тяжести. Участницы были распределены на две группы: 41 женщина с ХБП (основная группа) и 52 без ХБП (группа сравнения). Определялись биохимические показатели крови, белковый спектр, функциональная активность альбумина, кислотно-основное состояние и газовый состав крови. Результаты: У женщин с ХБП отмечены более выраженные нарушения липидного обмена, повышение креатинина, мочевины, холестерина и ЛДГ. Снижение общего белка и альбумина, повышение γ-глобулинов, нарушение соотношения альбумин-глобулинов. Функциональная активность альбумина снижена, индекс токсичности повышен. Газовый состав крови показал метаболический ацидоз на фоне респираторного алкалоза, снижение транспорта кислорода и признаки глубокой гипоксии.

Ключевые слова: хроническая болезнь почек, преэклампсия, беременность, преэклампсия, биохимические показатели крови

SURUNKALI BUYRAK KASALLIGI BILAN BOG‘LIQ PREECLAMPSIYA BO‘LGAN HOMILADOR AYOLLARDA QON KO‘RSATKICHLARINING KLINIK-BIOKIMYOVIY TAVSIFI

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Xulosa. Maqsad: Surunkali buyrak kasalligi (SBK) fonida preeklampsiya bilan og‘rigan homilador ayollarda qonning bioximik va kislota-asos ko‘rsatkichlarini o‘rganish, poliorgan yetishmovchiligi darajasini baholash va individual terapiyani tanlash. Usullar: 93 homilador ayol tekshirildi: 41 nafari SBK bilan (asosiy guruh) va 52 nafari SBK bo‘lmagan (solishtirish guruhi). Ularning qon biokimyoviy tahlili, oqsil spektri, albumin, kislota-asos muvozanati holati va qonning gaz tarkibi baholandi. Natijalar: SBK mavjud ayollarda lipid almashinuvi buzilishi kuchli, kreatinin, mochevina, xolesterin va LDG darajasi yuqori. Umumiy oqsil va albumin miqdori pasaygan, γ-globulinlar oshgan va albumin-globulin nisbati buzilgan. Albuminning funksional faoliyati pasaygan, toksiklik indeksi oshgan. Qonning gaz tarkibi metabolik atsidoz va respirator alkaloz belgilarini ko‘rsatdi, kislorod tashuvchanlik kamaygan va chuqur gipoksiya aniqlanadi.

Kalit so‘zlar: homiladorlik, preeklampsiya, surunkali buyrak kasalligi, qonning bioximik ko‘rsatkichlari.

Preeclampsia remains one of the most serious complications of pregnancy and consistently ranks third among the causes of maternal mortality [1]. The most severe forms of this complication usually develop against a background of extragenital pathology, among which chronic kidney disease (CKD) occupies a special place [4].

The presence of CKD in pregnant women significantly complicates the course of pregnancy and contributes to the early development of multiple organ failure.

In this regard, it is particularly important to study the biochemical and acid-base parameters of blood in pregnant women with preeclampsia developing against the background of CKD. These parameters reflect the severity of metabolic disorders and the depth of tissue hypoxia and allow for an objective assessment of the severity of multiple organ failure as well as justification of the choice if optimal infusion therapy and of course systemic therapy.

Between 2023 and 2025, a total of pregnant women diagnosed with moderate and severe preeclampsia were enrolled in the study at the maternity complex of the Tashkent Medical Academy. Among them, 41 patients with confirmed chronic kidney disease (CKD) were assigned to the study group, whereas 52 women without CKD formed the control group. The groups were comparable in terms of baseline clinical and sociodemographic characteristics and differed primarily by the presence of chronic kidney disease in the current pregnancy.

Table 1

Biochemical parameters of peripheral blood in pregnant women with preeclampsia upon admission to hospital (M±m)

Peripheral blood parameter	Groups of women (M±m)		P1-2
	Main group (n=41)	Comparison group (n=52)	
Bilirubin (μmol/l)	14.94	10.88±0.93	>0.05
AST (units/l)	32.20±3.50	35.23±2.10	>0.05
ALT (units/l)	28.70±2.70	22.70±2.50	>0.05
Glucose (mmol/l)	4.17±0.1	44.47±0.12	>0.05
Urea (mmol/l)	15.47±0.35	4.52±0.24	<0.001
Creatinine (μmol/l)	175.2 1±3.4	72.30±3.10	<0.001
Cholesterol (mmol/l)	13.80±0.45	7.60±0.38	<0.001
Triglycerides (mmol/l)	6.92±0.34	2.93±0.31	<0.001
β, pre-β-lipoproteins (mg%)	1426±112.0	1164±92.0	>0.05
Lipoproteins by fraction			
Chylomicrons (mmol/l)	0.50±0.10	0.35±0.17	>0.05
β-lipoproteins (mmol/l)	88.20±3.10	51.88±1.57	<0.001
Pre-β-lipoproteins (mmol/l)	46.20±2.50	24.25±2.13	<0.001
α-lipoproteins (mmol/l)	11.10±2.60	23.52±3.90	<0.05
LDH (units/l)	528.7±71.0	328.9±61.3	<0.05
Free haemoglobin	0.39±0.03	0.45±0.05	<0.05

Note: p1-2 — indicator of the reliability of differences in data among pregnant women in the compared groups.

Lipid metabolic alternations were found to be markedly greater in patients with chronic kidney disease, whereas women with isolated preeclampsia (without extragenital comorbidities) exhibited less pronounced changes. In the main group, serum creatinine and urea levels were significantly elevated (175.21 ± 3.4 μmol/L and 15.47 ± 0.35 μmol/L, respectively) compared to the control group, which had creatinine and urea concentrations of 72.30 ± 3.10 μmol/L and 4.52 ± 0.24 μmol/L, respectively ($p < 0.001$). Significant differences were also observed in the content of cholesterol and other lipids: in the main group, cholesterol was 13.80±0.45 mmol/L, and in the control group, it was 7.60±0.38 mmol/L ($p<0.001$). In the lipid spectrum, the levels of β-lipoproteins (88.20±3.10 mmol/L), pre-β-lipoproteins (46.20±2.50 mmol/L) and LDH (528.7±71.0 U/L) in the main group compared to 51.88±1.57 mmol/L, 24.25±2.13 mmol/L and 328.9±61.3 units/L, respectively, in the comparison group ($p<0.001$).

Within the lipid profile, special attention was given to free hemoglobin levels, as their increase is considered a marker of disease severity, reflecting a heightened risk of hemolysis and potential changes in the physicochemical characteristics of erythrocyte membranes.

Protein metabolism indicators also play a key role in maintaining systemic homeostasis. In clinical practice, assessment commonly included total serum protein, albumin concentration, and distribution of protein fractions determined by electrophoretic methods. In pregnant women with preeclampsia complicated by chronic kidney disease, a decrease in total protein levels was observed (59.02±1.15 g/L). Electrophoretic analysis demonstrated a reduction in albumin content to 40.20 ± 2.40%, accompanied by an increase in the γ-globulin fraction up to 24.8 ± 1.10%.

Table 2

Blood protein spectrum indicators in women with preeclampsia

upon admission to hospital (M±m)

Peripheral blood indicator	Groups of women (M±m)		P1-2
	Main group (n=41)	Comparison group (n=52)	
Total protein, g/l	59.02±1.15	62.24±0.98	<0.05
Albumin, g/l	37.50±0.55	37.10±0.72	>0.05
Fibrinogen, g/l	3.73±0.17	3.80±0.16	>0.05
Protein fractions (electrophoresis), %			
Albumin	40.20±2.40	51.37±1.26	<0.001
α1-globulin	7.5±0.5	6.56±0.40	>0.05
α2-globulin	10.20±0.96	10.40±0.27	>0.05
β-globulin	21.61±1.32	11.30±1.80	<0.001
γ-globulin	24.8±1.1	10.06±1.30	<0.001
A/G, relative units	0.67±0.10	1.06±0.10	<0.05
Protein fractions (high-resolution electrophoresis), %			
Prealbumin	0.10±0.01	0.15±0.08	>0.05
Albumin	36.77±2.03	39.47±1.92	>0.05
α1-antitrypsin	6.20±0.45	5.70±0.49	>0.05
Gc globulin	1.20±0.41	1.80±0.54	>0.05
α2-macroglobulin	7.40±0.68	7.00±0.65	>0.05
Haptoglobin	2.20±0.45	2.10±0.60	>0.05
β-lipoproteins	7.10±0.54	3.40±0.43	<0.001
Transferrin	8.20±0.56	10.14±0.46	<0.05
C-complement	3.55±1.08	2.65±0.36	>0.05
Fibrinogen degradation products	5.15±0.43	4.52±0.32	>0.05
Fibrinogen	7.90±1.24	8.46±1.28	>0.05
γ-globulins	14.23±1.79	14.61±2.38	>0.05

Note: p1-2 — indicator of the reliability of differences in data among pregnant women in the compared groups.

A desreased albumin-to-globulin ratio was also identified, amounting to 0.67 ± 0.10 compared to 1.14 ± 0.19 in the reference group. These findings reflect pronounced disturbances in protein metabolism in pregnant women with preeclampsia complicated by chronic kidney disease.

Detailed electrophoretic profiling demonstrated significant qualitative shifts in serum proteins. In particular, high resolution proteinogram analysis revealed a marked reduction in prealbumin (by approximately 75%), albumin (by 10.5%), transferrin (by 26%) and fibrinogen (by 8.6%). At the same time. A substantial increase, in α_1-lipoproteins (up to 3.5-fold) and immunoglobulin levels was observed. In addition, there was a tendency toward elevated concentrations of α_1-antitrypsin and α_2-macroglobulin when compared with patients presenting with isolated CKD.

An increase in α_1-pre-β-lipoproteins in pregnant women with CKD was confirmed both quantitatively and through electrophoretic serum analysis, as evidenced by a higher proportion of α-lipoproteins in proteinograms and an increased fraction of α_1-pre-β-lipoproteins in lipoproteinograms. Hydrophobic protein fractions, which serve as structural components, possess the ability to bind biologically active compounds, including low-molecular-weight hydrophobic metabolites that may exert toxic effects in their unbound state. Among the most clinically relevant are non-esterified saturated fatty acids, bilirubin, and other metabolites, wich are transported by albumin via specific binding sites.

In view of the presence of hypertensive disorders in patients with preeclampsia, evaluation should extend beyond total albumin levels to include the functional integrity of its binding sites. This approach is essential for predicting the risk of severe multiple organ dysfunction and for selecting the most appropriate therapeutic strategy. The ratio of total to effective albumin

concentration (TAC/EAC, or PCA) depends exclusively on the activity of the binding sites and is normally close to 1 (100%).

The “albumin toxicity index” (T) was introduced, reflecting the degree of binding centre saturation with toxic substances, and the plasma binding capacity index (PBC), characterising the ability of plasma to bind metabolites. Women with CKD showed an increase in the albumin toxicity index and a decrease in PCA and BPA, indicating severe metabolic disorders, organ dysfunction, and endotoxicosis. At the same time, higher PCA levels in pregnant women with preeclampsia without CKD indicate a more favourable prognosis.

Evaluation of the blood acid-base balance revealed features of metabolic acidosis superimposed on respiratory alkalosis, as evidenced by reduced true bicarbonate levels, a base deficit, and decreased arterial CO_2 tension. In the main group, arterial blood showed reduced hemoglobin concentration and oxygen carrying capacity, resulting in diminished oxygen delivery to tissues, while pulmonary gas exchange remained largely preserved. Venous blood demonstrated decreased partial pressure and oxygen content, along with an increased arteriovenous O_2 difference and higher extraction coefficient from arterial blood, reflecting pronounced tissue hypoxia.

The observed reduction in oxygen utilization is likely attributable to microcirculatory disturbances and shunting through arteriovenous anastomoses, whereby blood bypasses exchange capillaries, causing tissue hypoxia despite elevated venous O_2 levels. Furthermore, arterialization of mixed venous blood may occur due to modifications in hemoglobin properties under conditions of endotoxemia and oxidative stress, accompanied by a leftward shift of the oxyhemoglobin dissociation curve during prolonged hypoxia and a decrease in organic phosphate concentrations.

Table 3

Indicators of the functional state of albumin in women with preeclampsia upon admission to hospital (M±m)

Peripheral blood indicator	Groups of women (M±m)		P1-2
	Main group (n=41)	Comparison group (n=52)	
Total protein, g/l	59.02±1.15	62.24±0.98	<0.05
Total albumin concentration (TAC), g/l	34.0±0.78	37.59±0.72	<0.001
Effective albumin concentration (EAC), g/l	21.30±0.70	24.00±0.40	<0.001
Albumin binding reserve (ABR), %	61.90±1.50	63.80±1.50	>0.05
Albumin toxicity index, relative units	0.67±0.05	0.54±0.03	<0.05
Plasma binding capacity (PBC), g/l	31.8±1.17	37.4±1.4	<0.01

Note: p1-2 — indicator of the reliability of differences in data among pregnant women in the compared groups.

Table 4

Gas composition and acid-base status of blood in women with preeclampsia upon admission to hospital (M±m)

Indicator	Groups of women (M±m)		P1-2
	Main group (n=41)	Comparison group (n=52)	
Arterial blood			
pH, 7.35–7.45	7.410±0.016	7.430±0.014	>0.05
pCO_2, 35–45 (mm Hg)	31.60±1.65	32.83±0.79	>0.05
pO_2, 69–116 (mm Hg)	98.83±3.95	82.74±4.15	<0.05
sO_2, 95–99%	96.84±0.23	92.89±3.12	>0.05
tO_2, 15.8–19.9 (ml/dl)	13.31±0.7	14.19±1.54	>0.05
$AaDpO_2$, 7–40 (mm Hg)	39.98±3.70	25.13±3.67	<0.01
ctO_2(a–v), 3.5–5.5 (ml/dl)	1.89±0.28	8.63±0.71	<0.001
K^+, 3.48–5.3 (mmol/l)	4.48±0.13	4.30±0.19	>0.05

Na^+, 130.5–156.6 (mmol/l)	136.57±1.37	135.29±1.57	>0.05
Cl^-, 95.9–109.9 (mmol/l)	106.57±1.86	107.43±3.90	>0.05
HCO_3^-, 21.3–24.8 (mmol/l plasma)	19.73±1.25	21.71±0.94	>0.05
SBEs, −3.4 – +1.4 (mmol/L blood)	−4.10±1.34	−2.18±1.26	>0.05
tHb, g/l	118.5±3.9	117.2±2.8	>0.05
Venous blood			
pH, 7.34–7.43	7.390±0.009	7.370±0.013	>0.05
pCO_2, 45–60 (mm Hg)	35.62±1.37	44.63±1.46	<0.001
pO_2, 38–42 (mm Hg)	59.70±6.70	22.08±1.98	<0.001
sO_2, 70–75 %	81.44±5.56	35.90±5.36	<0.001
tO_2, 8–12 (ml/dl)	14.46±0.65	4.27±0.40	<0.001
KEK 26–34 (%)	11.83±1.31	56.93±2.05	<0.001

Note: p1-2 — indicator of the reliability of differences in data among pregnant women in the compared groups.

In preeclampsia, regardless of the presence of extragenital pathology, the ability of haemoglobin molecules to bind oxygen remains almost unchanged, and the key factor in the development of hypoxic is microcirculation impairment [2]. It is especially important to main normal oxygen transport and stable blood acid-base parameters, wich are fundamental constants of homeostasis. It is especially important to maintain normal oxygen transport and stable blood acid-base parameters, which are fundamental constants of homeostasis. Cellular oxygen deficiency results in reduced ATP production, which may trigger a cascade of metabolic, functional, and structural abnormalities, potentially culminating in cell death [3].

Hypoxia represents a key pathogenic factor is a wide range of disorders, including preeclampsia, while disturbances in blood buffering capacity may promote decompensation and aggravation of clinical manifestations [6].

The combination of hypoxic conditions and acidosis intensifies lipid peroxidation through the activation of reactive oxygen species such as free radicals, singlet oxygen, hydrogen peroxide, and organic hydroperoxides, importantly, the pathological impact is not only the presence of hypoxia and acidosis themselves, but also the failure of their regulatory mechanisms, wich leads to dysregulated metabolic pathways and primarily affects cellular energy production. In preeclampsia, accumulation of partially oxidized metabolites together with metabolic acidosis contributes enhanced oxidative stress, increased formation of secondary toxic compounds (including aldehydes and ketones), suppression of antioxidant defense systems, and activation of damaging biochemical cascades underlying clinical symptoms [5].

Evaluation of acid-base status and gas exchange parameters demonstrated the presence of academia. Impaired oxygen transport to tissues, and the development of hypoxic states with progression toward metabolic acidosis. These abnormalities were most pronounced in pregnant women with concomitant chronic kidney disease.

A comprehensive laboratory assessment of patients with preeclampsia revealed stable shifts in biochemical and hematological indicators of homeostasis, consistent with manifestations of endogenous intoxication. These changes were characterized by activation of antioxidant defense mechanisms, increased optical density of eritrocyte titratable hemolysate fractions, alterations in membrane physicochemical properties, and a decrease in the effective concentration of albumin.

Thy syndrome of endotoxicosis was further accompanied by elevated activity of the antioxidant system, accumulation of lipid peroxidation products, increased optical density of plasma hemolysate fractions, reduced levels of both total and functionally active albumin, as well as increased concentrations of triglycerides, cholesterol, and apolipoprotein B-containing lipoproteins. In addition, pronounced structural disturbances of cellular membranes were observed. All of these pathological processes were significantly more severe in patients with preeclampsia combined with chronic kidney disease [2,3,6].

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ANNALS OF CLINICAL DISCIPLINE

АННАЛЫ КЛИНИЧЕСКИХ ДИСЦИПЛИН

КЛИНИК ФАНЛАР ЙИЛНОМАСИ

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