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# FEATURES OF THE COURSE OF CHRONIC PYELONEPHRITIS IN CHILDREN AGAINST THE BACKGROUND OF ANEMIA

***M.Sh.Ganieva,***

***D.S.Khodzhaeva***

*Andijan State Medical Institute*

**Relevance.**Anemia, being one of the manifestations of chronic kidney disease (CKD) in children, is characterized by a decrease in the level of red blood cells and hemoglobin below normal values [1]. In this case, anemia is usually normochromic, normocytic; with iron deficiency, anemia is hypochromic, microcytic and hypoproliferative [2, 3].The cause of anemia development in CKD is primarily a deficiency of erythropoietin (EPO) and iron, as well as a number of other factors: a decrease in the lifespan of red blood cells (as a result of metabolic acidosis), the content of EPO inhibitors in the blood, hemolysis, blood loss, hyperparathyroidism, aluminum intoxication, increased activity of proteases and glycosidases, infections, and disruption of hormonal homeostasis [1].

In addition to iron deficiency and erythropoietin deficiency, chronic inflammation, hyperparathyroidism, vitamin B12 and folic acid deficiency, side effects of drug therapy (in particular, angiotensin-converting enzyme inhibitors), etc. can be the causes of anemia in CKD [1, 7, 8]. Many researchers also believe that L-carnitine deficiency, which destabilizes the red blood cell membrane and reduces their survival, is the cause of anemia in CKD.

E. Costa et al. [31] found that patients treated with hemodialysis and not responding to therapy with erythropoiesis-stimulating drugs had lower levels of serum albumin, lymphocytes, and CD4+ cells compared to patients with an adequate erythropoietic response. These results suggested a relationship between EPO resistance and the magnitude of the inflammatory response [31]. The authors of the study showed that prohepcidin, soluble transferrin receptors in the blood serum, and CPB are markers of anemia resistance to therapy with erythropoiesis-stimulating drugs [32].

**Purpose of the study:**to assess the impact of anemia on the course of chronic pyelonephritis in children.

**Material and research methods**. The study included 53 children treated in the nephrology department of the Andijan Regional Medical and Medical Center from 2023 to 2024 at the age of 0 to 18 years. The control group consisted of 30 practically healthy children of the same age. Table 1 shows the distribution of children by gender and age.

**Table 1**

| **No.** | | **Chronic pyelonephritis (ChrPEN) (n=53)** | |
|---|---|---|---|
| | **Age** | **boys** | **girls** |
| 1 | 1-3 years | 3 | 4 |
| 2 | 4 - 7 years | 6 | 6 |
| 3 | 8 - 14 years old | 3 | 19 |
| 4 | 15 - 18 years old | 1 | 11 |
| | Total(n=53) | **13** | **40** |

**Distribution of patients with chronic pyelonephritis**

From the data in Table 1 it is evident that in the group of children with Chronic PEN, girls predominate, with the maximum distribution at the age of 8-14 years, although up to 7 years the gender difference was minimal.The average age of children in the group was-11.7±4.2. The clinical diagnosis is made according to the ICD-X standards. This classification defines the form of pyelonephritis (primary, secondary), the nature of the course (acute, chronic), activity and state of renal function. In most cases, the examination revealed the secondary nature of this disease (dysmetabolic nephropathy, neurogenic bladder, VUR, hypospadias, ureterohydronephrosis). Only in 10 cases out of 53 cases, concomitant nephrological pathology of obstructive and non-obstructive nature was excluded and the cause of urostasis was indicated.The chronization of the process was established on the basis of the duration of the disease being more than 3 months. The duration of the disease in the examined children was on average 6.2 years.

The diagnosis of chronic renal failure was made based on the anamnesis data, characteristic clinical picture and confirmed by laboratory and instrumental studies. In this case, kidney damage is manifested by one or more of the following signs: changes in the general blood test (CBC), urine (UAM), feces, detection of changes in visualization methods of kidney examination, urine culture with determination of the degree of bacteriuria and sensitivity to antibiotics. Determination of the functional state of the kidneys was carried out based on a biochemical blood test with determination of azotemia with subsequent calculation of the SCF.

Most of the observed patients lived in satisfactory housing and living conditions, however, parents of 8.5% of children complained of poor housing and living conditions (poor apartment amenities, cramped conditions, overcrowding, lack of sewage, etc.); 44.7% of the observed patients were from large families (three or more children). In 7.2% of cases, mothers of sick children had moderate forms of iron deficiency anemia during pregnancy, 10.5% of mothers were diagnosed with nephropathy of pregnancy, 32.9% of the observed children with acute and chronic pyelonephritis had a hereditary burden of urinary system diseases (urolithiasis, pyelonephritis, glomerulonephritis in mothers or fathers, grandmothers or girls), 12.5% of mothers of sick children suffered from chronic pyelonephritis.

As is known, the occurrence of pyelonephritis can be caused by various microorganisms and microbial flora, as a rule, precedes and accompanies the disease. More than half of the parents (61.2%) associated the occurrence of pyelonephritis in their children with an acute respiratory disease, 27.6% - with cystitis, 11.8% with vulvitis, 1.3% with phimosis, which is consistent with the literature data. (G. A. Majdrakov, N. Popov, 1980; E. Polachek et al., 2008; A. I. Gnatyuk et al., 2009; Ya. Yu. Illek, 2013).

In the active period of acute and chronic pyelonephritis, upon admission to the hospital, true pathological bacteriuria was detected in all observed children - 105 - 1012 microbial bodies in 1 ml of urine. When sowing urine taken by catheter, staphylococcus was detected in most patients - 55 (68.8%), much less often E. coli - 15 (18.7%) and Klebsiella - 10 (12.5%). Figure 1.

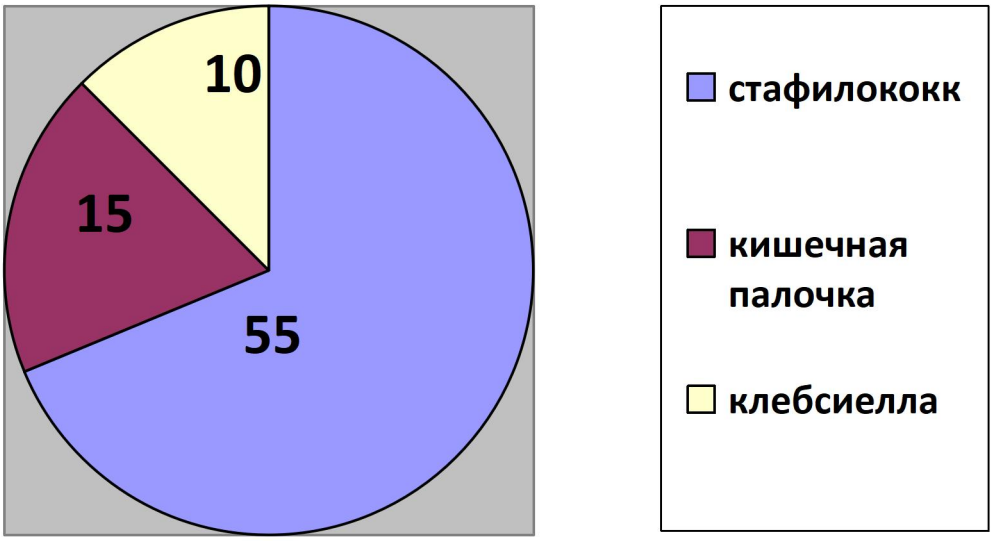


**Fig. 1. Results of urine cultures in patients with chronic pyelonephritis.**

The data we obtained correspond to the conclusions of a number of researchers (N.A. Lopatkin et al., 2009; A.I. Gnatyuk et al., 2006; Ya.Yu. Illek, 2012) that the causative agent of pyelonephritis in children in most cases is staphylococcus and E. coli. Before discharge from the hospital, bacteriuria was not detected in the observed children with acute and chronic pyelonephritis. The results of studies in the dynamics of clinical and laboratory parameters of renal function in children with chronic pyelonephritis are presented in Table 2.

Table 2

**Clinical and laboratory parameters in patients with chronic pyelonephritis [M±m]**

| **Indicators** | **In healthy children** | **In patients with chronic pyelonephritis** | |
|---|---|---|---|
| | | Upon admission | Before discharge |
| Daily diuresis, ml | 1179±31 | 1341±74 | 1247±87 |
| Relative density of urine, conventional units | 1.019±0.0005 | 1.012±0.0005 | 1.019±0.0004 |
| Urine protein, g/l | -avs | 0.176±0.007 | 0, 033±0,01 |
| Blood protein, g/l | 67.4±1.0 | 60.0±0.6 | 63.7±0.6 |
| Albumins, g/l | 41.5±0.6 | 38.0±0.9 | 3.2±0.8 |
| Globulins, g/l | 25.9±0.7 | 26.8±0.7 | 25.8±0.7 |
| Albumin/globulin index | 1.66±0.07 | 1.41±0.08 | 1.48±0.07 |
| Blood urea, mol/l | 5.36±0.16 | 5.90±0.32 | 5.72±0.28 |
| Residual nitrogen in blood, mol/l | 18.16±0.31 | 19.48±1.51 | 19.02±0.81 |
| Blood creatinine, mol/l | 0.069±0.002 | 0.073±0.004 | 0.070±0.002 |
| Urine creatinine, mol/l | 5.37±0.29 | 5.50±0.51 | 5.78±0.68 |
| Creatinine excretion, mol/day | 6.24±0.32 | 6.82±0.35 | 7.00±0.43 |
| Creatinine clearance, ml/min. | 104.32±2.14 | 96.96±3.54 | 100.00±2.47 |
| Tubular water reabsorption, % | 98.89±0.07 | 98.90±0.06 | 99.01±0.08 |

As follows from the material presented in Table 2, in children with an exacerbation of chronic pyelonephritis upon admission to the hospital and before discharge from the hospital, no reliable changes in daily diuresis were noted. However, in the observed patients, a decrease in the relative density of urine was noted in the first period of the study [P < 0.001]. An acidic urine reaction was detected upon admission to the hospital in 94.1% of cases, and in the remaining children with acute pyelonephritis and exacerbation of chronic pyelonephritis, the urine reaction was alkaline. Upon admission to the hospital and during treatment, patients were recorded to have a small and mild proteinuria, respectively, whereas before discharge from the hospital, protein was not detected in the urine of the observed children.

All girls were examined by a pediatric gynecologist during their stay in the hospital. We divided the identified pathology into 2 conditional groups: infectious diseases (vulvitis, vulvovaginitis, colpitis) and other diseases (delayed sexual development, hypothalamic syndrome with menstrual cycle disorders, oligomenorrhea, juvenile uterine bleeding, ovarian cysts, hyperandrogenism of unknown genesis, erosion and pseudo-erosion of the cervix). When determining the frequency of gynecological pathology in the groups, we found its higher frequency in group I: for infectious pathology it was 7.7±3.3%, in group II only 3.0±1.1%.

One of the pathognomonic manifestations of renal pathology is anemia, which in adults and children often takes on a severe course (Petrova K G, Vasiliev N, N., 1969; Tareev E. M., 1972; Shulga Yu. D., 1973; Ignatova M. S., 1973; Javad-zade M. D., Malkov P. Cl, 1978; Pukhlev A., 1980; Schwartz M. S., Steyskal J., 1980; Oan- ieli G. Mantroni V., 1966; Smith C., 1969). The data obtained from the study of quantitative and qualitative parameters of peripheral red blood and indicators of erythrocyte balance according to L.N. Mosyagina in children observed by us with various clinical forms of chronic pyelonephritis without functional impairment are presented in Table 2.

**Table 2**

**Peripheral blood parameters in patients with chronic pyelonephritis (M±m)**

| Indicators | In healthy children (n= 30) | In patients with chronic pyelonephritis (n= 53) | |
|---|---|---|---|
| | | Upon admission | Before discharge |
| Erythrocytes, 1012/l | 4.23±0.03 | 3.55±0.06 | 3.82±0.06 |
| Hemoglobin, g/l | 123.2±1.1 | 106.9±1.3 | 108.1±2.3 |
| Color indicator | 0.89±0.01 | 0.84±0.02 | 0.850±0.01 |
| Leukocytes, 10*9/l | 6.72±0.17 | 9.33±0.50 | 8.51±0.42 |
| Leukocyte formula,%: | | | |
| Band neutrophils | 3.1±0.2 | 5.3±0.9 | 3.3±0.4 |
| segmented | 55.1±1.0 | 54.4±2.1 | 56.6±2.1 |
| lymphocytes | 34.7±1.0 | 36.9±2.1 | 33.1±1.4 |
| Eosinophils | 2.3±0.2 | 4.8±0.5 | 2.8±0.3 |
| Monocytes | 4.8±0.3 | 4.6±0.3 | 4.2±0.3 |
| ESR, mm/hour. | 5.5±0.4 | 12.9 ±2.5 | 10.0±1.4 |

As can be seen from the data in Table 2, the children with chronic pyelonephritis we observed had a significant decrease in the number of erythrocytes in the blood and an increase in the ESR (P < 0.01-0.001) upon admission to the hospital and before discharge, in the absence of reliable changes in the hemoglobin content in the blood and the color index value. However, in patients with chronic pyelonephritis, the laboratory signs of anemia were more pronounced and persistent. Along with this, in the observed patients, an increase in the total number of leukocytes in the blood was recorded in the first two study periods (P < 0.001). Changes in the leukocyte formula in the form of an increase in the percentage of band neutrophils in the blood (P < 0.01) were

detected in children with acute pyelonephritis only upon admission to the hospital. The above data indicate that we observed patients who had clinical manifestations and changes in clinical and laboratory parameters characteristic of chronic pyelonephritis with preserved renal function.

When examining children with chronic PEN, we identified a number of features reflecting the features of the pathological process against the background of anemic syndrome. When clarifying the complaints and anamnesis of patients, we found that 20% of children (11) did not present any complaints at the time of admission to the hospital - these patients were diagnosed with mild anemia. In this regard, the 42 sick children included in the study were divided into 2 groups depending on the severity of anemia: Group 1 - children with chronic PEN + grade 2 anemia (35 children); Group 2 - children with chronic PEN + grade 3 anemia (7 children).

Chronic renal failure against the background of anemia was characterized by a higher frequency of manifestations of the infectious symptom, and in children with severe anemia, signs of intoxication in the form of fever, anorexia, general weakness, dyspepsia were more pronounced and prolonged. The frequency of headaches associated with intoxication (they pass with the improvement of the general condition, with the relief of fever, neurological pathology is excluded during examination by a neurologist) in group I was 1.5 ± 0.5%, and in group II - 3.7 ± 1.6%. Fever in chronic renal failure was noted in children in group I in 3.8 ± 0.8% and in 6.7 ± 2.1% in group II.

The results of the assessment of general well-being significantly differed from the literature data, which indicate a decrease in the quality of life and well-being with the association of Chronic renal failure with anemia. In our study, complaints of impaired general well-being (weakness, lethargy, fatigue, decreased appetite, decreased academic performance at school and tolerance to physical activity) in the 1st group of children with anemia occurred in 5.9±2.0% of cases, while in the 2nd group almost 2 times more often - 10.9±1.4% ($p<0.05$). We studied the absolute number of complaints in children in the comparison groups taking into account the stage of the disease, since a more severe impairment of renal function could affect the results of the study. Children in group 1 had a greater number of complaints than in group 2. That is, in the early stages, chronic renal failure against the background of anemia occurs more acutely, with a large number of complaints, whereas in the later stages of the disease, general well-being primarily determines the severity of the underlying process (Table 3).

**Table 3**

| Chronic PEN and degrees of anemia | 0-1 complaint | | 2-3 complaints | | More than 3 complaints | |
|---|---|---|---|---|---|---|
| | Group I, M±t, % | Group II, M±t, % | Group I, M±t, % | Group II, M±t, % | Group I, M±t, % | Group II, M±t, % |
| II degree | 10.8±3.8 | 11.14=1.9 | 0 | 3.4±1.1* | 1.5±1.5 | 0.4±0.4 |
| III degree | 13.8±4.3 | 23.3±2.6 | 7.7±3.3 | 4.2±1.2 | 1.5±1.5 | 0 |

**Total number of complaints upon admission in groups**

The results of ultrasound examination of the kidneys were analyzed and are presented in Table 4, where no significant differences were found. However, such an indicator of the chronic process in the kidneys as compaction of the CEC is noted somewhat more often in Group I - 22.2±3.6 in Group I and 17.3±1.7 in Group II. Results of ultrasound examination of the kidneys in children of the comparison groups

**Table 4**

| Ultrasound data | Group I | II group |
|---|---|---|

| | Abs. | M±m, % | Abs. | M±m, % |
|---|---|---|---|---|
| Expansion of the ChLS | 9 | 6.7±2.1 | 38 | 7.3±1.1 |
| Compaction of the CEC | 30 | 22.2±3.6 | 91 | 17.3±1.7 |
| Nephroptosis | 13 | 9.6±2.5 | 30 | 5.7±1.0 |
| Decreased echogenicity of the renal parenchyma | 29 | 21.5±3.5 | 99 | 19.0±1.7 |
| Congenital organic pathology of the kidneys | 12 | 8.9±2.4 | 42 | 8.1±1.2 |
| Violationcorticomedullary differentiation | 7 | 5.2±1.9 | 35 | 6.7±1.1 |

**Ultrasound results in study groups**

In accordance with the standards of medical care in the hospital, all children with chronic pathology underwent excretory urography and micturition urethrocystography to exclude congenital organic pathology. Various pathologies of the bladder, urethra and VUR were detected in2.3±0.7% of children in group I and 3.0±1.5% in group II. At the same time, the absence of pathology according to the results of this examination was observed in group II - 43.7±4.3% significantly less frequently ($p<0.05$) than in group I - 55.7±2.2%. Pathology during urography was detected in13.3±2.9%cases in group I and somewhat more often -16.9±1.6%in group II. We studied the structure of organic kidney pathology based on excretory urography data. Congenital pathology (expansion and deformation of the renal pelvis, tubular reflux, achalasia of the renal pelvis, sclerosis of the renal tissue) in children of group I occurred with the same frequency as in children without anemia, but manifestations of the chronic process in the kidneys were noted in group I more often. Based on the data obtained, it can be concluded that in group II the pathological process is characterized by greater activity, accompanied by more pronounced damage to the kidney structure.

Thus, the data obtained in children of the two groups may indicate a more severe course of chronic renal failure in combination with severe anemia and greater activity of the pathological process.

If there were indications (complaints of pain in the right hypochondrium associated with the intake of fried, fatty foods, increasing with physical activity, bitter taste in the mouth, unstable stool; hepatosplenomegaly determined by palpation), children underwent additional ultrasound of the hepatobiliary system. This study was conducted on 19 children of group I and 31 children of group II. Pathology of the hepatobiliary system was more common in group II - 14.1 ± 3.0%, while in group I only 6.0 ± 1.0% ($p < 0.05$). When examining the structure of this pathology, we found out that its individual types were more common in children of group I. A combination of different types of pathology was also more common in children of group II - 7.4 ± 2.3% - while in group I more than 2 times less often - 2.9 ± 0.7% (Table 5).

**Table 5**

| Test result | Group I | | II group | |
|---|---|---|---|---|
| | Abs. | M±m, % | Abs. | M±m, % |
| Hepatomegaly | 4 | 5.2±1.7 | 9 | 1.7±0.6 |
| Violation of liver echostructure | 5 | 4.4±1.8 | 11 | 2.1±0.6 |
| Signs of pancreatopathy | 6 | 7.4±2.3* | 11 | 2.1±0.6 |
| Gallbladder pathology | 12 | 8.1±2.4 | 21 | 4.0±0.9 |

**Results of ultrasound examination of the hepatobiliary system**

Note * - $p<0.05$

**Conclusions:**

1. In patients with chronic pyelonephritis, laboratory signs of anemia were more pronounced and persistent; in the first two periods of the study, an increase in the total number of leukocytes in the blood was recorded, which indicates the presence of a chronic infection.

**2.** Chronic renal failure in combination with severe anemia occurs with greater activity of the pathological process and is accompanied by more pronounced damage to the structure of the kidneys.

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