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Choice of Surgical Tactics for Calculus Anuria in Young Children

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Research objective: Selection of surgical treatment tactics depending on the duration and complications of calculus anuria in young children.
Material and methods: Our study included 53 children aged 4 months to 3 years. The patients were divided into 2 groups. Group 1 consisted of 35 (66%) patients with anuria duration of no more than 3 days. Group 2 consisted of 18 (33.9%) patients with anuria duration exceeding 3 days.
Results: The choice of surgical tactics for calculus anuria in young children depended on the severity and manifestation of symptoms, which were determined by the presence of concomitant and background diseases, as well as the duration of anuria.
Conclusion: Analysis of the restoration of homeostasis in children after unblocking showed that the normalization of clinical and biochemical parameters in patients with a longer duration of anuria (more than 3 days) occurred significantly slower than in patients with a shorter duration of anuria. The dynamics of metabolic processes depended on the duration of anuria and the severity of the patients' condition.
Preliminary nephrostomy placement and stabilization of the patients' condition contribute to faster restoration of the child's body disturbances caused by anuria compared to radical stone removal.
Key words: anuria, surgical treatment of children

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Relevance. The opinions of urologists regarding the choice of optimal surgical tactics for post-renal calculus anuria (PCA) in young children often differ [1, 2, 5, 6, 11]. According to S.M. Javad-Zadeh et al. [3], the treatment outcomes of patients who underwent preoperative urinary passage restoration and preparation aimed at eliminating azotemic intoxication and controlling the inflammatory process were significantly better than those who underwent emergency surgery. After restoring the urinary passage, the operation was performed when the levels of urea and creatinine, electrolyte balance were normal or subnormal, which was associated with a relatively smooth postoperative course and relatively rapid recovery of kidney function [3, 4, 8, 10]. However, there are proponents of radical lithotomy without prior urinary diversion, which, in their opinion, allows addressing the primary task of eliminating the etiological factor of anuria [2, 7, 9]. Nevertheless, it is evident that the determination of the

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surgeon's tactics in PCA in young children determines time as a decisive factor in the effectiveness of therapeutic measures [1, 5, 7].

Material and methods. Our study included 53 children aged 4 months to 3 years. The severity and manifestation of symptoms, depending on the presence of concomitant and background diseases, as well as the duration of anuria, allowed us to divide the patients into 2 groups. The first group consisted of 35 (66%) patients with unilateral calculus obstruction combined with spasm of the contralateral renal vessels, leading to reflex anuria, with a duration of anuria of no more than 3 days. Anuria developed acutely in these patients in the absence of any pre-existing health issues. The children were lethargic, adynamic, with a subfebrile temperature, progressing azotemia, anemia, and hypoproteinemia.

The second group included 18 (33.9%) patients with anuria caused by obstruction of both kidneys or the solitary functioning kidney (2 (11.1%)). The duration of anuria was more than 3 days. Anuria in this group of patients started gradually, against the background of severe underlying or concomitant diseases and oliguria, which was caused by partial obstruction and obstructive pyelonephritis. The condition of the patients in this group was extremely severe with pronounced signs of intoxication.

The control group consisted of 21 patients with urolithiasis without impairment of the urodynamics of the upper urinary tract and without signs of anuria.

The diagnosis was established based on ultrasound examination, an overview radiograph of the urinary tract, and radioisotope renography.

In addition to clinical and biochemical investigations to assess the kidney's reserve capacity, the condition of renal hemodynamics was studied using duplex Doppler ultrasonography of the main renal vessels, which involved simultaneous use of B-mode, color Doppler mapping (CDM), and pulse-wave Doppler ultrasonography (PWD). Maximum systolic velocity (Vps) and minimum diastolic velocity (Ved) of blood flow, as well as the resistance index (RI) of the renal vessels, were evaluated.

Results and Discussion. CDM allowed us to assess the condition of the vascular pattern of the renal parenchyma and demonstrate qualitative characteristics of renal blood flow, such as depletion or absence of the vascular pattern. The quantitative parameters of renal hemodynamics obtained from PWD are presented in Figure 1.

As can be seen from the figure, a non-significant ($p > 0.05$) increase in RI to 0.81 ± 0.11 compared to the control group was observed in the kidneys of patients with reflex anuria ($p > 0.05$).

In patients of the first group, an increase in RI to 0.88 ± 0.06 was noted, which significantly ($p < 0.05$) differed from the values (0.74 ± 0.08) of the control group. A decrease in maximum and minimum blood flow velocities to 0.17 ± 0.03 and 0.11 ± 0.03 m/s, respectively, was also observed.

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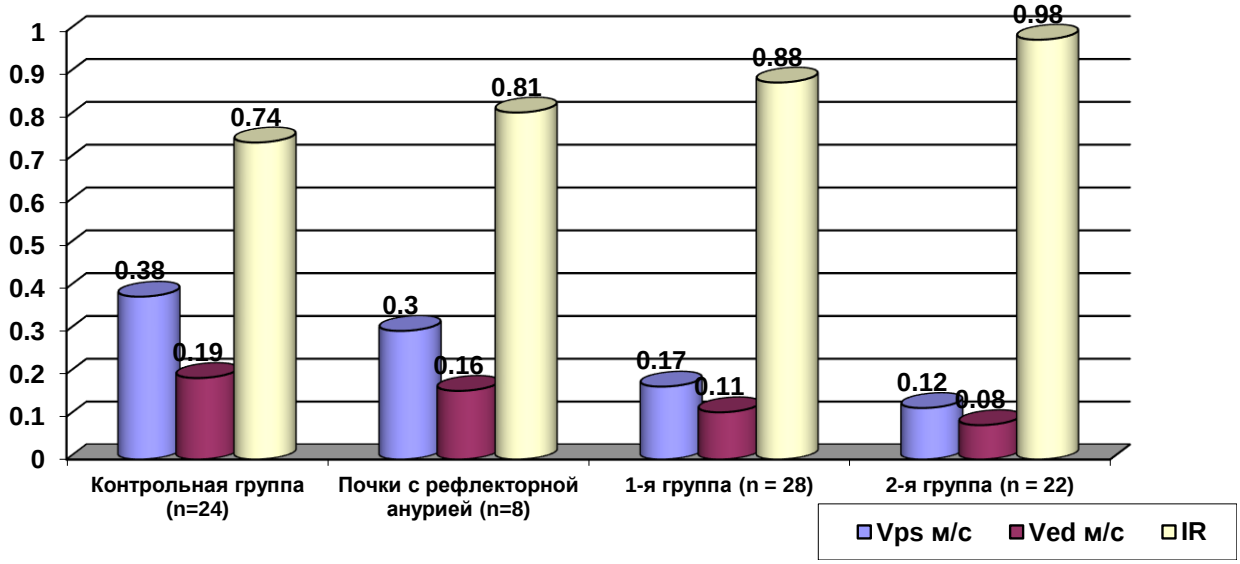

Note: - * p > 0,05 - p < 0,05 p <0,01

Fig. 1. Indicators of renal blood flow.

Severe disturbances in renal hemodynamics were observed in patients of the second group. CDM revealed a significant depletion of the intrarenal vascular pattern in all observations, with a decrease in maximum systolic blood flow velocity to 0.12 ± 0.03 m/s accompanied by an increase in RI to 0.98 ± 0.02 compared to the control group ($p < 0.01$).

Thus, the analysis of Dopplerometric parameters of renal hemodynamics showed a direct correlation with the duration of anuria ($r = 0.78$; $p < 0.01$).

Depending on the severity of the clinical picture and the underlying renal function impairment, the following surgical tactics were applied to patients of the first group:

- In 16 (45.7%) patients (subgroup 1a) with acute unilateral calculus obstruction and initially normal renal function, pyelolithotomy and ureterolithotomy were performed.
- In 19 (54.2%) patients (subgroup 1b) with anuria occurring due to suppression of contralateral kidney function, percutaneous nephrostomy (PCN) was performed due to the severity of the clinical picture.

In patients of subgroup 1b, a decrease in blood pressure by 25-30% was observed within the first day after PCN, along with normalization of pulse rate and circulating blood volume. Compensatory polyuria was observed after urine diversion by the end of the first week, and by the beginning of the second week, the biochemical indicators of uremia in these patients were completely normalized (Table 1).

Table 1

The dynamics of diuresis parameters in the early stages of PCA treatment

Groups	1st day		3rd day		7th day		0-12 days	
	Diuresis, ml.	USG	Diuresis, ml.	USG	Diuresis, ml	USG	Diuresis, ml	USG
1a	160±21	1028±3	252±38*	1016±8	708±37***	1002±2	614±51**	1011±2
1b	200±28	1026±6	296±41	1014±5	912±52*	1003±2	516±30**	1010±3
2nd	147±22	1028±6	220±34*	1008±4*	611±46***	1004±3	1075±38***	1006±2

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Note: USG – Urine specific gravity; * reliability of the data compared with the indicators on the 1st day (* - P<0,05; ** - P<0,01; *** - P<0,001).

In patients of subgroup 1a, the secretory-excretory function of the kidneys recovered relatively slowly, reaching significance at 9-10 days (p > 0.05), which we attributed to the delayed restoration of urodynamics in the upper urinary tract in response to surgical trauma.

A stepwise surgical treatment approach for PCA with prior high-level urine diversion, performed based on vital indications to reduce uremia, endotoxemia, and prepare the child for radical surgery, was also carried out in 18 patients of the second group.

In two patients with extremely severe condition, bilateral urolithiasis, and high azotemia, two sessions of hemodialysis were performed alongside high-level urine diversion, which resulted in a pronounced positive effect.

The restoration of diuresis was slower in patients of the second group, with compensatory polyuria and hyposthenuria persisting for 10-12 days. This may be attributed to irreversible changes in the renal parenchyma due to prolonged urinary obstruction and the presence of associated complications.

The restoration of the secretory-excretory function of the kidneys within 3-4 weeks after preliminary urine diversion allowed all patients to undergo organ-preserving interventions. Doppler ultrasound data of the renal vessels indirectly indicated a gradual improvement in renal hemodynamics following deblocking.

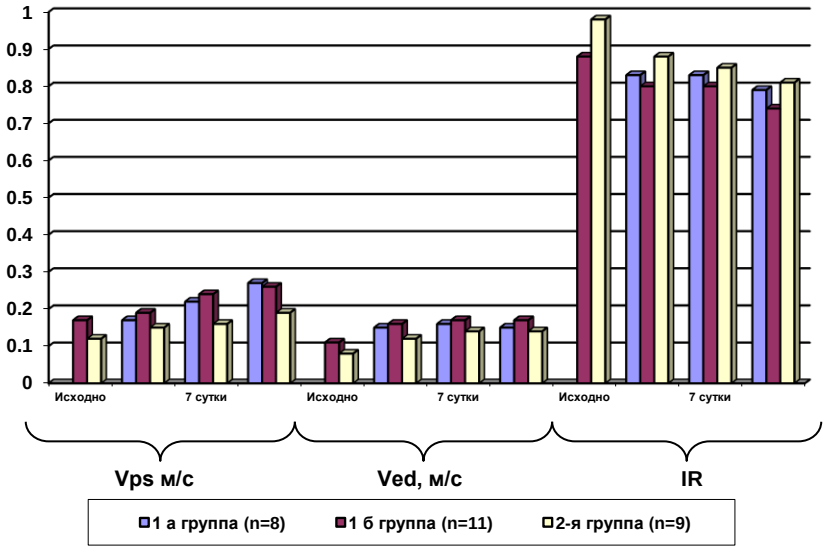

Fig. 2. Dopplerometric indicators of renal hemodynamics after kidney deblocking.

As evident from Figure 2, the maximum blood flow velocity in the renal artery of the obstructed kidney significantly improved in patients of subgroups 1a and 1b, from 0.17±0.03 to 0.27±0.02 and 0.26±0.02 m/s, respectively. The resistance index (RI) decreased from 0.88±0.06 to 0.79±0.04 and 0.74±0.04 in patients of subgroups 1a and 1b, respectively. Improvement in renal hemodynamics parameters was observed in the postoperative period in patients of the second group, although less pronounced than in subgroups 1a and 1b (p > 0.05).

The immediate postoperative period in patients of subgroup 1a following stone removal proceeded favorably, except for an exacerbation of calculus pyelonephritis, which was managed through conservative measures, intensified antibiotic therapy, additional uroseptics, and forced diuresis.

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Patients who had a percutaneous nephrostomy (PCN) as the first stage of treatment and had their condition stabilized were discharged home on days 12-15. In two patients with obstructive ureteral stones after high-level urine diversion, spontaneous passage of stones was observed, which can be attributed to the positive effect of PCN on the contractile activity of the ureter.

The second stage of treatment involved operative stone removal. The postoperative period in both groups of patients proceeded without significant complications. Standard postoperative measures ensured a smooth recovery during the immediate postoperative period.

Therefore, the data obtained allow us to conclude that high-level urine diversion (HLUD) is a method that enables the preparation of a child with posterior urethral valve (PUV) for operative stone removal. HLUD in PUV rapidly eliminates renal insufficiency and creates conditions for effective restoration of the secretory-excretory function of the kidneys, treatment of underlying and associated diseases, and optimal conditions for performing a radical operation.

The preliminary placement of a nephrostomy tube and stabilization of the patients' condition contribute to the rapid recovery of disturbances in the child's body caused by anuria compared to after radical stone removal. The dynamics of metabolic parameters depend on the duration of anuria and the severity of the patient's condition. Analysis of the restoration of homeostasis in children after deblocking showed that the normalization of clinical and biochemical parameters in patients with a longer duration of anuria (more than 3 days) proceeds significantly slower than in patients with a shorter anuria period. We believe this is due to more pronounced disturbances in metabolic processes and kidney function resulting from prolonged urine retention. The high risk of complications in this patient group is associated with irreversible changes that have occurred in the renal parenchyma due to prolonged urinary obstruction, the presence of associated complications, and underlying diseases. This emphasizes the need for early detection and active conservative and surgical treatment of these complications before the development of kidney blockage and anuria, even during the oligoanuric stage.

Conclusions:

1. When predicting the risk of complications and treatment outcomes in patients with posterior urethral valves (PUV), it should be taken into account that the treatment outcome depends primarily on the initial condition of the kidney, the degree of reduction in renal blood flow, the choice of treatment strategy, and the timing of surgical intervention.
2. In young children with primary urolithiasis and PUV, which acutely develops against the background of normal contralateral kidney function, with a duration of anuria up to 3 days and subcompensated renal circulation disorders, radical surgery such as pyeloureterolithotomy can be recommended.
3. In cases of PUV with a duration of anuria exceeding 3 days, bilateral obstruction, reduced renal blood flow, and severe endotoxemia, it is advisable to establish high-level urine diversion (HLUD) to reduce the level of intoxication, improve organ hemodynamics, stabilize the clinical picture, and prepare the child for stone removal.

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