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SURGICAL OUTCOMES IN EARLY CHILDHOOD POSTRENAL CALCULOUS ANURIA

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ABSTRACT

Background: Pediatric patients with postrenal acute kidney injury (AKI) due to ureteral obstruction often require timely intervention to prevent renal damage and complications. This study aimed to assess the clinical outcomes of different therapeutic approaches for pediatric patients with postrenal AKI.

Methods: A total of 53 pediatric patients, aged 4 months to 3 years, were included in this study. They were categorized into two groups based on the presence and duration of anuria, as well as the underlying conditions. Diagnostic evaluations included ultrasonography, radiography of the urinary tract, and radioisotope renography. Additionally, renal hemodynamics were assessed using Doppler ultrasound.

Results: Among the patients, 35 (66%) exhibited unilateral calculous obstruction, leading to reflex anuria within 3 days, with associated symptoms of systemic distress. The remaining 18 (33.9%) patients had anuria due to bilateral obstruction or single functioning kidneys for over 3 days, often accompanied by systemic complications. Doppler ultrasound revealed significant differences in intrarenal vascular patterns and resistive indices between the groups. Patients in the first group showed improvements in renal hemodynamics following surgical intervention, while those in the second group experienced delayed recovery.

Conclusion: The findings emphasize the importance of prompt and tailored treatment in pediatric patients with postrenal AKI. Patients with acute unilateral obstruction can benefit from

early surgical intervention, while those with bilateral or prolonged obstruction may benefit from preoperative high urinary diversion, leading to better postoperative renal function. Understanding the timing and appropriate management of postrenal AKI in pediatric patients is crucial for optimizing clinical outcomes and minimizing complications.

KEYWORDS: anuria, surgical treatment of children

INTRODUCTION

Postrenal calculous anuria (PCA) in early childhood is a complex condition, and the approach to its surgical management remains a subject of considerable debate among urologists [1, 2, 5, 6, 11]. The varying opinions on the most appropriate surgical tactics can be attributed to the intricate nature of the disease.

Research conducted by S.M. Javad-Zade and colleagues [3] has shed light on the critical importance of the initial steps in PCA treatment. Their findings emphasize that patients who underwent preoperative interventions to restore urinary flow and address azotemic intoxication and inflammation experienced significantly better outcomes compared to those who required urgent surgical procedures. In particular, when the urinary passage was successfully restored and the surgical procedure was carried out under normal or slightly subnormal urea, creatinine, and electrolyte levels, the postoperative course tended to be less turbulent, and kidney function was restored more swiftly [3, 4, 8, 10].

However, there are proponents of an alternative approach, favoring radical lithotomy without prior urinary diversion. They argue that such an approach directly addresses the primary cause of anuria, offering an expedited resolution to the etiological factor, which they consider paramount [2, 7, 9].

It is important to note that the decision regarding the surgical strategy for PCA in young children is a pivotal factor influencing the effectiveness of therapeutic measures. The timing and nature of the intervention have a substantial impact on patient outcomes [1, 5, 7].

MATERIALS AND METHODS

Study Population

Under our observation, a total of 53 children, ranging in age from 4 months to 3 years, were included in the study. The severity and manifestation of symptoms, which varied

depending on the presence of concurrent comorbidities, as well as the duration of anuria, allowed us to categorize the patients into two distinct groups.

Group 1

In the first group, 35 individuals (66%) were identified. These patients exhibited unilateral calculous obstruction in conjunction with spasm of the renal vessels of the contralateral kidney, leading to reflex anuria. The duration of anuria in this group did not exceed 3 days. In these cases, anuria manifested abruptly in otherwise healthy children. These children presented with lethargy, adynamia, subfebrile temperatures, and progressing azotemia, anemia, and dysproteinemia.

Group 2

The second group comprised 18 patients (33.9%) who experienced anuria due to bilateral obstruction of both kidneys or the sole functioning kidney (2 cases, 11.1%). The duration of anuria in this group exceeded 3 days. Anuria in these patients developed gradually, in the presence of severe underlying or concurrent illnesses, and often in the context of oliguria, attributed to partial urinary tract obstruction and obstructive pyelonephritis. The condition of patients in this group was notably severe, marked by pronounced signs of intoxication.

Control Group

A control group consisting of 21 patients with urolithiasis without disturbances in upper urinary tract urodynamics and without signs of anuria was established for comparative purposes.

Diagnosis

The diagnosis was established based on ultrasound (US) imaging, overview radiography of the urinary tract, and radioisotope renography.

In addition to clinical and biochemical investigations for assessing renal reserve capabilities, the state of renal hemodynamics was studied using Doppler ultrasound of major renal vessels. This technique involved simultaneous employment of B-mode, color Doppler mapping (CDM), and pulse-wave Doppler sonography (PWDS). The maximal systolic (Vps) and minimal diastolic (Ved) blood flow velocities, as well as the resistance index (IR) of renal vessels, were assessed.

RESULTS AND DISCUSSION

Assessment of Renal Hemodynamics:

Color Doppler mapping (CDM) allowed us to evaluate the vascular pattern within the renal parenchyma and identify qualitative characteristics of renal blood flow, including attenuation or absence of the vascular pattern. Quantitative parameters of renal hemodynamics, obtained through pulse-wave Doppler sonography (PWDS).

A statistically insignificant ($p > 0.05$) increase in the resistance index (IR) up to 0.81 ± 0.11, compared to the control group values, was observed in the kidneys of patients with reflex anuria ($p > 0.05$).

In the first group, IR increased significantly to 0.88 ± 0.06, which was statistically different ($p < 0.05$) from the control group (0.74 ± 0.08). Additionally, there was a reduction in both maximum and minimum blood flow velocities to 0.17 ± 0.03 and 0.11 ± 0.03 m/s, respectively.

Notably, severe disruptions in renal hemodynamics were observed in patients of the second group. During CDM, all observations revealed a sharp attenuation of intrarenal vascular patterns, along with a decrease in the maximum systolic blood flow velocity to 0.12 ± 0.03 m/s, while IR increased to 0.98 ± 0.02, which was significantly different from the control group ($p < 0.01$).

Correlation with Anuria Duration:

Our analysis of Doppler metrics for renal hemodynamics revealed a direct correlation with the duration of anuria ($r = 0.78$; $p < 0.01$).

Surgical Approach Based on Clinical Severity:

Depending on the severity of the clinical presentation and the initial renal function impairment in patients of the first group, the following surgical approaches were employed:

In 16 patients (45.7%) with PCA that had acutely arisen with initially normal renal function (subgroup 1a), pyelo- and ureterolithotomies were performed.

In 19 patients (54.2%) with anuria occurring in the context of contralateral kidney dysfunction and severe clinical presentation (subgroup 1b), percutaneous nephrostomy (PCN) was carried out.

Patients in subgroup 1b showed a decrease in blood pressure (BP) by 25-30% within the first day following PCN, normalization of heart rate, and an increase in circulating blood volume. A compensatory polyuria was observed by the end of the first week following urinary diversion, and by the beginning of the second week, the urea biochemical indicators in these patients had returned to normal (Table 1).

Table 1

Dynamics of diuresis indicators during the early stages of treatment for PCA

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

Note: UVM - Urine Specific Gravity; * Significance compared to Day 1 values (* - $p < 0.05$; ** - $p < 0.01$; * - $p < 0.001$).**

In patients of subgroup 1a, the restoration of renal secretory and excretory function occurred relatively slowly, reaching a plateau by the 9th to 10th day ($p > 0.05$). This was attributed to the delayed recovery of upper urinary tract urodynamics in response to surgical trauma.

A staged surgical approach for treating PCA, which included preliminary high urinary diversion conducted based on clinical necessity to reduce uremia, endotoxemia, and prepare the child for radical surgery, was also implemented in 18 patients from the second group.

In two critically ill patients with bilateral urolithiasis and severe azotemia, two hemodialysis sessions were performed alongside high urinary diversion, resulting in a marked positive effect.

The recovery of diuresis was slower in patients from the second group, with compensatory polyuria and hypoisosthenuria persisting for 10-12 days. This may be associated with irreversible changes that occurred in the renal parenchyma due to prolonged urinary obstruction and the presence of complications that developed during this period.

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

Ehe maximum blood flow velocity in the renal artery of the obstructed kidney significantly improved in patients of groups 1a and 1b, with values increasing from 0.17±0.03 to 0.27±0.02 and 0.26±0.02 m/s, respectively. The resistance index (IR) decreased from 0.88±0.06 to 0.79±0.04 and 0.74±0.04, respectively, in patients of 1a and 1b groups. Improvement in renal hemodynamic parameters during the postoperative period was noted in patients of the second group ($p > 0.05$), although it was less pronounced than in groups 1a and 1b.

In the immediate postoperative period after the removal of calculi, patients in the 1a group experienced favorable progress, except for the occurrence of an exacerbation of calculous pyelonephritis. This exacerbation was managed with conservative measures, intensified antibiotic therapy, the prescription of additional uroseptics, and enhanced diuresis.

Patients who had a percutaneous nephrostomy (PCN) as the first stage of treatment and whose condition stabilized were discharged home on days 12-15. In two patients with obstructive ureteral stones after high urinary diversion, the stones were

observed to spontaneously pass. This could be attributed to the positive influence of PCN on the contractile activity of the ureter.

Second Stage of Treatment: Surgical Removal of Calculi

The postoperative period in both groups of patients proceeded without significant complications. The implementation of standard postoperative measures ensured a smooth recovery in the immediate postoperative period.

In conclusion, the data obtained in this study suggest that percutaneous nephrostomy (PCN) is an effective method for preparing children with postrenal calculous anuria (PCA) for the surgical removal of calculi. PCN, when applied in PCA cases, rapidly eliminates manifestations of renal insufficiency, enabling the effective restoration of renal secretory and excretory function, the treatment of concurrent and underlying conditions, and the creation of optimal conditions for radical surgery.

The preliminary placement of a nephrostomy and the stabilization of patients' conditions contribute to a faster recovery from disturbances caused by anuria compared to radical stone removal. The dynamics of metabolic parameters depend on the duration of anuria and the severity of the patient's condition. An analysis of homeostasis restoration in children after deblocking revealed that normalization of clinical and biochemical parameters in patients with longer anuria duration (over 3 days) occurred significantly more slowly than in patients with a shorter anuria period. This delay is attributed to more pronounced disruptions 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 in renal parenchyma due to prolonged urinary obstruction, the presence of concurrent complications, and underlying diseases. This highlights the importance of early identification and active conservative and surgical treatment of these conditions before the development of kidney blockage and anuria, even during the oligoanuric phase.

CONCLUSION

1. When predicting the risk of complications and treatment outcomes in patients with postrenal calculous anuria (PCA), it should be considered that treatment outcomes depend primarily on the initial state of the kidney, the degree of renal blood flow reduction, the choice of treatment strategy, and the timing of surgical intervention.
2. In young children with primary urolithiasis and PCA, which acutely developed with normal contralateral kidney function, anuria lasting up to 3 days, and subcompensated renal circulation disturbances, radical surgery, such as pyeloureterolithotomy, can be recommended.
3. In cases of PCA with anuria lasting more than 3 days, occurring in the context of bilateral obstruction, along with reduced renal blood flow and severe endotoxemia, it is

advisable to perform percutaneous nephrostomy (PCN) to reduce the level of intoxication, improve organ hemodynamics, stabilize the clinical condition, and prepare the child for calculus removal.

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