



CURRENT STATUS OF THE PROBLEM OF HYDRONEPHROSIS IN CHILDREN

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ABSTRACT

The review examines current aspects of the diagnosis, pathogenesis, classification, and treatment of hydronephrosis in children, with particular attention paid to minimally invasive surgical techniques and the specifics of antenatal diagnosis. Current data on the prevalence of the disease, pathophysiological mechanisms, features of the clinical picture, and effective approaches to the correction of hydronephrosis, based on the latest research for the period 2022-2024, are presented. Particular attention is paid to a comparative analysis of traditional and modern treatment methods, as well as the postoperative management of patients. The work demonstrates the practical significance of using new technologies in pediatric urology and emphasizes the need for further research in this area

Introduction

Hydronephrosis is a pathological dilatation of the renal pelvis, arising as a result of impaired urine outflow and leading to structural and functional changes in the kidney [9]. In children, the disease is quite common, observed in both newborns and younger age groups, which is due to both congenital anomalies and acquired pathologies of the urinary system [13].

In recent years, the issue of diagnosis and correction of hydronephrosis has become particularly relevant due to the widespread use of antenatal diagnosis and the development of minimally invasive surgical techniques [7]. Against the background of an increasing number of detected cases, the disease requires detailed study both in the context of pathogenesis and in the evaluation of modern treatment methods and postoperative management.

The aim of this review is to analyze current scientific data on hydronephrosis in children, to highlight the main aspects of etiology, clinical presentation, diagnosis, classification, as well as modern treatment, which allows drawing conclusions about the directions of further research and the improvement of treatment algorithms. Particular emphasis is placed on the differences in approaches to the treatment of hydronephrosis in children and adults, as well as on statistical data confirming the effectiveness of modern interventions [10].

Etiology and Pathogenesis

The pathogenesis of hydronephrosis in children is a complex interaction of congenital anomalies, pathophysiological disorders, and factors of external exposure.

The main etiological link is deviations in the process of embryonic development of the urinary system, such as anomalies in the formation of the ureteropelvic junction, defects in the development of the pyelocaliceal system, as well as disorders in the development of renal caliceal-pelvic structures [15]. Additionally, modern research reveals a genetic predisposition to the development of such disorders, which is confirmed by the work of Boşoteanu M. and colleagues [3].

Pathophysiological mechanisms include impaired urine outflow, increased intrarenal pressure, compression of the parenchyma, and decreased microcirculation, leading to gradual atrophy of kidney tissue [9]. In addition, congenital forms of hydronephrosis, manifesting already in the antenatal period, and acquired forms associated with inflammatory processes and obstructive changes in the peripheral parts of the urinary system are observed in children [3, 11].

Age-related features play an important role: in newborns, the disorder may be asymptomatic, while in older children, the disease is more often associated with infectious complications and functional disorders.

Thus, the multifactorial nature of pathogenesis requires complex diagnostics and individual treatment tactics, which is confirmed by the latest publications in the field of pediatric urology [15].

Clinical Presentation

The clinical presentation of hydronephrosis in children is characterized by a wide variability of symptoms, which is associated with age-related changes and the severity of anatomical abnormalities.

In newborns and infants, hydronephrosis often proceeds asymptotically, being detected during routine screening ultrasound examinations or during antenatal diagnosis [14]. In this case, minor changes in temperature or increased irritability may serve as the only signs of a pathological process.

Preschoolers and schoolchildren exhibit more pronounced symptoms: periodically expressed pain in the lumbar region, changes in urination patterns, and in some cases – signs of impaired kidney function, such as hypertension and fluid retention [4].

An additional complication is the presence of concomitant urological anomalies, for example, vesicoureteral reflux, which can aggravate the course of the disease and contribute to its chronic nature [9]. The latest research notes that in children with severe hydronephrosis, the development of a chronic inflammatory process leading to fibrosis and a decrease in the function of the renal parenchyma is possible [6]. The accidental detection of hydronephrosis is often associated with an increase in the number of studies using contrast-enhanced ultrasound, which allows detecting even minor changes in the structure of the kidney.

Thus, the clinical spectrum of the disease varies from an asymptomatic course to a pronounced clinical picture with complications, which requires careful monitoring and timely intervention.

Modern Diagnostic Methods

The modern diagnostic approach to hydronephrosis in children is based on a multidisciplinary interaction of prenatal, instrumental, and laboratory methods.

At the initial stage, antenatal diagnosis using ultrasound plays a key role, allowing not only the identification of anatomical anomalies but also the assessment of the dynamics of the renal system formation in utero [12].

In the postnatal period, high-quality B-mode ultrasound remains the mainstay, providing visualization of the kidney structure and determination of the degree of dilatation of the pelvicalyceal system [9].

In modern conditions, contrast-enhanced *ultrasound diagnostics* are increasingly used, allowing for additional assessment of microcirculation in kidney tissues. *Dopplerography* helps to evaluate blood flow and detect hidden changes, especially in concomitant inflammatory processes [10]. *Magnetic resonance imaging (MRI)* and *computed tomography (CT)* are actively used for the accurate determination of anatomical features and the degree of hydronephrosis severity, with MR urography gaining increasing importance due to the absence of ionizing radiation. *Excretory urography* remains an important tool for studying the dynamics of excretion and transport characteristics of urine, which significantly affects the choice of treatment tactics [17]. *Radionuclide methods*, including renography and nephroscintigraphy, allow for the quantitative assessment of the functional state of the kidneys and the identification of areas with impaired perfusion [14]. *Voiding cystourethrography* provides additional diagnostic information, especially when a concomitant vesicoureteral reflux is suspected, allowing for an accurate assessment of the retrograde flow of urine [9]. *Laboratory tests*, including biochemical blood analysis and evaluation of urinary parameters, help to assess the patient's overall condition and the functional capabilities of the kidneys.

Modern **differential diagnosis** is based on the integrated use of all the above-mentioned methods, which allows excluding other pathologies of the urinary system and ensuring an accurate determination of the degree of the pathological process [13].

Classification and Staging of Hydronephrosis

Modern classifications of hydronephrosis in children are based on the assessment of the degree of dilatation of the renal systems and the functional state of the organ.

The most common is the grading according to the degree of dilatation of the pelvicalyceal system, which allows determining the stages of the disease from minimal changes to pronounced dilatation with parenchymal involvement [7]. At the same time, the clinical significance of the classification lies in the use of the obtained data to make decisions about treatment tactics, whether it is conservative observation or surgical intervention [9].

The assessment of the functional state of the kidney is carried out using excretory urography and nephroscintigraphy, which helps to quantitatively determine the degree of impairment of excretion and blood supply [5].

The stages of the disease range from the initial stage, characterized by local changes, to the late stage, when there are pronounced structural changes and a decrease in organ function. It is important to note that combined methods are used in modern clinical practice for more accurate diagnosis and staging, which allows adapting treatment algorithms taking into account the individual characteristics of the patient [9].

Thus, a systematic approach to the classification and staging of hydronephrosis ensures the possibility of prompt decision-making and the selection of the optimal treatment strategy for each specific case.

Modern Treatment Approaches

Treatment of hydronephrosis in children requires an individual selection of tactics taking into account the degree of obstruction and functional impairment. Current data indicate that in cases of low severity of the disease, a conservative approach with dynamic observation, regular ultrasound examinations, and laboratory monitoring may be recommended [10]. If kidney function deteriorates or symptoms increase, surgical intervention becomes necessary.

The traditional treatment method remains Anderson-Hynes pyeloplasty, which shows high efficacy in children with a pronounced obstructive syndrome [11].

Modern medicine offers a wide application of minimally invasive technologies. Laparoscopic and retroperitoneoscopic techniques allow performing corrective surgeries with minimal intervention, reducing the postoperative period and decreasing pain syndrome [2, 4]. Endourological procedures, including stent placement and balloon dilatation of narrowed areas, have proven their effectiveness in the temporary and permanent correction of obstruction [17]. Robotic surgery, as one of the latest trends, provides high accuracy and safety of intervention in complex anatomical cases, allowing achieving optimal long-term results [1, 9]. Additionally, a comparative analysis of modern techniques reveals that minimally invasive approaches significantly reduce the risk of complications and contribute to the rapid recovery of kidney function, which improves the quality of life of patients [14].

When choosing a treatment method, not only anatomical and physiological features are taken into account, but also the results of functional studies, which allow for personalized therapy and adaptation of the treatment algorithm to the specific needs of the patient [6].

Postoperative Management and Long-Term Outcomes

Postoperative monitoring of children with hydronephrosis includes regular monitoring of the kidney condition using ultrasound, laboratory, and functional studies, which allows for prompt adjustment of therapeutic tactics in case of complications [7]. Particular attention is paid to the prevention of postoperative complications such as recurrence of obstruction, infectious complications, and decreased kidney function. Effective postoperative management is based on an interdisciplinary approach involving pediatricians, urologists, and nephrologists, which ensures timely detection and correction of changes in the functioning of the renal systems [8].

Statistical data from recent years demonstrate the high effectiveness of minimally invasive techniques, confirming the restoration of renal function in the vast majority of patients with approved surgical interventions [5]. In addition, long-term follow-up allows assessing the quality of life of patients and guaranteeing a high level of rehabilitation, which is especially important for younger age groups [10].

Thus, comprehensive postoperative care, including both technical monitoring methods and clinical observation, is the key to a successful outcome in the treatment of hydronephrosis in children.

Conclusion

The conducted review demonstrates that hydronephrosis in children remains a relevant problem in modern pediatric urology, requiring timely diagnosis and an individualized approach to treatment. The main findings of the study indicate the significance of the integrated use of modern diagnostic methods, including antenatal diagnosis, ultrasound, MRI, CT, and functional studies, which allows assessing both structural and functional changes in the kidney.

The development of minimally invasive surgical techniques – laparoscopic, retroperitoneoscopic, and robotic interventions – significantly improves postoperative outcomes and the quality of life of patients.

Despite the progress achieved, questions remain unresolved regarding the optimal treatment strategy for antenatally detected hydronephrosis and the selection of the most effective surgical method for each age group.

The prospects for the development of this area are related to the further improvement of diagnostic protocols and the adaptation of individual treatment programs, which will allow achieving higher rates of successful treatment outcomes and a reduction in the number of complications

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