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Role of Echography in Diagnosis of Chronic Kidney Disease in Children

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ABSTRACT

The article provides data from a literature review on the possibilities of the complex application of ultrasound diagnostics in chronic kidney disease in children. The resolution of ultrasound examination of internal organs in children is fundamentally higher than in adults, due to the poorly developed subcutaneous fat layer, which, together with the advent of new high-resolution ultrasound technologies, allows us to differentiate pathological changes in organs with high accuracy. In recent years, the number of specialized literatures in the field of ultrasound diagnostics, including in pediatrics, has increased significantly, however, many aspects remain insufficiently covered.

Thus, ultrasound diagnosis is the method of choice in the diagnosis of chronic kidney disease in children.

KEY WORDS:ultrasound diagnostics, Doppler angiography, chronic kidney disease, chronic pyelonephritis, children.

Chronic kidney disease (CKD) is the presence of kidney damage or decreased kidney function for three months or more, regardless of the diagnosis. The prevalence of CKD is comparable to such socially significant diseases as hypertension, diabetes, obesity, and metabolic syndrome [1].

Causes of CKD in children can be followings such as obstructive uropathy, hypoplasia/dysplasia, glomerulonephritis, polycystic fibrosis, pyelonephritis, interstitial nephritis, hereditary nephritis, hemolytic-uremic syndrome (HUS), systemic diseases and other causes.

For the diagnosis of CKD, a minimum set of available and inexpensive diagnostic tests is required which is consists of general urine analysis, blood creatinine and calculation of glomerular filtration rate (GFR) according to the Schwartz formula and ultrasound of the kidneys in patients with the absence of proteinuria – a test for microalbuminuria [2, 8].

Chronic kidney disease in the early stages is described as a decrease in the renal reserve or kidney failure, which can progress gradually. Initially, the loss of renal tissue function has almost no obvious pathological manifestations as the remaining tissue works hard which is in fact shows the functional adaptation of the kidneys [4, 11].

Decreased renal function correlates with the ability of the kidneys to maintain water and electrolyte homeostasis. In the early stages, the ability of the kidneys to concentrate urine is impaired, and then a decrease in the ability to excrete excess phosphates, acid and potassium is added. With severe renal insufficiency, the ability to effectively dilute or concentrate urine is lost. Thus, the osmolarity of urine approaches the osmolarity of plasma, and the volume of urine does not immediately respond to changes in the volume of liquid consumed [5, 9].

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CKD of stage 1-2 can include any chronic disease with damage to the renal parenchyma and preserved or slightly reduced GFR (chronic pyelonephritis, chronic glomerulonephritis, tubulointerstitial nephritis, obstructive nephropathy, malformations, early stages of diabetic nephropathy, etc.). On these stages timely diagnosis and adequate specific treatment of a particular disease can completely prevent the development of kidney failure.

Stages 3-5 of CKD respectively correspond to CRF. With the onset of CRF, its progression to the terminal stage is inevitable. Therapeutic tactics in stage 3-5 of CKD are less dependent on the nature of the initial pathology and should be aimed at slowing the progression of CKD, preventing cardiovascular pathology, and ensuring normal growth and development of the child [5, 7].

Relatively, any severe kidney disease leads to a progressive decrease in the number of functioning nephrons. From a certain point on, the mechanisms of progression of kidney damage are the same in any disease, whether it is a primary glomerular lesion, tubulointerstitial process, or congenital dysplastic changes in the parenchyma. The result of the pathological process is glomerular sclerosis in combination with interstitial sclerosis, which is a morphological substrate of CRF, regardless of its cause [7, 11].

The above changes are also characteristic of chronic pyelonephritis. Pyelonephritis is a non-specific inflammatory process in the kidney tissue and the calyx-pelvis system with a predominant lesion of tubulointerstitionthat is one of the most common infectious diseases in all age groups. Every year up to 1.3 million cases of acute pyelonephritis are registered in Russia. Pyelonephritis, together with cystitis, asymptomatic bacteriuria and infections of the male genitals, is combined into the UTI syndrome.

The classification of pyelonephritis was developed by the International and European Associations of Urologists (EAU, 2004), using the UTI criteria of the American Society for Infectious Diseases (ASID, 1992) and the European Society for Clinical Microbiology and Infectious Diseases (ESCMID, 1993).

1. According to the place of occurrence it is divided into:
   - out-of-hospital (ambulatory);
   -nosocomial (hospital-acquired).
2. According to the presence of complications:
   - uncomplicated;
   - complicated (abscess, carbuncle, paranephritis, acute renal injury, urosepsis, shock).
3. According to the course of the disease:
   - acute (first episode; new infection (de novo) later than 3 months after the acute episode);
   - recurrent (relapse - an episode of infection that developed within 3 months after acute pyelonephritis).

Mostly, Chronic pyelonephritis is a usual consequence of acute pyelonephritis. Sonographic diagnosis of the disease in the initial stage without exacerbation is not possible, since the ultrasound picture of the kidneys does not differ from the normal one [3]. With an exacerbation of chronic pyelonephritis, sometimes such a sign as a thickening of the pelvic wall and the manifestation of its layered structure could be found. Repeated exacerbations lead to a gradual decrease in the volume of the affected kidney and with the depletion of its capabilities, an increase in the opposite kidney begins to develop.

Apostematous pyelonephritis is a purulent-inflammatory process with the formation of

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numerous small pustules (apostemes) mainly in the kidney cortex. It is most often a complication of acute obstructive pyelonephritis. With a detailed picture of the apostematous purulent process, ultrasound examination determines a sharp increase in the volume of the kidneys, multiple small abscesses the size of a pinhead appear under the capsule, the contours of the kidneys are uneven, bumpy, and there is almost no mobility during breathing. With superficial abscesses or pus may spread under the capsule of the kidney, on perinephric and paranephric.

Paranephritis is an inflammatory process in the parotid tissue. The inflammatory process of the renal capsule, which, as a rule, is involved in the process of severe purulent pyelonephritis, is called perinephritis. In these processes, ultrasound examination determines a sharp decrease in the respiratory mobility of the kidneys, the indistinctness of their contours. Areas of reduced echogenicity, as well as fluid cavities, are identified around the kidneys.

Sonography is an important and sometimes the only beam method, which allows to identify the carbuncle of the kidney. The disease is a purulent-necrotic lesion of the organ with the formation of a delimited infiltrate. In the area of carbuncle formation, a large-focal area of heterogeneous structure is reduced, and sometimes increased, echogenicity, deforming the contour of the kidney is revealed. During dynamic examination, cavities containing liquid are formed in this formation over time. In the future, there is a decrease in the size of the formation and the capsule of the abscess is formed. When an abscess is formed, the ultrasound picture is represented by a focus with a cystic structure with a thick, uneven wall, in the cavity of which a suspension is determined. In the future, the focus may break into the calyx or pelvis. But most often the resolution occurs in the adjacent tissues-paranephral tissue, which leads to the development of purulent paranephritis. This process can also be a complication of acute pyelonephritis or the result of the fusion of pustules in apostematous pyelonephritis.

Pionephrosis-the disease is a terminal stage of purulent-destructive pyelonephritis.

The pionephrotic kidney in sonography is an organ that has undergone purulent melting, consisting of separate cavities filled with pus, urine and decay products. Pioneros always accompanied by peri - or paranephritis. The disease is observed in all patients with clinical and laboratory manifestations of kidney inflammation, renal echographic changes are noted, which can be divided into reliable and indirect relative to the picture of pyelonephritis pathomorphogenesis [6]. Reliable echographic tissue manifestations are characterized by constancy and phase development, according to the stages of pathomorphogenesis of acute inflammation (stages of alteration, vascular-tissue reaction and proliferation). The main pathomorphological stereotypes detected in pyelonephritis by ultrasound are:

- Phasic inflammatory changes in intra-pararenal structures, as well as target organs in urosepsis.

- Ischemic tissue manifestations in the form of phase vascular obstructive changes in the renal parenchyma.

With the help of dynamic ultrasound diagnosis, it is possible to clearly identify local echographic changes that accompany clinical and laboratory manifestations of pyelonephritis [2].

Summuringall the above-mentioned research data the following conclusions can be mentioned:

- Firstly, Dynamic ultrasound diagnosishelps to assess changes in blood flow in the renal parenchyma remains the most objective and harmless imaging method for the patient to timely solve the problem of diagnosing pyelonephritis in children with high accuracy.

- Secondly, the use of high-resolution ultrasound and tissue Doppler angiography allows us

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to obtain timely data on the presence, location, stage, extent and evolution of inflammatory changes in intra - and extrarenal tissues, which in turn allows us to detect local and clinical and laboratory manifestations of chronic inflammation, which may indicate the presence of chronic pyelonephritis.

- Thirdly, Echographic changes in renal structures and the stages of their development are determined by the dynamic morphological specifics of pyelonephritis, which in turn is associated with the manifestation of pathomorphogenesis of the disease. It is noted that these changes do not depend on the gender and age of the patients, as well as whether there is a primary attack of pyelonephritis or an exacerbation of the chronic process. This, in turn, allows us to talk about the ultrasound semiotics of pyelonephritis, which implies the echographic phases of renal changes: exudative, infiltrative, reparative, nephrosclerotic (diffuse or local).

- Fourthly, the proposed method of diagnosis by ultrasound allows us to evaluate the signs of inflammation of tissue intra-and extrarenal structures that are not differentiated in clinical, physical and laboratory studies. The ability of ultrasound non-limiting only to identify signs of change bodies and their comparison with clinical and laboratory data, but this method allows us to differentiate tissue changes accordingly phases of photomorphogenesis, i.e. to integrate the phase of the pathological process, not focusing on clinical manifestations. If we take into account that focal and generalized changes develop rapidly in children against the background of many clinical masks of pyelonephritis, this may be of fundamental importance in the timely determination of organ-preserving tactics.

Moreover, the informativeness of conventional ultrasound increases with the use of Doppler scanning. In this case, you can study the state of blood flow in the kidney.

Lastly, the resolution of ultrasound examination of internal organs in children is fundamentally higher than in adults, due to the poorly developed subcutaneous fat layer, which, together with the advent of new high-resolution ultrasound technologies, allows us to differentiate pathological changes in organs with high accuracy. In recent years, the number of specialized literatures in the field of ultrasound diagnostics, including in pediatrics, has increased significantly, however, many aspects remain insufficiently covered.

Thus, ultrasound diagnosis is the method of choice in the diagnosis of chronic kidney disease in children. Due to its simplicity, accessibility, non - invasiveness and lack of radiation, this method is very valuable and is recommended for wide use in children.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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