

# Examination of the child's uropoietic system

Kidney and urinary tract diseases are the second most common cause of illness in children of all ages after respiratory diseases. The kidneys have a homeostatic, detoxifying, excretory and endocrine function in the body.

## Examination of the child's uropoietic system :

1. anamnesis,
2. physical exam,
3. laboratory examination,
4. imaging methods,
5. functional examination.

## Embryological development of the uropoietic system

The kidneys of the human embryo produce urine in the 12th week of gestation. Urine makes up 90% of amniotic fluid volume. Severe congenital malformations of the kidneys associated with a reduction in the number of nephrons are the cause of insufficient amniotic fluid volume (oligohydramnios) and, secondarily, lung hypoplasia.

Nephrogenesis is complete in the human fetus at 36 weeks of gestation (ie about 1 million glomeruli per kidney). Functionally morphological maturation is completed around the 2nd year of age. The newborn's kidneys are relatively large and their surface is reniculated (divided into 10-20 lobes), this surface arrangement disappears by the age of 2 years. In the newborn, the bladder is located in the abdominal cavity and, in its unfilled state, reaches approximately halfway between the navel and the upper edge of the symphysis. As the child grows, the child descends and at school age the unfilled bladder is completely hidden behind the symphysis. The urethra of a newborn baby girl measures 2-3 cm.

Most newborns urinate shortly after birth (92% within 24 hours). The first evacuation of urine more than 48 hours after birth is a pathological manifestation. Insufficient protein resorption is the cause of mild physiological proteinuria in newborns. Premature babies have reduced kidney function and are therefore more prone to hydropathy and metabolic breakdown.

## The most common symptoms of diseases of the uropoietic system

### Non - specific symptoms

- Fever, hypothermia, jaundice, irritability, apathy, anorexia, nausea, vomiting, weight loss, swelling, ascites, headache, paleness, fatigue, mood swings
  - the manifestation of these symptoms is a manifestation of exhaustion of compensatory mechanisms, homeostasis disorders and uremia development,
- chronic renal insufficiency → decreased production of vitamin D<sub>3</sub> → rickets, growth disorder,
- Alport's syndrome → vision and hearing disorders.

### Pain

- Pain arising from the kidneys and urinary tract is projected into the abdomen, small pelvis and lumbar region,
- painful sensation is caused by tensioning its sheath when the volume of the kidney increases (edema, hydronephrosis, polycystosis, tumor),
- sharp to colic abdominal pain is usually the result of acute overpressure in the upper ducts (hydronephrosis), or the passage of urinary stones (nephrolithiasis),
- ureteral pain comes from the lumbar region and radiates along the ureters into the hypogastrium (sometimes to the inside of the thigh),
- suprapubic pain due to enormous bladder filling or inflammation,
- pain in the scrotum is usually during torsion of the testicle or orchid.

### Dysuria

- Burning, cutting pain coming from the urethra or its surroundings,
- causes:
  - local irritation of the urethral orifice (intertrigo, balanitis, vulvovaginitis, use of inappropriate soaps or bath additives),
  - evacuation of too concentrated urine (dehydration),
  - inflammation of the lower urinary tract (cystitis, urethritis),
  - using drugs that irritate the bladder mucosa (sulfonamides, cyclophosphamide, amitriptyline).

### Unusual urine coloration

- Darker yellow urine - markedly concentrated urine during dehydration,
- pink, reddish or brown urine - admixture of blood (hematuria), hemoglobin (hemoglobinuria), myoglobin (myoglobinuria).

- myoglobinuria ), or urobilinogen or exogenous dyes (blueberries, beets) or medicines,
- in newborns and infants, pink or rusty spots may appear on the diaper - massive urate excretion,
- dark to almost black urine - alkaptonuria , tyrosinosis .

## Disorders of urine production and emptying

- Anuria - urine production lower than 0.5 ml / kg / h (can be reliably measured only during bladder catheterization),
- oliguria - urine production 0.5–1.0 ml / kg / h (less than 500 ml / 24 h / 1.63 m<sup>2</sup> ),
  - causes of oliguria and anuria: severe dehydration, shock, renal failure, tubular necrosis ,...
- polyuria - excretion of more than 150% of the usual urine volume per unit time depending on fluid intake (more than 2000 ml / 24 h / 1.73 m<sup>2</sup> ),
  - causes of polyuria: excessive fluid intake (polydipsia), excessive osmotic load ( diabetes mellitus ), antidiuretic hormone deficiency ( diabetes insipidus neurohumoralis) or antidiuretic hormone receptor (diabetes insipidus renalis), chronic renal insufficiency , relief of extensive swelling, some congenital tubulopathy, phase of acute tubular necrosis , VVV (polycystosis, renal dysgenesis,...), diuretics , theophylline preparations,
- urinary retention - a state of preserved production but difficult evacuation of the bladder,
  - causes of urinary retention: obstruction (stenosis of the urethra or bladder neck or their neurogenic dysfunction),
- polakisuria - repeated evacuation of a small volume of urine at short intervals,
  - causes of polakisuria: inflammation (cystitis, urethritis), lithiasis, emotional lability,
- enuresis - persistent urination or involuntary urination at least twice a month in a child over 5 years of age during sleep,
- urinary incontinence - objectively demonstrable involuntary leakage of urine in older children,
  - causes of urinary incontinence: anatomical or functional disorders of the lower urinary tract and CNS (spinal cord, brain disorders, mental retardation, disorders of consciousness, stress, hysteria),
- dysfunctional micturition - urination of varying intensity, intermittent micturition, urgent micturition,...

## History

### Family history

- Genetic disorders

### Perinatal history

### Personal anamnesis

- frequency of urination in 24 hours; fluid intake in 24 hours;

The frequency of urination decreases with childhood with increasing age. An infant urinates up to 20 times a day, a 3-year-old child urinates about 10-11 times a day. Daily urine volume depends on the degree of development of renal function (infants and infants have lower function), fluid intake and loss.

- The nature of the urine flow,
- macroscopic changes in urine, conspicuous foaming ( proteinuria ); the smell of urine or wet diapers,
- enuresis, urination, incontinence;

The physiological development of micturition control is conditioned by maturity and proper integration of CNS, brainstem, spinal cord, detrusor muscle and external urethral sphincter functions. Day urine control is usually achieved at the age of 2-4 years, night control at the age of 10 in about 85% of children. Young children empty their bladder almost completely, with minimal postmictic residue.

- abdominal, lumbar and suprapubic landscape pain; dysuria ;
- subfebrile and febrile without signs of respiratory infection,
- in girls, vaginal discharge,
- frequency of bowel movements ( constipation ),
- swelling of the face and limbs (fluid retention, hypoproteinaemia ), ascites ( nephrotic syndrome ),
- headache (hypertension, uremia); bone and joint pain ( renal osteodystrophy ),
- anorexia, nausea, vomiting ( urinary tract infections , renal insufficiency , tubulopathy ),
- visual disturbances, muscle weakness, twitching or convulsions ( uremic syndrome ); hearing disorders ( Alport's syndrome ),
- growth failure ( decreased kidney function ),
- hemorrhagic skin and mucous membrane manifestations ( Henoch-Schönlein purpura ); rash ( systemic lupus erythematosus ),
- drug use,
- chronic diseases; congenital malformations .

## Physical examination

### Inspection

- General condition, height, nutritional status, aspects of the abdomen and external genitalia, skeletal deformities, arthropathy, skin,....,

- arching of the subfrenia or mesogastrium may be associated with hydronephrosis, polycystosis, or a large kidney tumor,
- arching suprapubically causes a filled bladder.

## Palpation and percussion

The kidneys and urinary tract are not normally visible or palpable, they are not painful . Physiologically, the kidneys are felt only in neonatal age (they are relatively large and relatively higher), later only in extremely slender individuals.

## Renal distension and resistance

- hypertrophy, tumor, polycystosis, kidney abscess, hydronephrosis, migrating kidney, ascites

## Israeli touch (bimanual examination)

- the patient lies on his back; with one hand we lift the kidney at a costvertebral angle, with the other we palpate the lower pole of the kidney under the rib arch in deep inspiration,
- positive in hydronephrosis, polycystosis, solitary cyst, kidney tumor,

## Tapotement

- gentle tapping with the edge of the palm on the kidney area at the back of the torso; patient sitting
- one-sided positive - acute pyelonephritis, perinephritis, in which there is also an infiltration of the environment,
- bilaterally positive - glomerulonephritis, bilateral pyelonephritis (obstructive uropathy),
- can be reliably assessed only at preschool age.

## Suprapubic pain

- urinary retention (bladder neck obstruction, phimosis), inflammation - palpation causes urination,
- the bladder filling may not be palpable.

## Blood pressure

## Laboratory tests

*See the Urine Examination page for more information .*

- chemical examination of urine and examination of urinary sediment , Hamburger sediment ,
  - hematuria - chemically hemoglobin in urine, erythrocytes in sediment,
  - myoglobinuria and hemoglobinuria - chemically hemoglobin in the urine, sediment without erythrocytes,
- bacteriological examination of urine ,
- examination of renal concentration ,
  - to differentiate the cause of significantly hypoosmolar urine (psychogenic polyuria vs. diabetes insipidus),
  - desmopressin concentration test (Minirin® test), the thirst test was previously used,
    1. determination of urine osmolality at the beginning of the test,
    2. administration of a synthetic analogue of antidiuretic hormone in a defined dose in the form of a nasal spray (Minirin spray®),
    3. strict limitation of fluid intake, control of water balance during the test, determination of urine osmolality in urine samples at given time intervals,
      - significant weight loss - during dehydration,
      - weight gain - with uncontrolled fluid intake - in combination with desmopressin can lead to water intoxication with a risk of brain edema,
      - physiological response in healthy children aged 2-12 years : increase in urine osmolality above 800 mmol / kg ,
      - physiological response in healthy children over 12 years of age : increase in urine osmolality above 900 mmol / kg ,
- examination of glomerular filtration (GF),
  - GF status reflects serum creatinine levels
  - Serum creatinine levels may be physiologically higher in the neonate (higher than maternal fetal levels cause a gradient that allows serum creatinine to be regulated by the maternal kidneys) - decreases during the first few days of life, reflecting GF maturation.
  - Serum creatinine levels in infants and older children increase with age, always slightly higher in boys than in girls.
  - GF examination:
    - examination of endogenous creatinine clearance,
    - serum cystatin C ,
      - cystatin C is a proteinase inhibitor permanently synthesized by all nuclear cells, freely filtered through the glomerular membrane and almost completely reabsorbed and catabolized by tubular cells,
      - the level is not affected by gender or height or muscle mass,
      - premature infants have the highest levels of cystatin C as a reflection of immature renal function.

# Display methods

## Ultrasonography

- The shape, placement and size of the kidney, assessment of the echotexture of the parenchyma and the spaciousness of the hollow system,
- Doppler - measurement of blood flow through renal vessels ( renal artery stenosis ),
- examination of the maximally filled bladder and measurement of post-micturition residue and bladder wall thickness,
- prenatal sonographic diagnosis of congenital kidney and urinary tract defects - enables prevention and early treatment of uropoietic tract diseases,
- area screening of renal and urinary tract VVV in neonatal or early infancy.

## Ascending pyelography

- Procedure: application of a contrast agent into the ureteral catheter,
- shows the course of the ureter and possibly the nature of the blockade.

## Urinary cystourethrography ( MCUG )

- Procedure: a contrast agent is administered through a bladder inserted into the bladder, a static image shows the bladder and possible passive vesicoureteral reflux (VUR), after removing the catheter the course of active micturition is serially scanned, tube,
- to assess the anatomy and function of the lower urinary tract, to demonstrate vesicoureteral reflux.

## CT

- For the diagnosis of tumors, lithiasis, abscess,...

## MR

- To illustrate a dilated hollow system,...

## MR angiography

- For examination of renal vasculature, especially in children with hypertension.

## Dynamic and static scintigraphy

## Urinary cystography

# Instrumental examination

- In girls with recurrent IMC or enuresis - urethral calibration to rule out stenosis,
- cystoscopy - in VUR, bladder evacuation disorders, unclear macroscopic hematuria.

# Kidney biopsy

- Percutaneous (under sonographic control) or open biopsy,
- indications: unclear acute renal failure, progressive deterioration of renal function, long-term proteinuria , hematuria , recurrent or atypical course of glomerulonephritis or nephrotic syndrome , suspected kidney damage in autoimmune diseases, graft control after kidney transplantation
- contraindications: bleeding disorders, thrombocytopenia, severe hypertension and anemia

# Links

## Related articles

- Radiodiagnostic examination of the urinary tract

**Examination of the child:** Examination of the child's cardiovascular system ■ Examination of the child's gastrointestinal system ■ Examination of the child's respiratory system ■ Examination of the child's endocrine system ■ Examination of the child's musculoskeletal system ■ Examination of the child's skin and skin adnexa ■ Examination of the child's eyesight and hearing

## Literature

- LEBL, Jan – PROVAZNÍK, Kamil – HEJCMANOVÁ, Ludmila, et al. *Preklinická pediatrie*. 2.

## Source

- ws:Vyšetření uropoetického systému dítěte