10. Hematuria

Hematuria is the presence of erythrocytes in urine (considered pathological with microscopic detection of >5 erythrocytes in a single field of view). Hematuria is divided into **microscopic** and **macroscopic** (grossly visible to the naked eye).

Possible causes of hematuria include:
- **inflammation** of the urinary tract - cystitis (burning, pressure, urgency, pain), pyelonephritis (flank pain, fever, sometimes together with symptoms of cystitis)
- **urinary stones** (acute renal colic or its history)
- **tumors** of the urinary tract or advanced kidney tumors
- **trauma** (kidneys, ureters, urinary bladder)
- glomerulonephritis (together with high proteinuria)
- spontaneous bleeding (e.g. in case of overdose of anticoagulants)

The origin of hematuria is urological in only 15-45%. The intensity and nature of hematuria do not correlate with the severity of the condition. The risk of malignancy in patients with hematuria increases with age, smoking, analgesic abuse, treatment with alkylating cytostatics, radiotherapy of the pelvis, and other chronic conditions of the urogenital tract. In intermittent hematuria, the risk of cancer reaches 3-9%, while in permanent hematuria it is between 5 and 20%.

The basic examination is ultrasonography of the urinary tract (kidneys and bladder).
CT urography for the detection of urothelial carcinoma (especially of the upper urinary tract) is now the method of choice in patients with hematuria. Cystoscopy is necessary to rule out bladder tumor.

Radiological imaging methods in hematuria:

Ultrasound:
- widely-available (also performed by urologists), non-invasive, inexpensive.
- Excludes dilatation of the kidney collecting system (may be caused by urothelial carcinoma, ureterolithiasis,…).
- Excludes large renal cell carcinoma (small is usually not the cause of hematuria).
- High sensitivity for detection of bladder tumors (when the bladder is full).
- Low sensitivity for detection of small nephrolithiasis, ureterolithiasis , upper urinary tract tumors.

Non-contrast CT **(without intravenous contrast administration)**
Plain CT is the method of choice for imaging urolithiasis (sensitivity is almost 100%, also displays uric acid stones).

CT urography **(= with intravenous administration of contrast agent including excretory phase)**
CT urography is used to detect tumors of the upper urinary tract and for staging of bladder tumors (most bladder tumors are already found on ultrasound or cystoscopy).

Note - in many patients with hematuria this examination is negative, so the effort is to adjust the protocol to reduce radiation exposure (smaller number of post-contrast phases, split bolus protocol –

i.e. with gradual application of the contrast in 3 boluses, allows visualization of the enhancing cortex, medulla, and renal drainage system on one post-contrast CT scan). Thus, the examination may not be optimal for other indications - for example, for staging of renal cell carcinoma or investigation of unclear kidney deposits, because the dynamics of enhancement are not evident (just one post-contrast phase). Therefore, two or three post-contrast phases are usually performed for staging of renal cancer.

MR urography:

- examination to visualize the urinary tract (tumors, congenital anomaly)

-2 basic types:

Excretory MR urography - with intravenous contrast administration

- includes an excretory phase similar to CT scan

- compared to CT, there may be a problem with movement artifacts and with too high concentration of gadolinium contrast agent in the urinary tract (susceptible artifacts)

Static MR urography (or MR hydrography) - only non-contrast with a special hydrographic sequence

- ureters are displayed, but enhancement of tumors cannot be evaluated

- it is performed mainly in patients with severe renal insufficiency and in children in the search for congenital anomalies.

MR urography is performed especially if CT urography cannot be performed (allergy to iodine, renal insufficiency)

CAVE! In CKD 4 and 5 (chronic kidney disease) there is a higher risk of nephrogenic systemic fibrosis, therefore only low-risk gadolinium contrast agents can be administered with caution.

Kidney tumors

- incidence: 30 / 100,000 inhabitants

- more histological subtypes differ in radiological image, the most common and most vascularized is the clear cell renal cell carcinoma (Grawitz's tumor)

- these are typically incidental findings on ultrasound / CT performed for another reason

- has a tendency to cause tumor thrombosis of the renal vein, especially the inferior vena cava (direct spread through the lumen of the veins)

- metastases - lungs, lymph nodes, skeleton, liver, brain, pancreas, …

Tumors of the urinary tract

- incidence: urinary bladder - 20 / 100,000, renal pelvis - 2 / 100,000, ureter - 0.8 / 100,000

- histologically - urothelial carcinoma (90%), squamous cell carcinoma, adenocarcinoma

- the main symptom is hematuria

- urological possibilities of examination - cystoscopy (biopsy, resection), ureterorenoscopy, cytology of the ureter, retrograde pyelography (direct application of a contrast agent into the ureter + visualization under fluoroscopy)

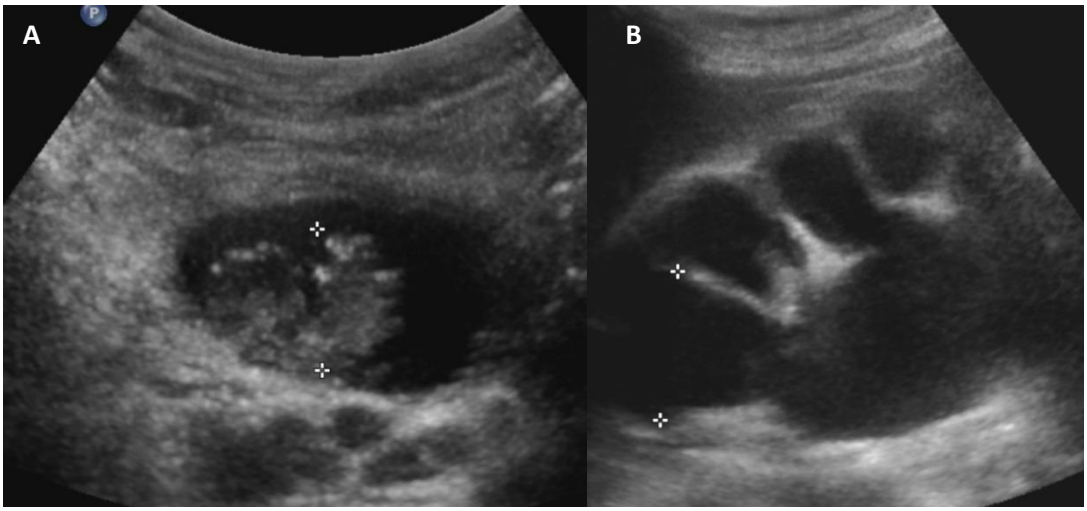

Fig. A - Ultrasound - urinary bladder tumor
Fig. B - Ultrasound - dilation of renal pelvis and renal cortex atrophy due to the urinary bladder tumor

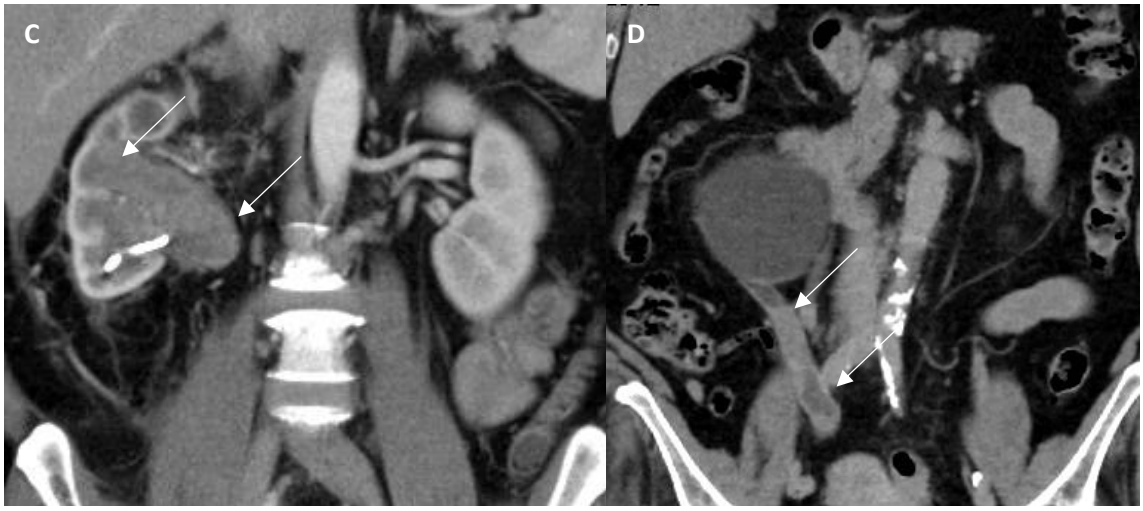

Fig. C - Contrast-enhanced CT – urotelial carcinoma of the renal pelvis **(white arrows)**
Fig. D - Contrast-enhanced CT – urotelial carcinoma of the ureter **(white arrows)**

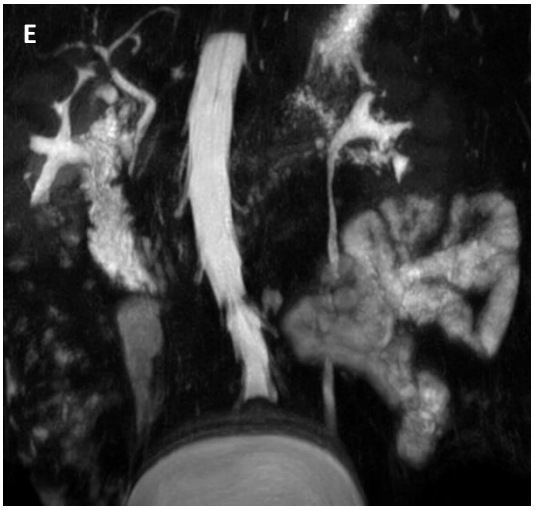

Fig. E - MR hydrography – well visualised is renal collecting system, bile ducts and cerebral fluid