KAPITEL 11 / *CHAPTER 11* [11]
X-RAY EXAMINATION OF THE URINARY SYSTEM. NORMAL RAY ANATOMY AND PHYSIOLOGY. RADIATION SIGNS OF DISEASES OF THE KIDNEYS AND URINARY TRACT

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Introduction.

This article will list all available methods of examining the urinary system, with a detailed description of each technique, ranging from conventional x-rays of the urinary tract to selective angiography, including CT and MRI. Special attention will be paid to types of Doppler studies with color Doppler mapping. Special attention is paid to methods of radioisotope diagnostics with congenital malformations.

Radiation methods of research:

1. X-ray of the urinary tract, urography

As well as ACT, RT methods

- X-ray examination of the abdominal cavity (planar tomography)
- excretory urography
- infusion urography - retrograde pyeloureterography - antegrade pyelography
- kidney angiography

(Selective angiography)

Survey urography

• This is usually the first X-ray examination performed on a patient with a urological profile.

• Covers almost the entire urinary tract and allows you to determine the skeleton topography of the kidneys, the condition of the bones and the retroperitoneal space, the presence of pathological R-signs and to determine the further tactics of the study.

• Shadows of stones in the kidneys and urinary tract can be seen on the examination urogram. Doppler effect 1842

 The Doppler effect is a change in sound frequency due to the relative movement of the sound source and receiver.

 When sound is reflected from a moving object, the frequency of the reflected signal changes (frequency shift occurs).

 When the primary and reflected signals are superimposed, there are beats that

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are heard using headphones or a loudspeaker.

Types of Doppler research:

□ Currently, the following are used in clinical practice:

1) continuous and pulsed flow spectral Doppler (PSD),

2) color Doppler mapping (CDM),

3) energy Doppler (ED),

4) convergent color Doppler (CCD)

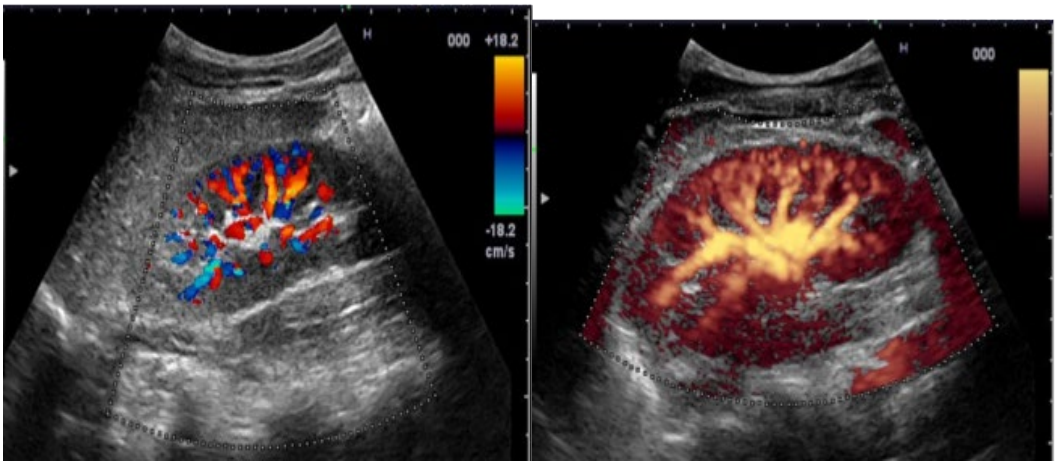
CDM and ED of kidney vessels

□ The Doppler effect is a change in sound frequency due to the relative movement of the sound source and receiver.

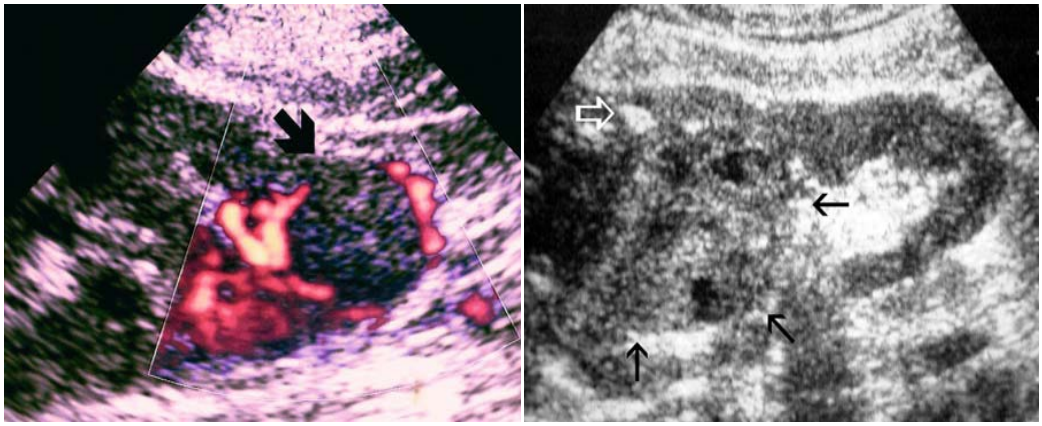
■ When sound is reflected from a moving object, the frequency of the reflected signal changes (frequency shift occurs).

■ When the primary and reflected signals are superimposed, there are beats that are heard using headphones or a loudspeaker.

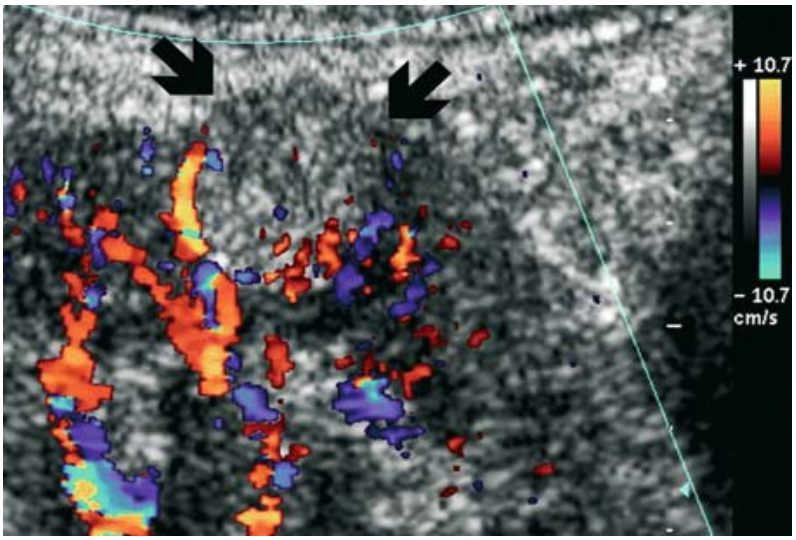
CDM and ED of kidney vessels



* Color and energy Doppler help in the differentiation of cysts and tumors, because the internal content of a cyst is devoid of vessels and can never have colored loci

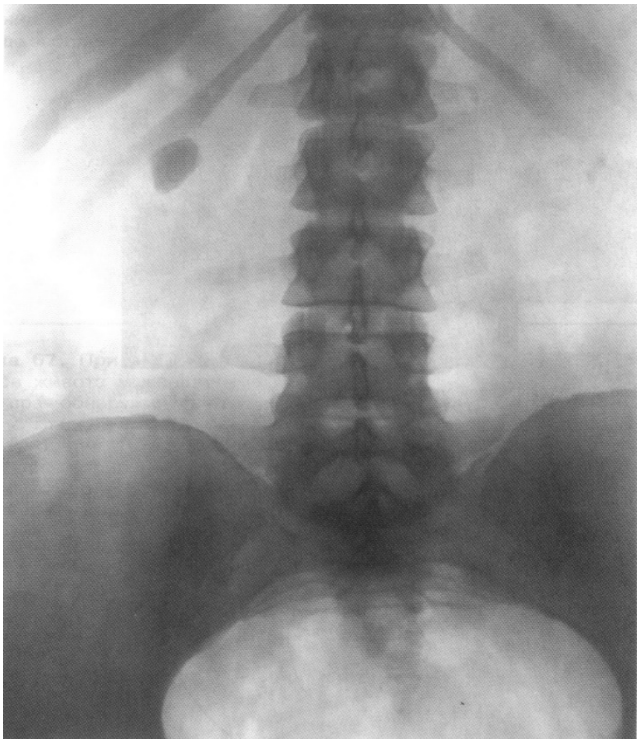


Kidney tumor and hypervascular formation around it (Doppler)



Vascularization of a kidney tumor. Ultrasound

Overview X-ray.



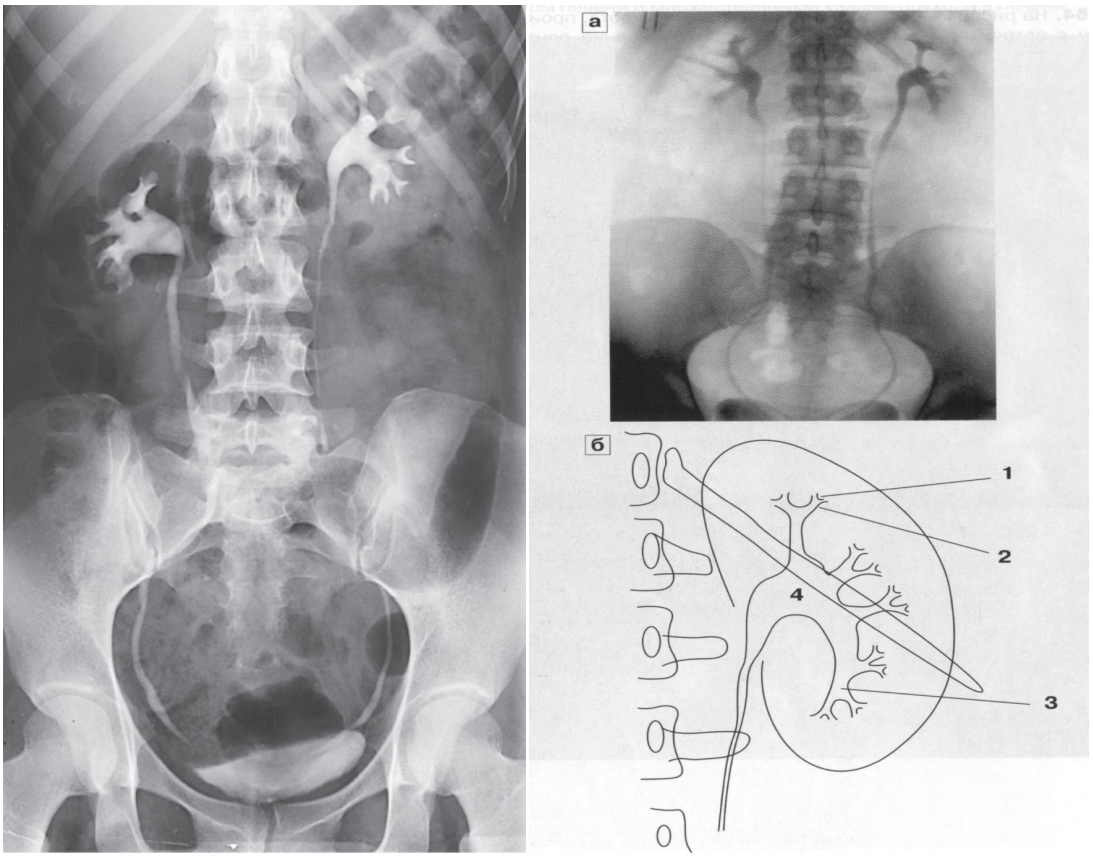
A stone in a renal pelvis.

Excretory urography

• A method of examining the kidneys and urinary tract by intravenously injecting the patient with a contrasting iodine-containing substance secreted by the kidneys.

• At certain points in time, X-rays are performed to obtain images of the kidneys

and urinary tract and assess their functional state.



A. Excretory urography (sensitivity test)

B. Topography of the left kidney

Excretory urography by minutes

3 min.

6 min

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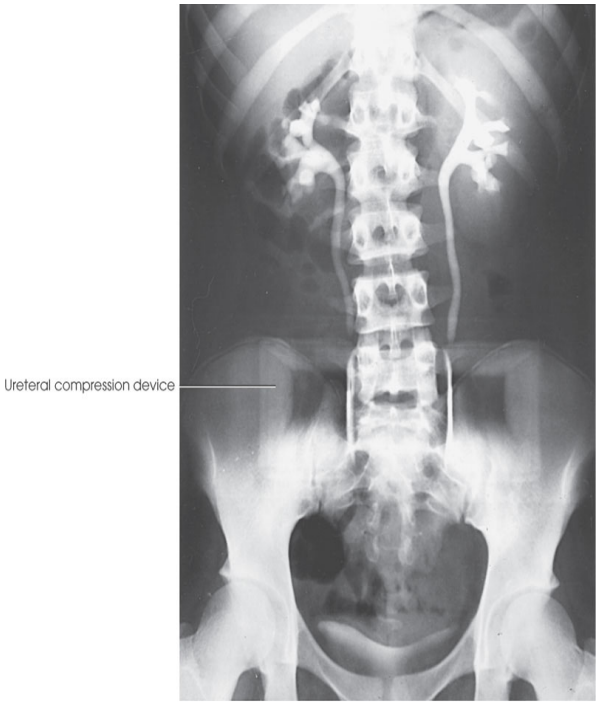
9 min



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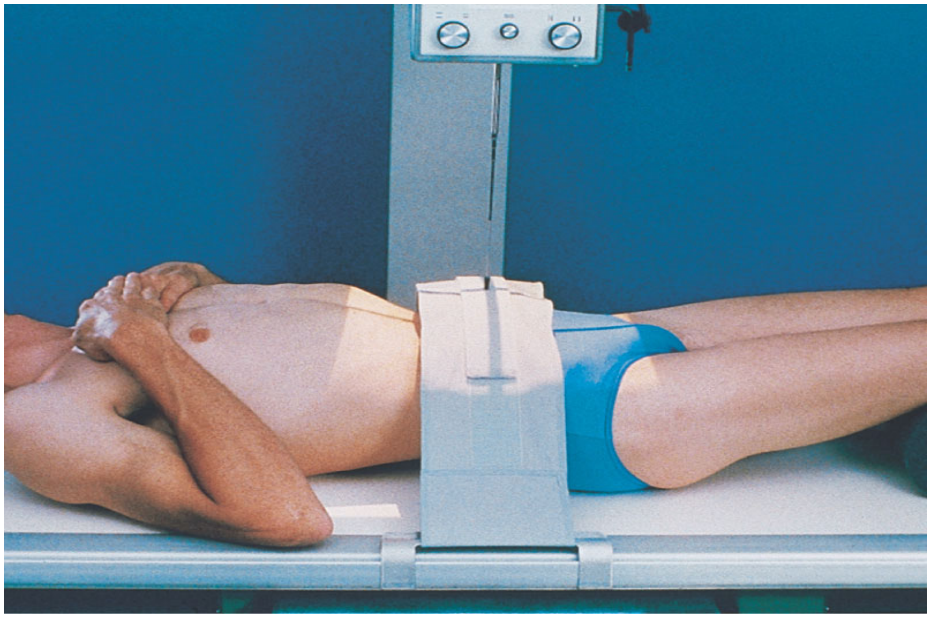
with compression

Compression of the ureter



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- Applies to the distal ends of the ureters
- Prevents the flow of urine into the bladder
- Expands renal bowls and calyces
- The compression device should be centered on the white line of the abdomen (ASIS, hypogastrium).
- Excretory urography for 5 minutes (24 x 30cm) A.P

A. P. renal areas to determine if excretion is symmetric or if uptake is poor and a further dose of contrast medium is required

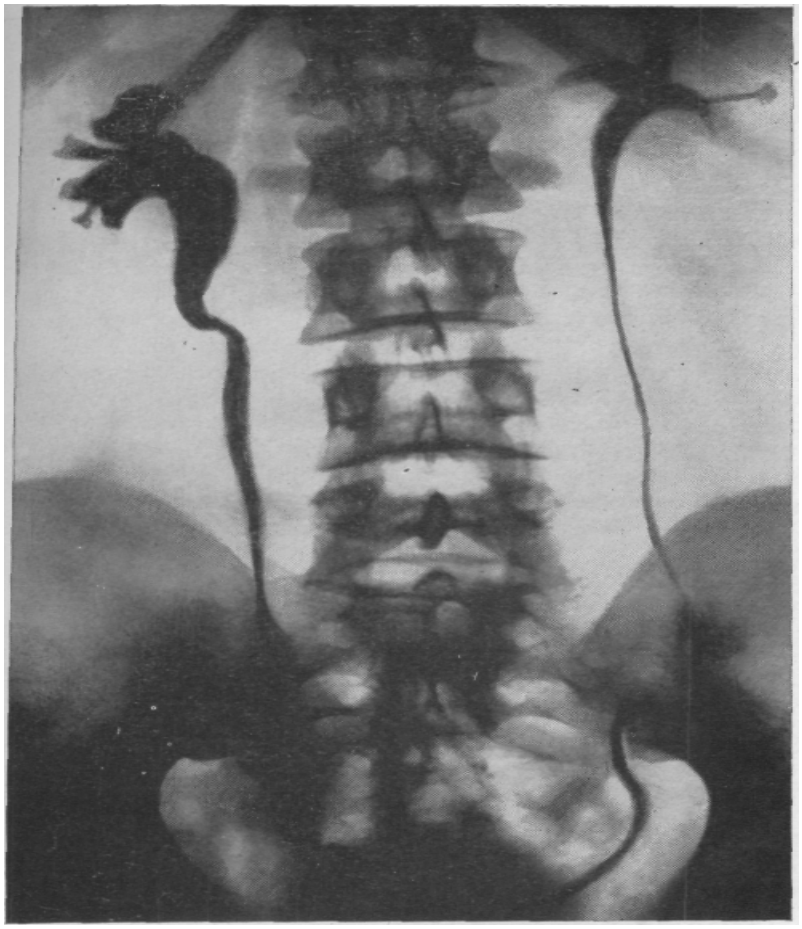
Excretory urography for 15 minutes. AR

■ *(35 x 43cm) demonstration of the pelvic system and ureters.*

Infusion urography

• Excretory urography with the introduction of a larger amount of contrast material by intravenous drip infusion. It allows to get a clearer image of the caliceal system of the kidneys even under conditions of chronic renal failure.

Excretory urogram.

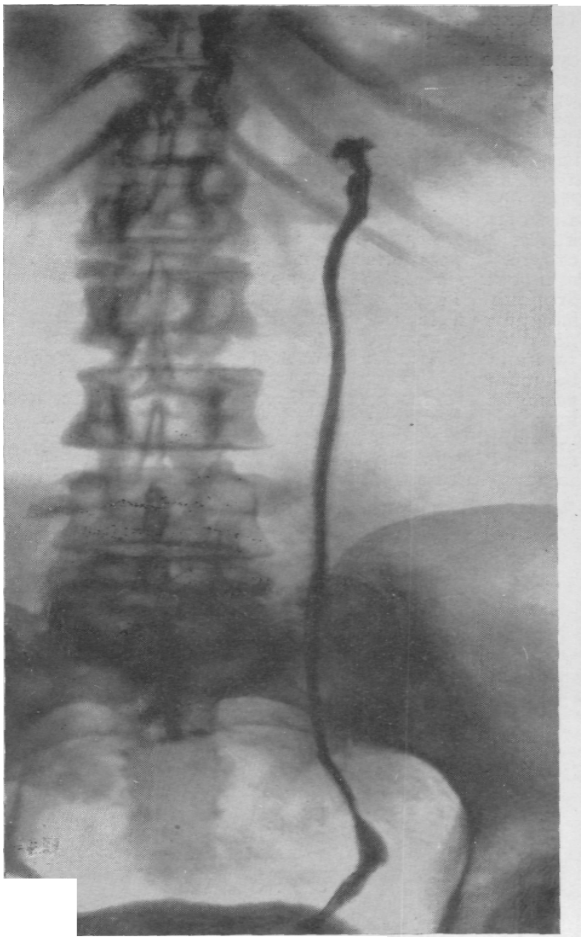


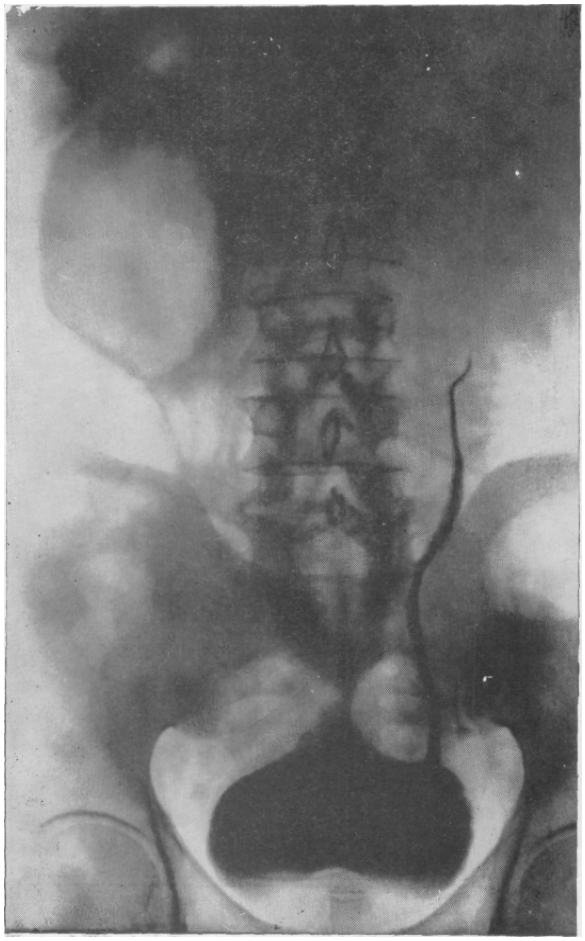
 Hypoplasia of the left kidney.

Retrograde ureteropyelography

 • Contrasting of the upper urinary tract with an iodine-containing water-soluble substance through a catheter inserted into the urethra.

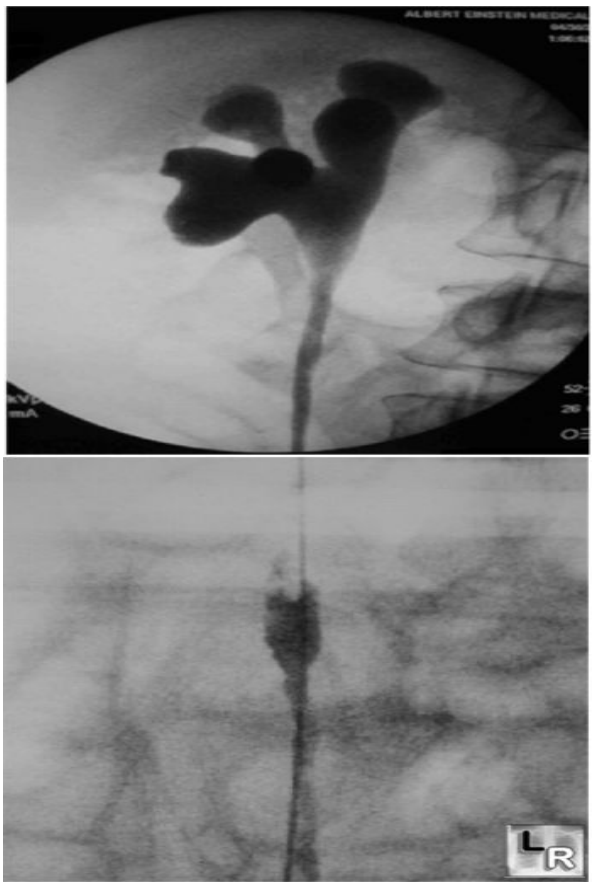
 • It allows detecting even minor changes in the calix system and ureter, regardless of the functional state of the kidney.





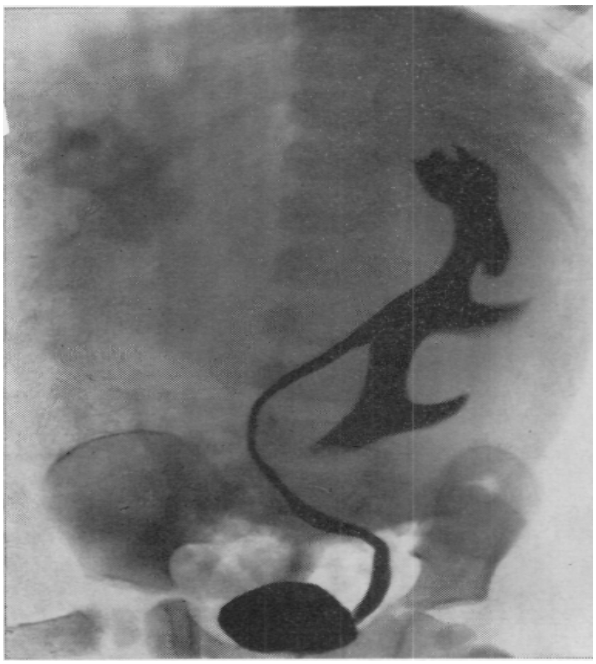
Aplasia of the left kidney.

Retrograde pyeloureterography.



Transitional cell carcinoma

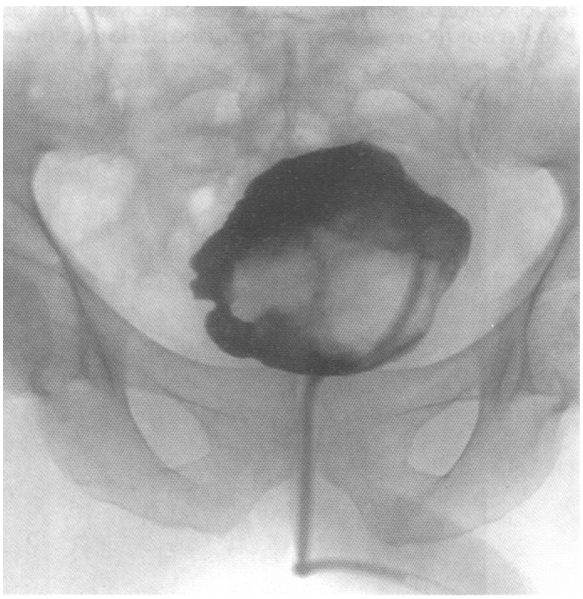
Left-sided retrograde pyelogram of a 2-year-old child.



Wilms tumor.

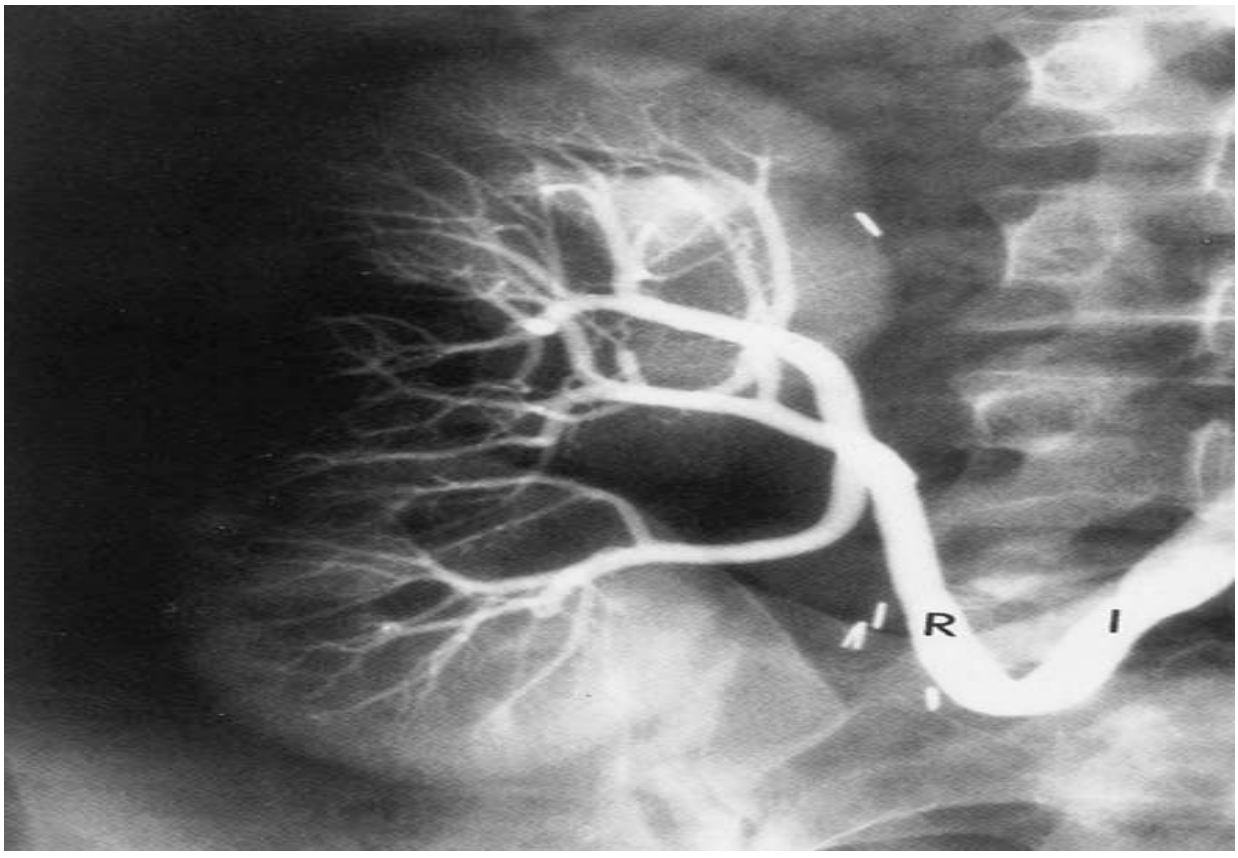
A giant left kidney whith a deformed calyx system, compression of the ureter by a tumor.

Retrograde cystography (sedimentary pneumocystography)



Bladder tumor

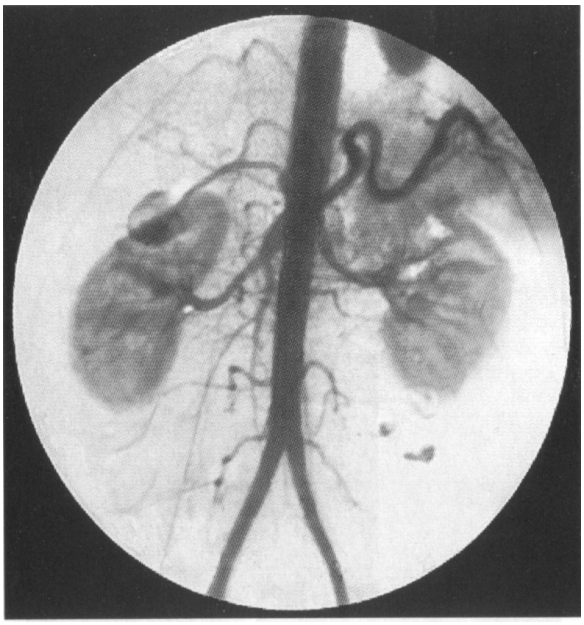
Angiography



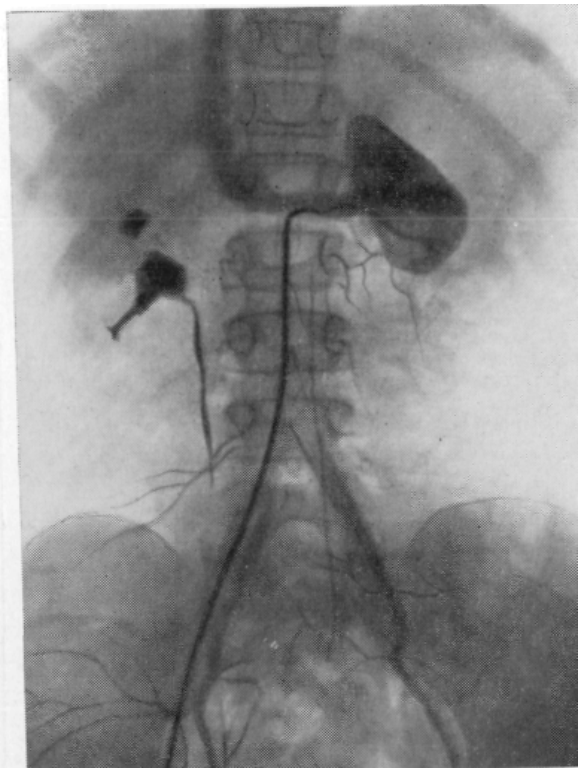
Visceral angiogram.

Arterial injection of a transplanted kidney showing the anastomosis of the renal artery (R) to the right iliac (I) artery. There is no stenosis of the main renal branches.

Digital subtraction angiography



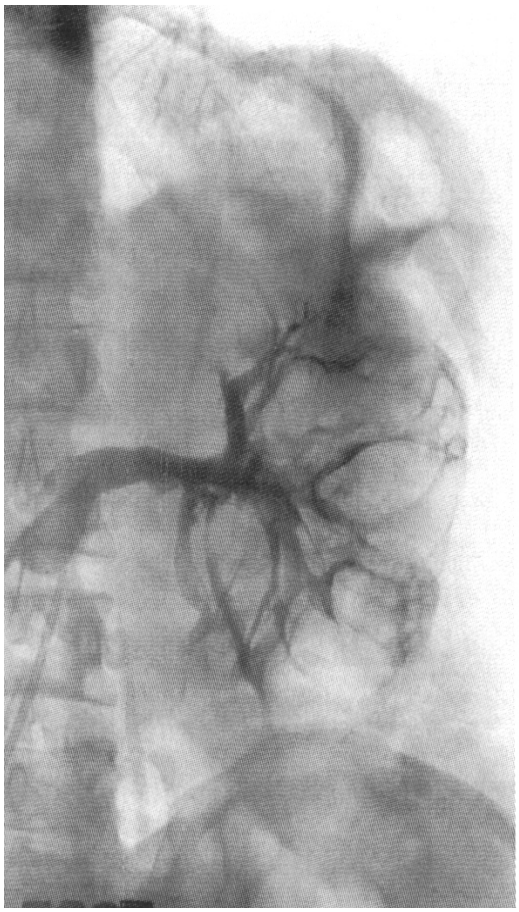
Selective arteriogram



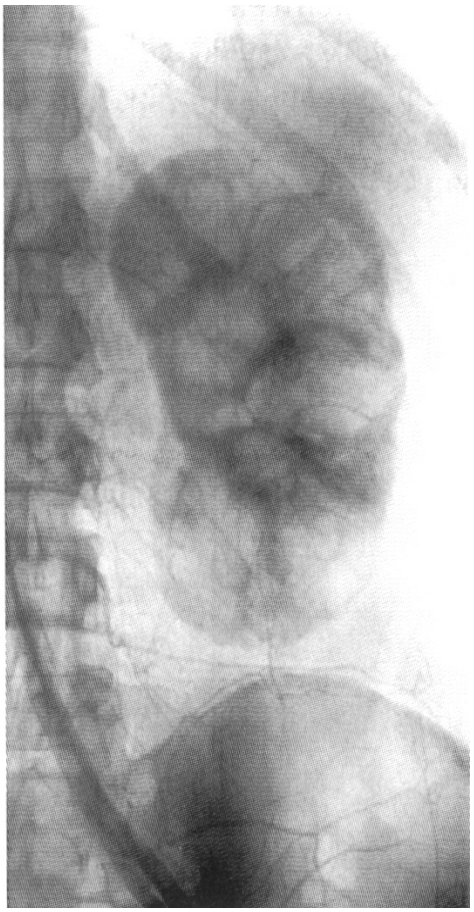
Left kidney (nephrography phase). Catheterization according to Seldinger

 A significant decrease in the size of the kidney compared to the norm. Deficiency of parenchyma is more than 60%.

Selective arteriography of the left kidney.



Early arterial phase.

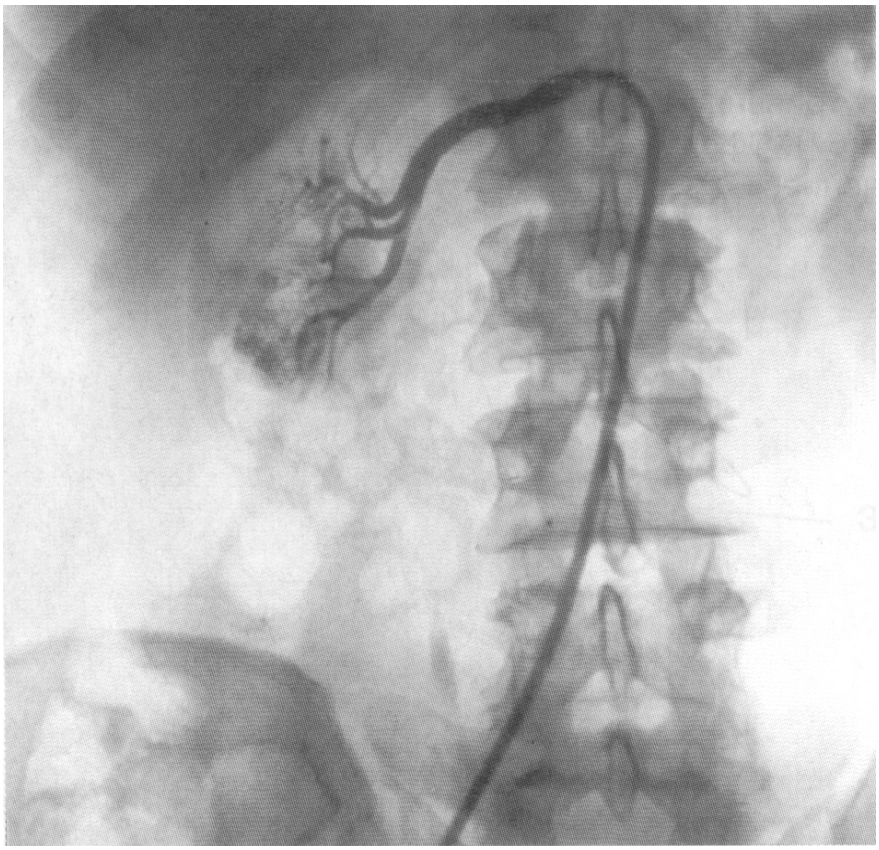


Parenchymatous phase.

Translumbar aortogram.

 Male, 22 years old. Aplasia of the left kidney.

Venography



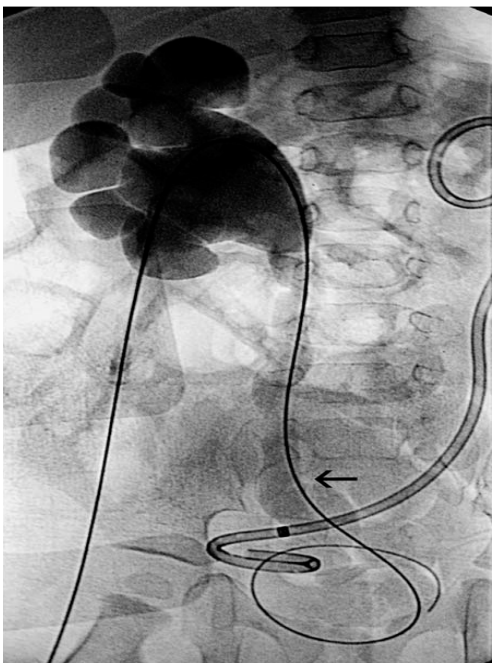
Antegrade pyeloureterography

 • Contrasting of the pelvic system and ureter with an iodine-containing liquid by percutaneous puncture of the kidney or through an existing nephrostomy.

 • It is used if other methods do not allow diagnosing diseases of the kidneys and upper urinary tract.

Antegrade pyelography (interventional techniques)

 Endovascular balloonization (dilatation) of arteries and ureters, stenting, lithotripsy, aspiration of renal pelvis contents, administration of antibiotics. Embolization of the renal artery, injection of styrene balls - occlusion of the internal iliac arteries in bleeding bladder cancer.

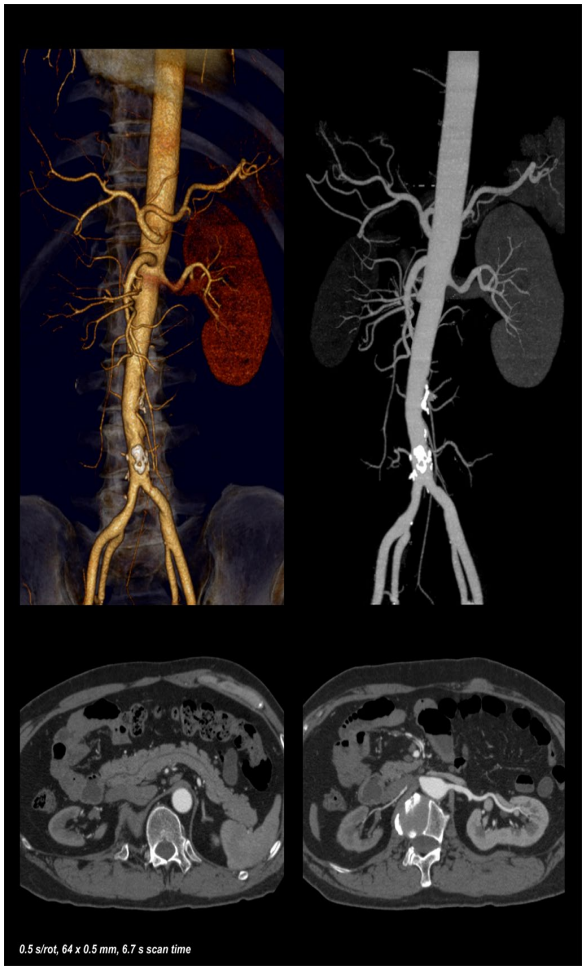


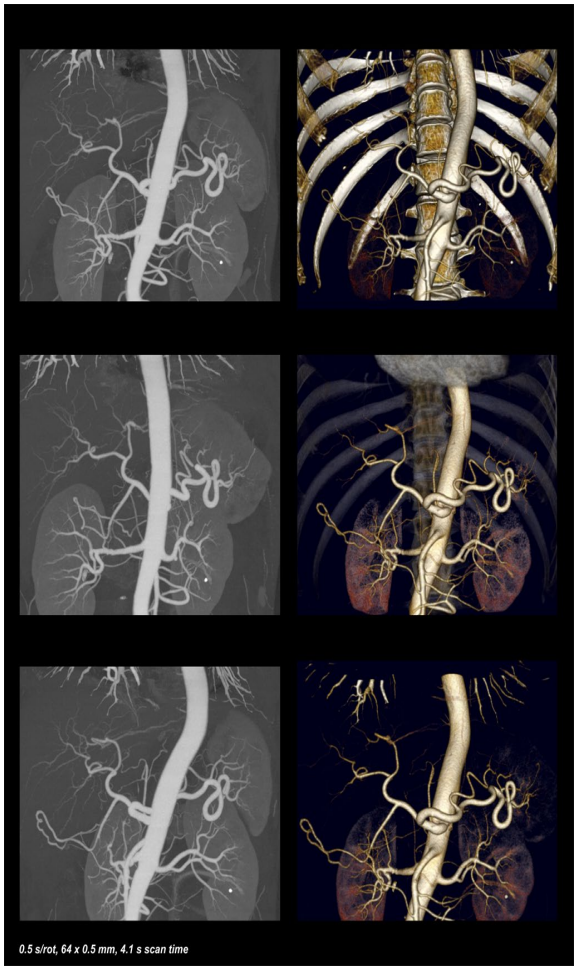
rainage of a blocked kidney

A percutaneous nephrostomy was performed, and a catheter was placed in the abnormal right kidney,

obliteration of the ureter, hydronephrosis.

Computed tomography (CT)





 • An X-ray examination in which a thin beam of X-rays passes through tissue and is picked up by several detectors.

 • The computer allows you to obtain step-by-step sections of the patient's organs and tissues.

 • In urology, CT is used to diagnose diseases of the kidneys, tissues and other organs of the retroperitoneal space, bladder and prostate, neoplasms of the pelvis, as well as to control invasive manipulations (puncture, aspiration, biopsy).

CT. Method

 Without special preparation of the patient

 Position: Lying on the back

 Sections: axial

 Number of slices: 8-10

 Slice thickness: 1 cm

 Step: 1 cm.

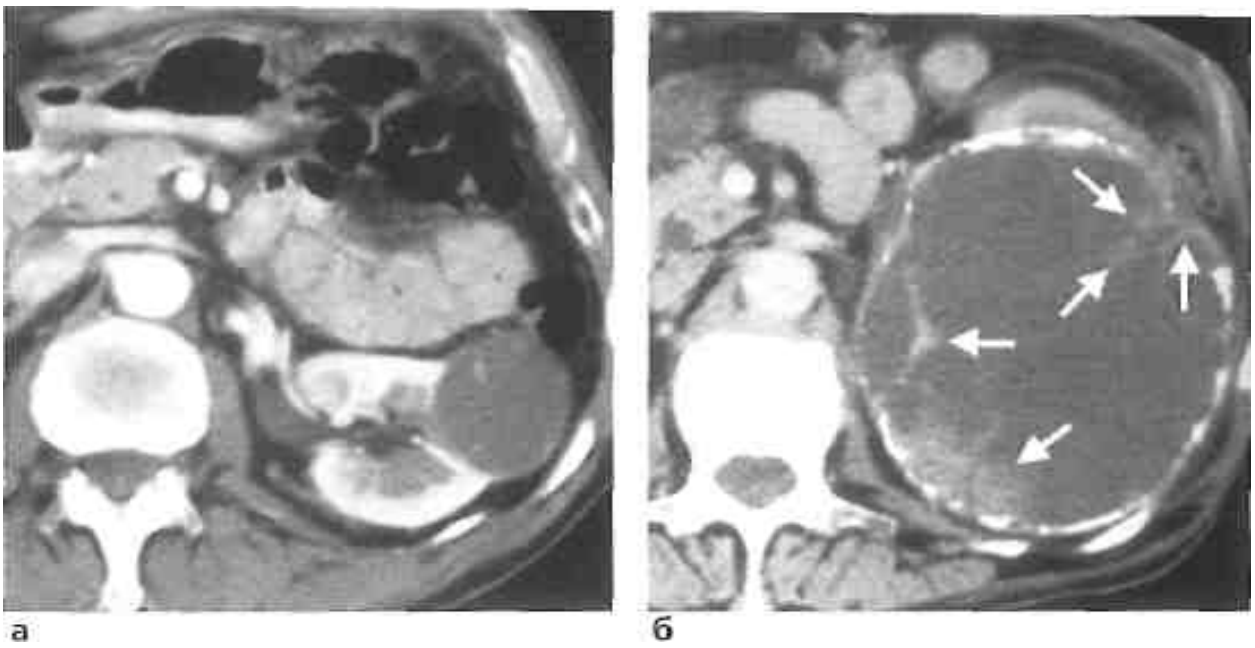
 Level of sections: IX thoracic - III-IV lumbar vertebrae.

 Reconstruction: frontal, sagittal

 Do not move (for children under 5 years of age, intravenous ketamine, for adults - intravenous seduxen, droperidol)

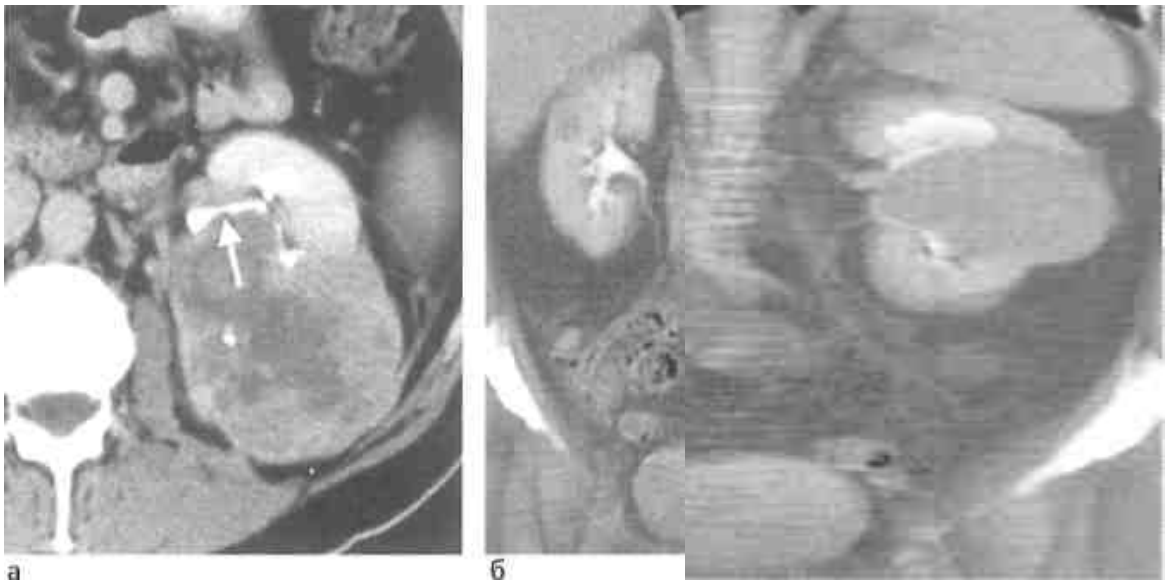
 Defined: anterior and posterior pararenal and perirenal space

Kidney cystadenoma (Perlmann tumor). Local polycystic lesions with persistent, worsening after contrast septa.



(a). Cystic renal cell carcinoma with septum-like internal structures

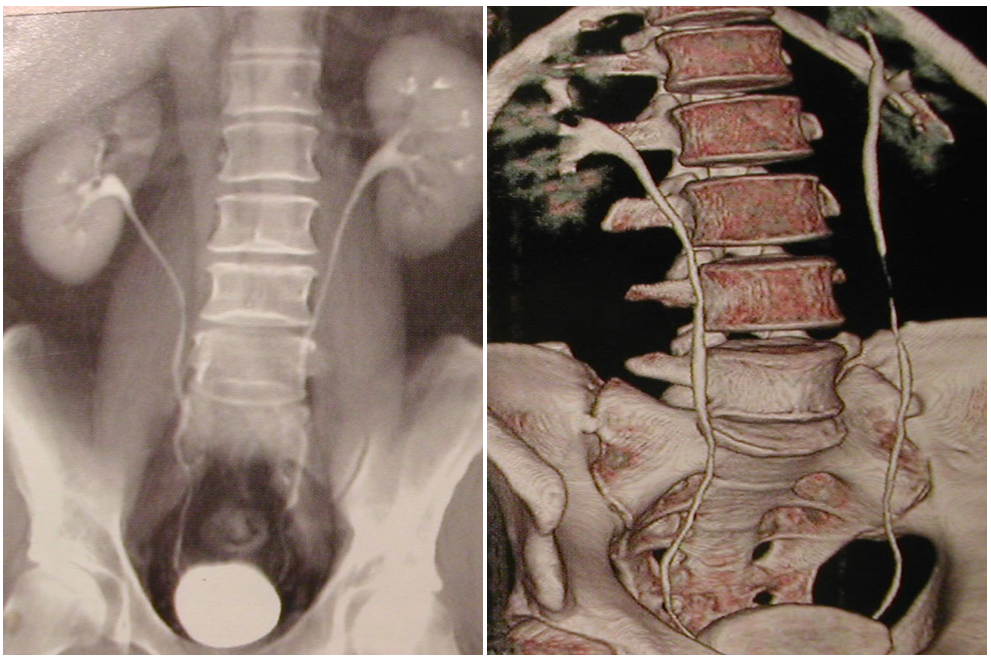
(b). A large cystic hypernephroma with an irregular soft tissue component and calcification (arrows).



CT pyelography with contrast enhancement. Advanced renal cell carcinoma with necrosis and sprouting into the pelvis - arrow (a). Another patient has renal cell carcinoma with displacement and deformation of the renal pelvis (b).

Stone of the right ureter

CT. Horseshoe-shaped kidney with typical forward and upward rotation of the renal hilum



CT Urogram

Magnetic resonance imaging (MRI)

• The study is performed with the help of a strong magnet, which arranges the hydrogen atoms in the tissues along the axis of the magnetic field. Excited hydrogen atoms produce an electrical signal that is received in a ring-shaped receiver.

• The advantage of MRI over CT is the absence of X-ray exposure, the need to use iodine-containing contrast agents, better imaging of blood vessels and soft tissues.

• The disadvantage of MRI is the higher cost of the study.•

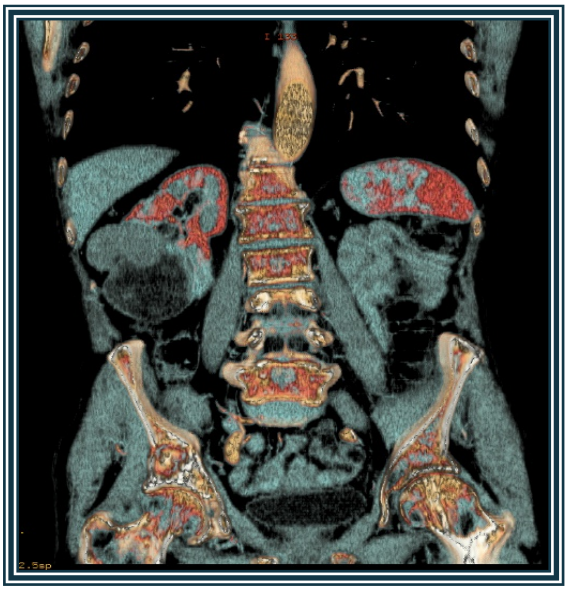
• At the current stage, the sequence of imaging methods is as follows: ultrasound-CT-MRI.

MRI. Method

- Without contrast
- Sections: frontal, sagittal, axial, oblique
- Bladder – full
- Visualized: cortex and medulla
- It is determined: the alignment of the kidney with

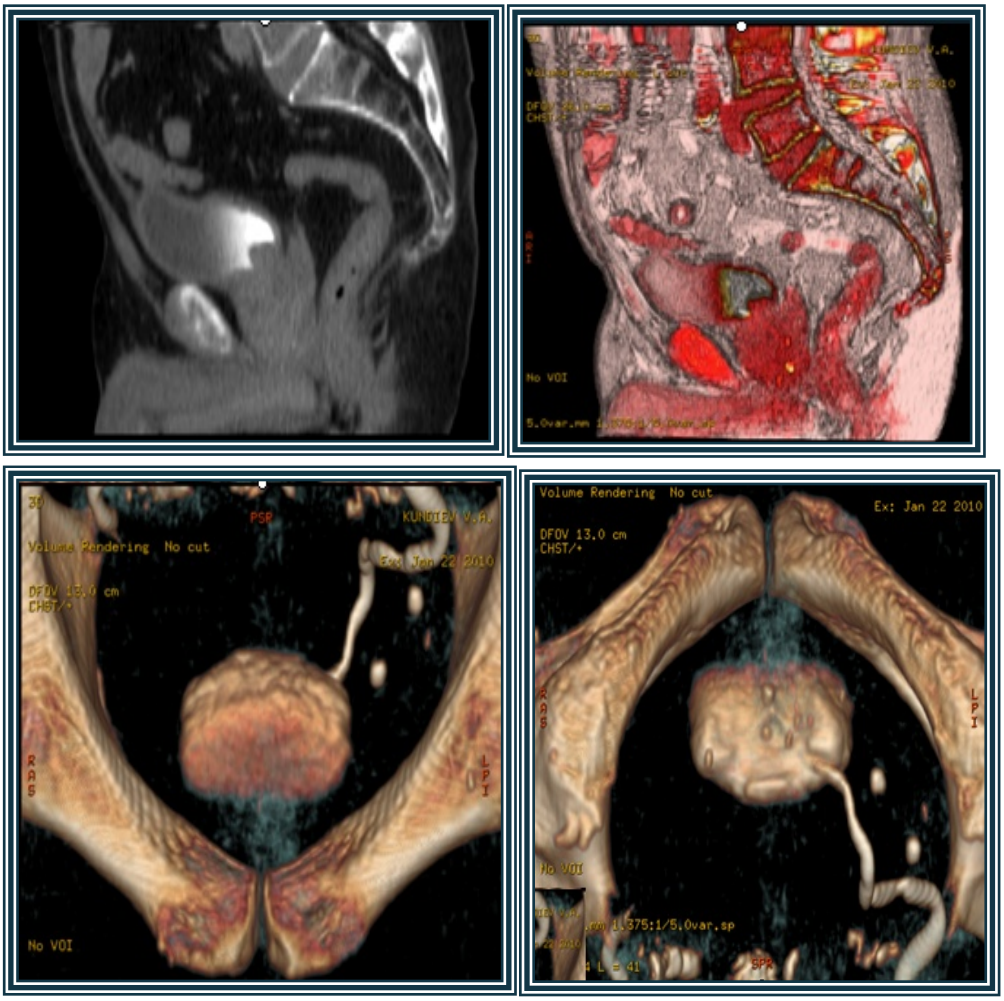
1) aorta,
2) inferior vena cava,
3) organs of the retroperitoneal space

Bladder carcinoma



MIP VR

Renal cell cancer



Prostate cancer

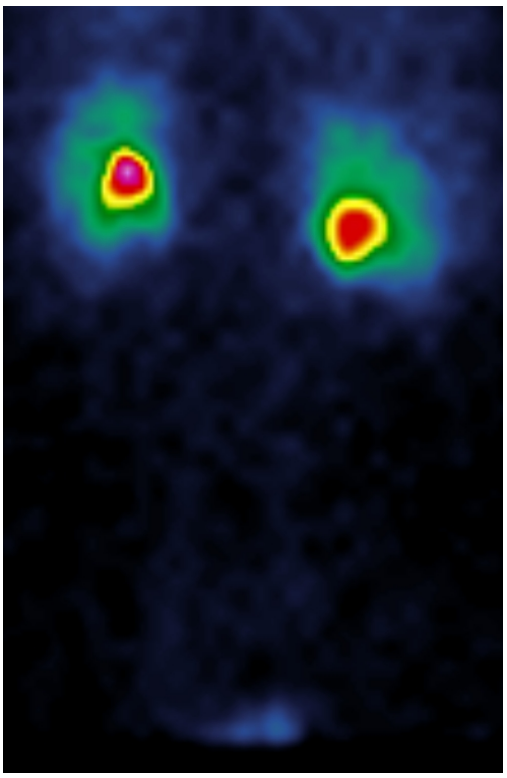
Methods of radioisotope diagnostics

 • They are distinguished by the non-invasiveness of the study for the patient, relative ease of execution in combination with informativeness.

 • Provide not only additional information about the functional and structural state of the organs of the urinary system, but also original diagnostic information.

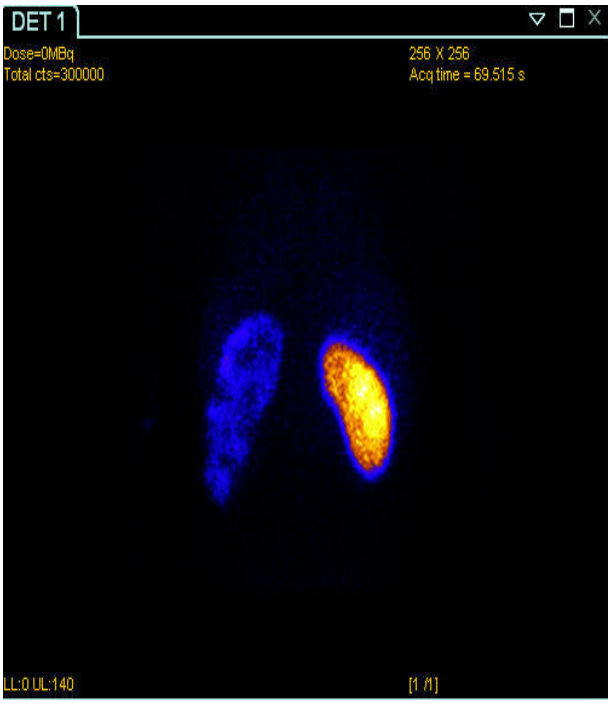
 • The most valuable information is the functional reserves of the renal parenchyma, the secretory function of the renal tubules.

Static scintigraphy of the kidneys



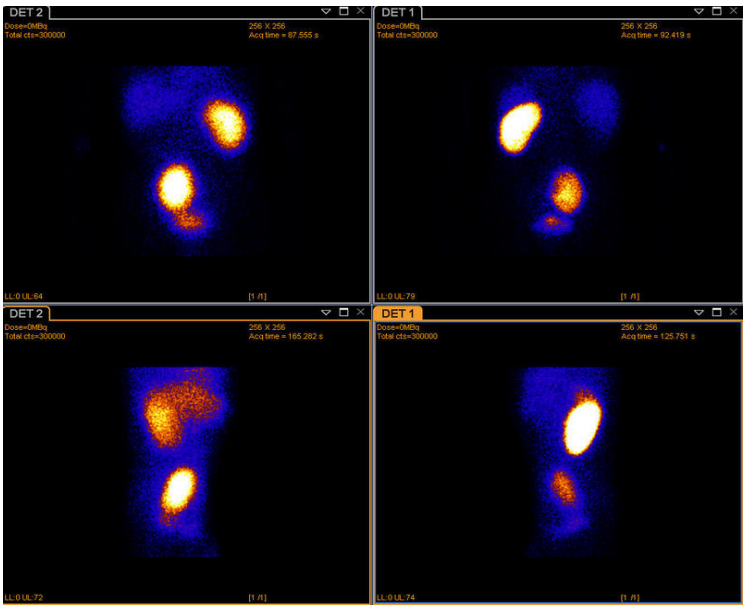
NORMA

Static scintigraphy of kidneys (posterior projection).



A pronounced decrease in the function of the left kidney

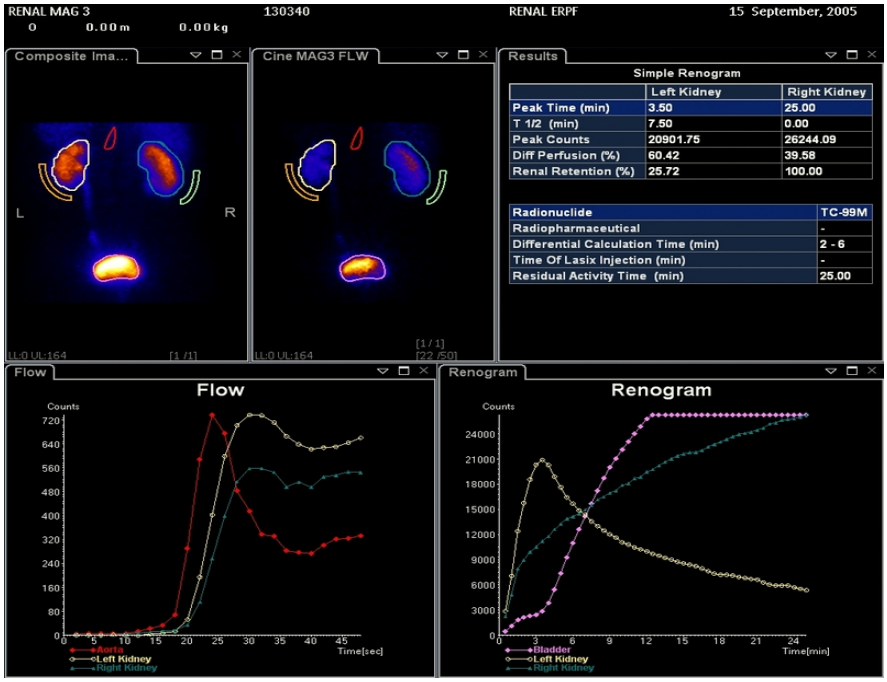
Back, front and side projections.



Anomaly of the position of the left kidney (pelvic position).

Dynamic renoscintigraphy

allows to evaluate the separate and total functional capacity of the kidneys.



Congenital malformations

A. Anomalies of quantity:

1. Aplasia
2. Doubling of the kidneys
3. Additional kidney

B. Magnitude anomaly:

Hypoplasia

B. Location anomaly:

1. Breast dystopia

2. Lumbar dystopia

3. Iliac dystopia

4. Pelvic dystopia

5. Cross dystopia

D. Anomalies of splicing:

1. Symmetrical: a) horseshoe-shaped

b) biscuit-shaped

2. Asymmetric: a) L-shaped

b) S-shaped

D. Abnormalities of the structure:

1. Kidney dysplasia: a) rudimentary

b) dwarf

2. Cystic diseases: a) multicystosis

b) polycystic

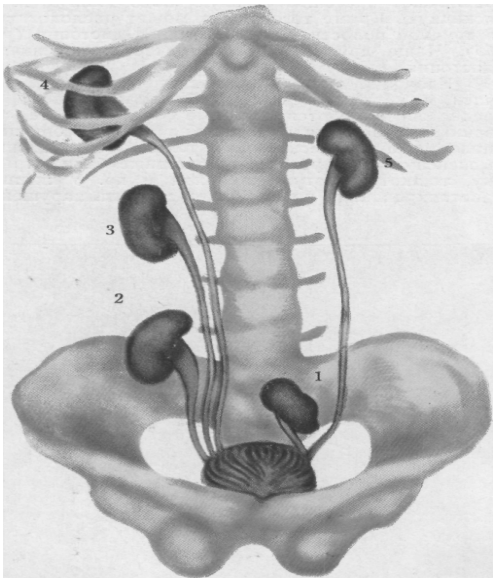
c) simple cysts

- solitary

- multilocular

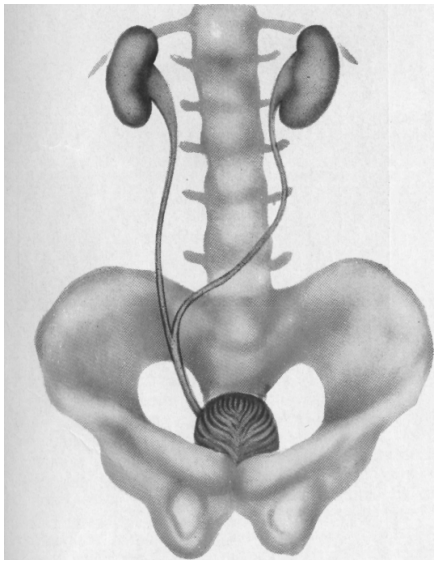
- dermoid

Types of kidney dystopias

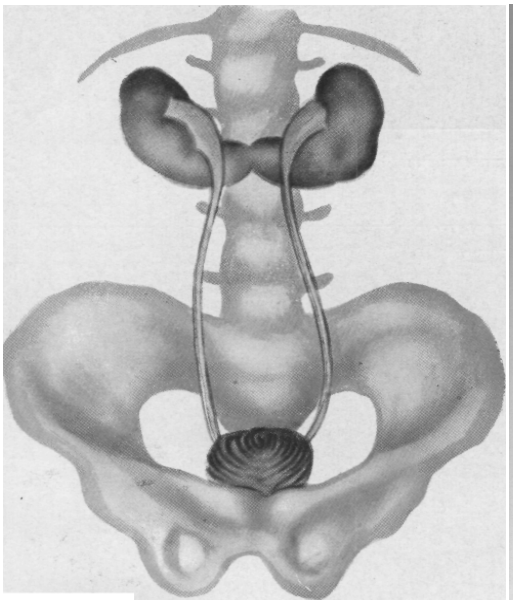


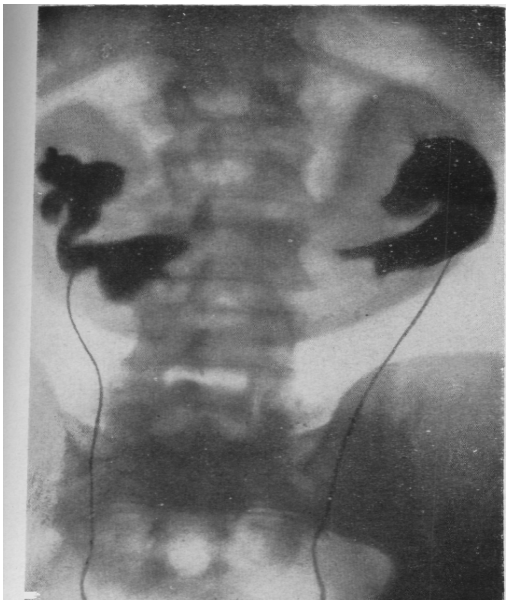
- 1. Pelvic
- 2. Iliac
- 3. Lumbar
- 4. Thoracic
- 5. Normal location.

A crossover dystopia

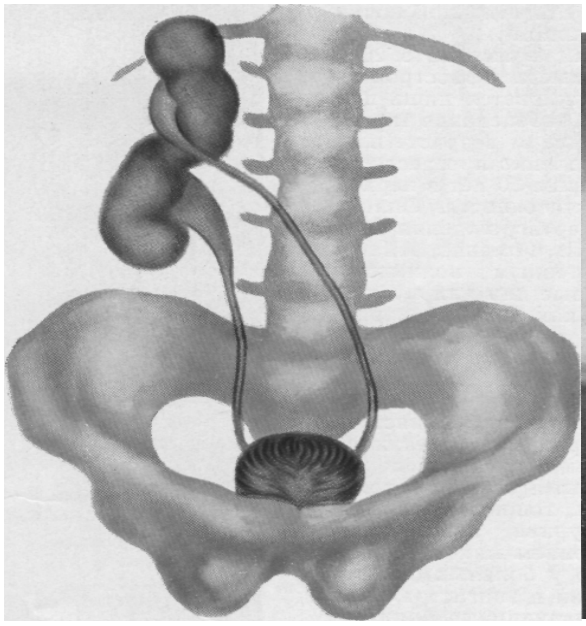


Horseshoe kidney

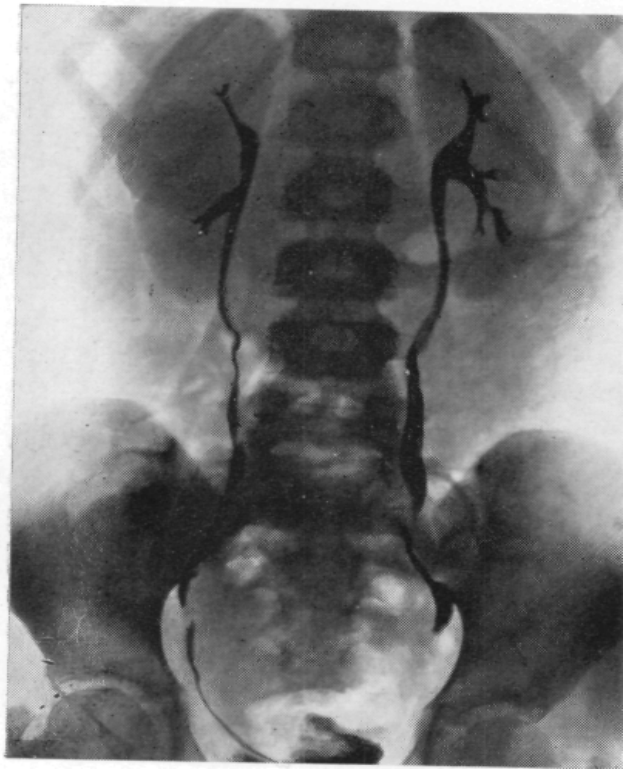




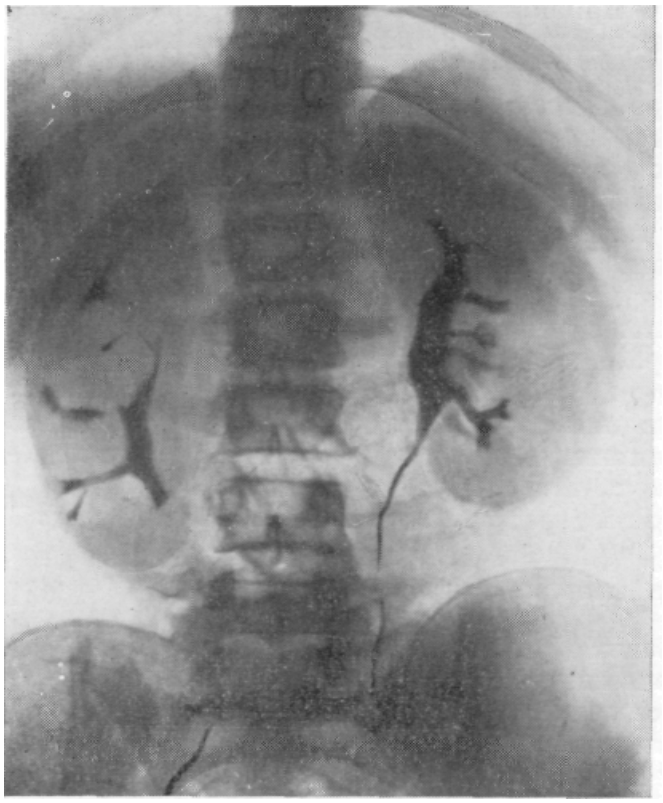
Biscuit-shaped kidney



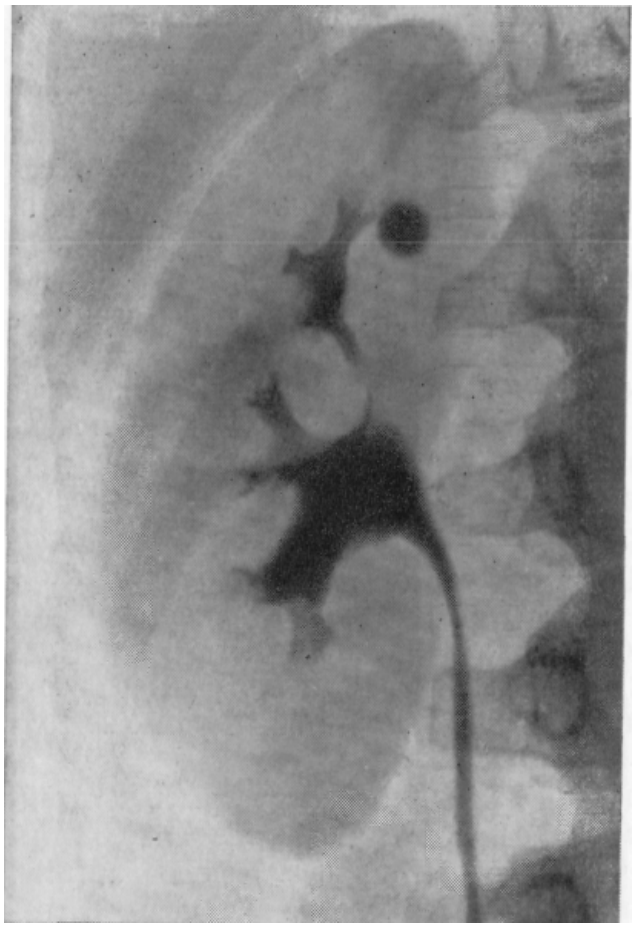
Solitary kidney cyst



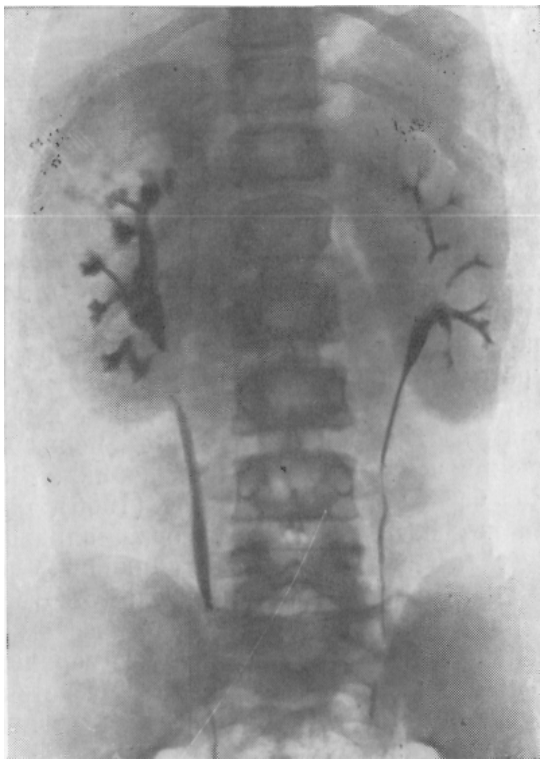
Polycystic kidney disease



Kidney diverticulum



Megacalycosis of the kidneys



Conclusion

X-ray research methods make it possible to assess the location, shape, contours, sizes of the kidneys and the presence of calculi.

Ultrasound can diagnose most diseases of the urinary system accompanied by macroscopic structural changes.

Radionuclide techniques make it possible to estimate time and quantitative parameters of renal hemodynamics (RH) using radiopharmaceuticals, allow to estimate time parameters of RH, diagnose renal artery stenosis and assess the degree of vascularization of kidney tumors.

CT is performed in the case of a clinical picture of urolithiasis, which is not confirmed by traditional methods and ultrasound.

MRI, in contrast to CT, allows obtaining layer-by-layer images of the kidneys in sagittal, frontal and axial projections, in cases where there are contraindications to the use of contrast agents in the case of CT, in the diagnosis of vascular lesions of the kidneys. During MRI, the bladder is clearly visualized, especially the bottom and upper wall, which are poorly visible during CT.

PET studies are used to determine the presence of malignant kidney tumors and regional and distant metastases.