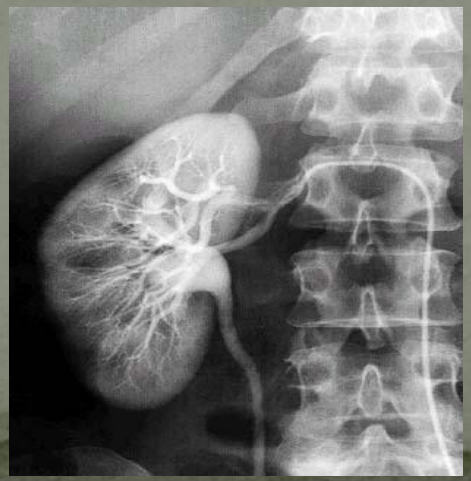
Imaging in nephrology

METHODS OF INVESTIGATION

- ULTRASONOGRAPHY
- RADIOLOGY
  - Simple abdominal radiography
  - Intravenous urography
  - Retrograde/anterograde pieloureterography
  - Renal angiography
  - CT
- NUCLEAR MEDICINE
  - Static studies: static renal scintigraphy
  - Dynamic studies: renogram
- MRI



Renal ultrasound determine:

Normal structures:

- kidneys dimensions (normally = 11-14 cm, with differences between the two kidneys < 2 cm);
- parenchymal index (normally > 1.5 cm);
- renal borders (normally smooth, regular);
- renal arteries by color Doppler.

Diseases:

- Dilatation of pielocaliceal system.
- Pielocaliceal stasis in different obstructive uropathies.
- Kidney stones: hyperechoic images with posterior shadow cone.
- Calcifications in the renal parenchyma.
- Polycystic kidney disease.
- Diagnosis of benign and malignant tumors.
- Monitoring transplanted kidney.
- Guiding percutaneous puncture for diagnostic / therapeutic reasons.

Right kidney

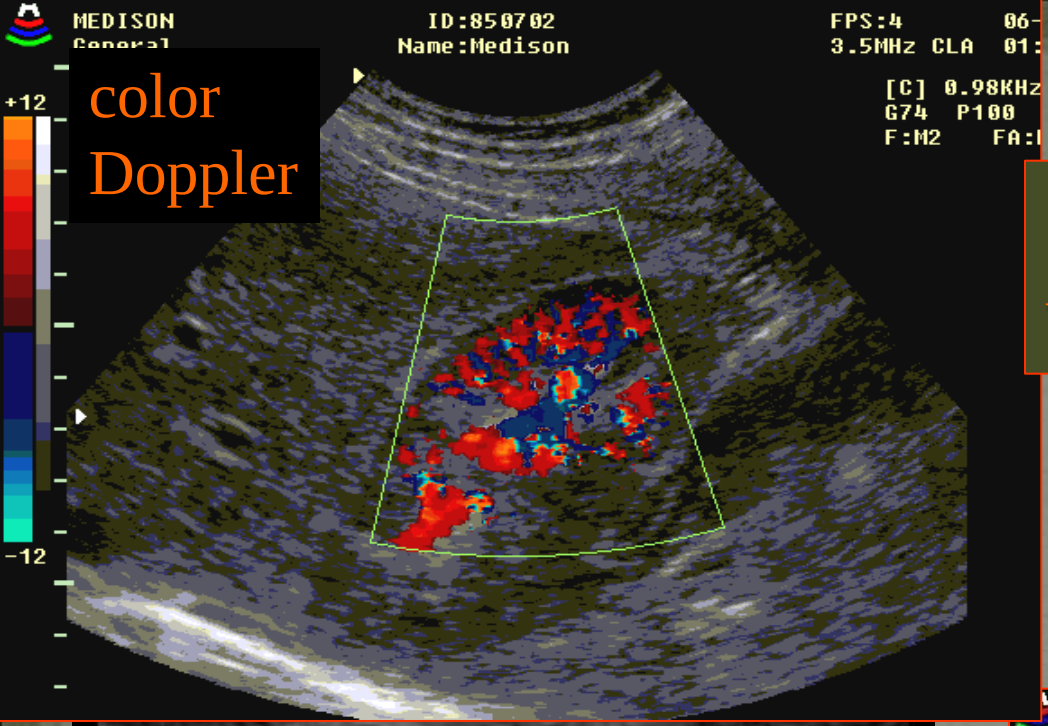
Normal view

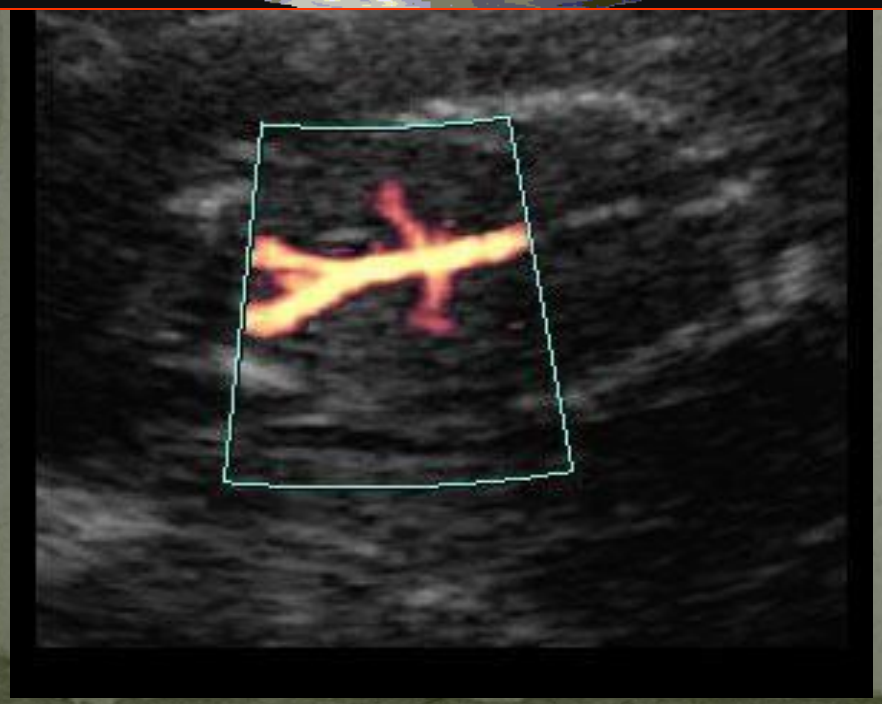
B mode

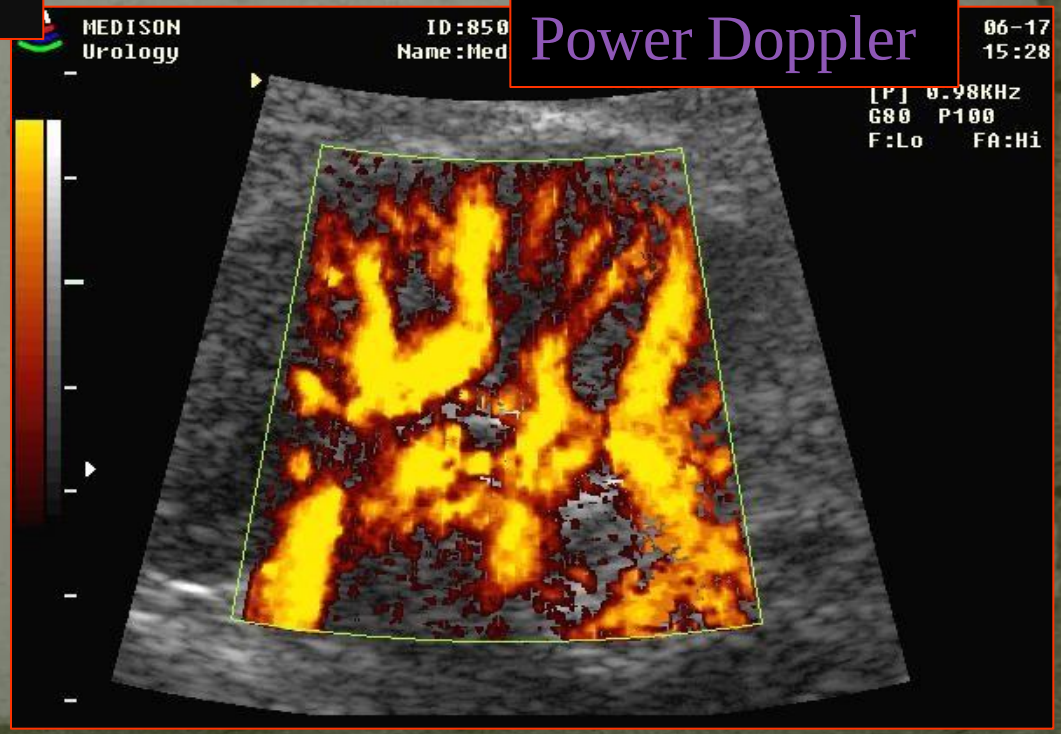
longitudinal

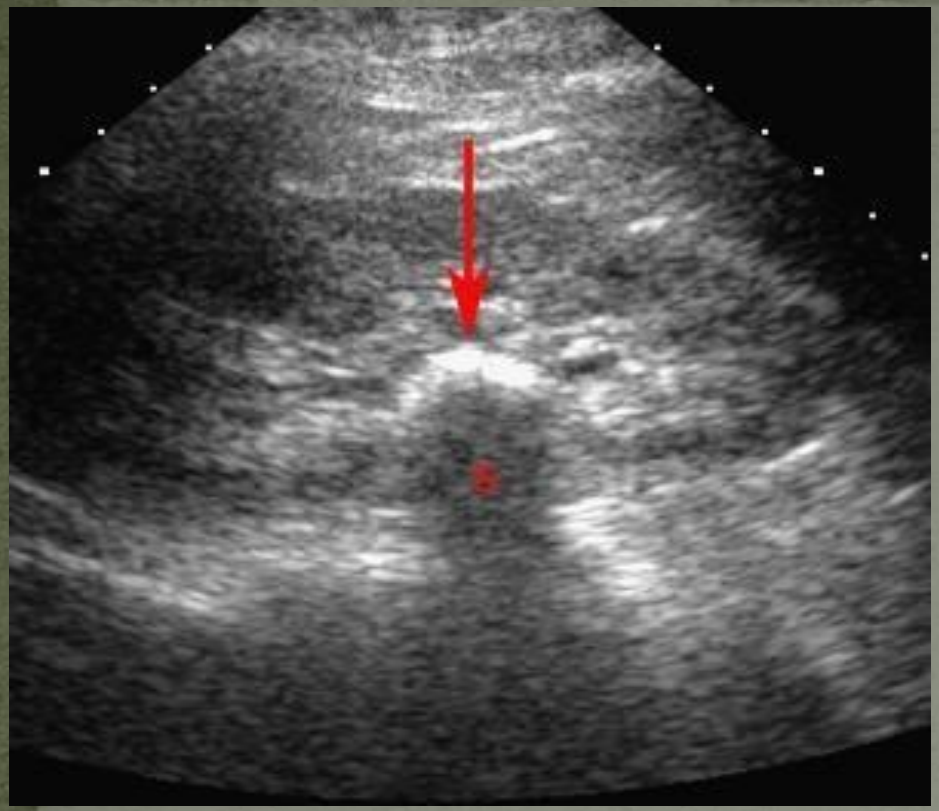
transversal

USG B Mode & Doppler









RENALABSCESS

Simple abdominal X-ray

Determine kidney area :

Location

Form (borders)

Dimensions

Radiopaque stones

Calcifications

Landmarks: m. psoas,

11-12th ribs, L1-L2 lumbar vertebral bodies

Intravenous urography

- Preparation.
- Iodine contrast medium (ionic/non-ionic).
- Sequence of images.

Intravenous urography

Patient preparation for investigation:

- young patients with regular chair don’t requires preparation, light breakfast is recommended;
- patients who are constipated will need purgative and laxative drugs or evacuator enema the day before the investigation + other evacuator enema 2-3 hours prior investigation;
- patients with flatulence will take antiflatulents (Espumisan);
- in special case can be prescribed calming remedies: valerian, chamomile infusion etc;
- check urinalysis (urea, creatinine).

Intravenous urography

- The first scan is performed on goal (RRVS).
- Intravenously administered iodine contrast media.
- Following administration of contrast solution is made to:
  - 05-07 min;
  - 12-15 min;
  - last radiography is performed orthostatic at 25-30 min.
- NB !!!! Sometimes it needed to perform radiography 2-3 min after the administrations of contrast media, to view nefrograma.
- On nefrograma can be detected early signs of pyelonephritis (parenchymal heterogeneous structure).

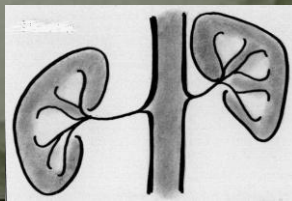
Intravenous urography

- -shows all three components of calyx: cup, body, rod;
- -towards X-rays calyx can be located perpendicular (see themselves as the triangle) or orthogonal (see themselves as ring formation);
- -three main groups of calyx: upper, middle, lower;
- -the renal pelvis has clear border, is homogeneous and can be located intrarenal, extrarenal or mixed;
- -the urethers have 25-30cm in length and 4mm in width, shows areas of insignificant narrowing and widening (normal anatomical structure) and aren't homogeneous contrasted;
- - the urethers are open in upper part of Lie-to triangle of urinary bladder, posterior side;
- - urinary bladder at men is round, at female – oval, need to be homogeneous contrasted.

IVU- normal anatomical structure

Kidney longitudinal diameter L = 13 cm
Kidney transverse diameter B = 6 cm.

1- renal axis tilt – 10, compared to the longitudinal axis;
2 - distance between renal pole:
✓- 4-5 cm - upper pole
✓- 6-9 cm - lower pole;
3 - uretheral diameter - 3-7 mm.
(Average = ADULT)



Intravenous urography

Simple radiography

IVU 5-7 min

IVU 12-15 min

Contraindications of i/v urography :

-Allergy to iodine solutions;

-In case of tiriotoxicoses;

-Asotemy (in this case we won’t see the kidneys);

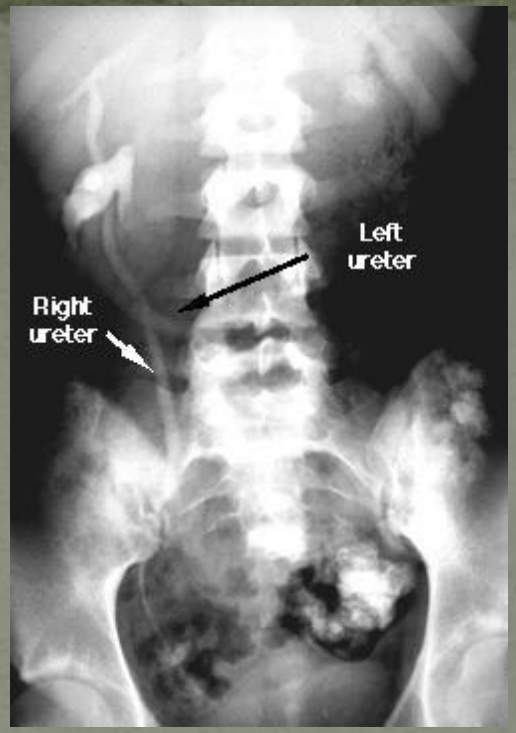
-Decompensate cardiovascular malformations;

-Malformations of liver;

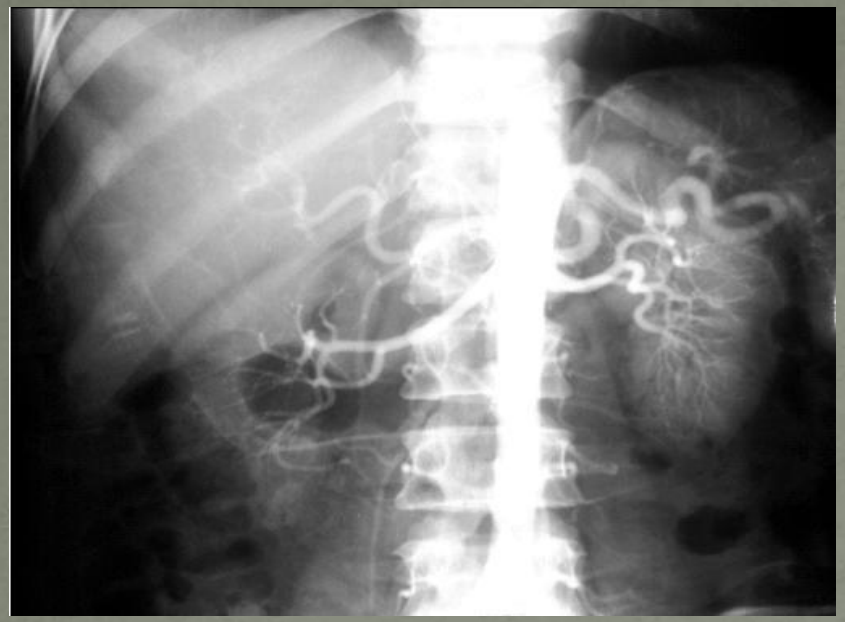
-Renal failure;

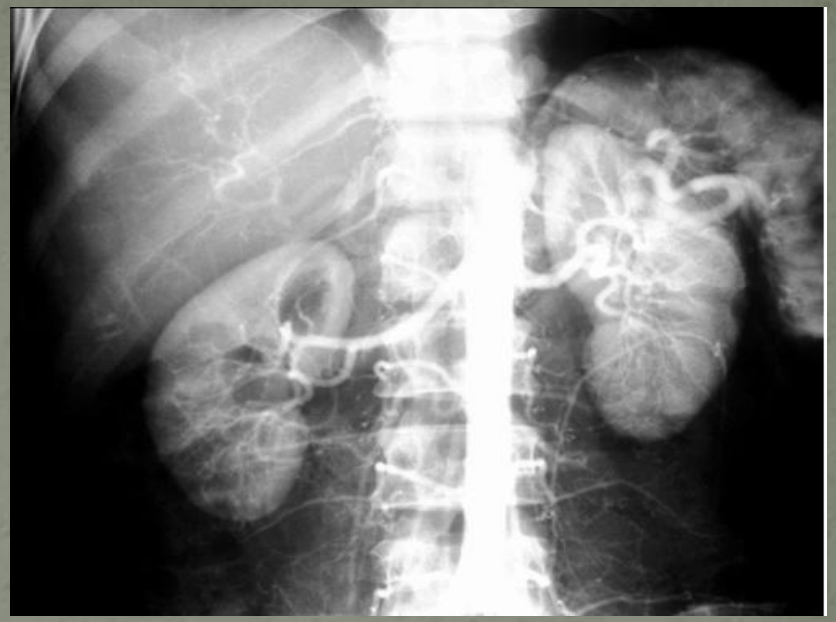
-Glomerulonefritis;

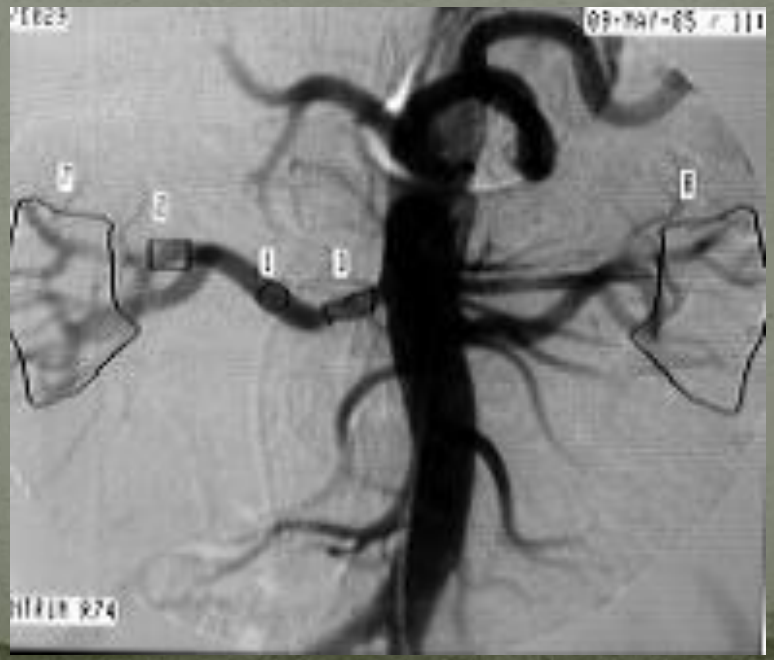
-Pregnancy.


Left
ureter
Right
ureter

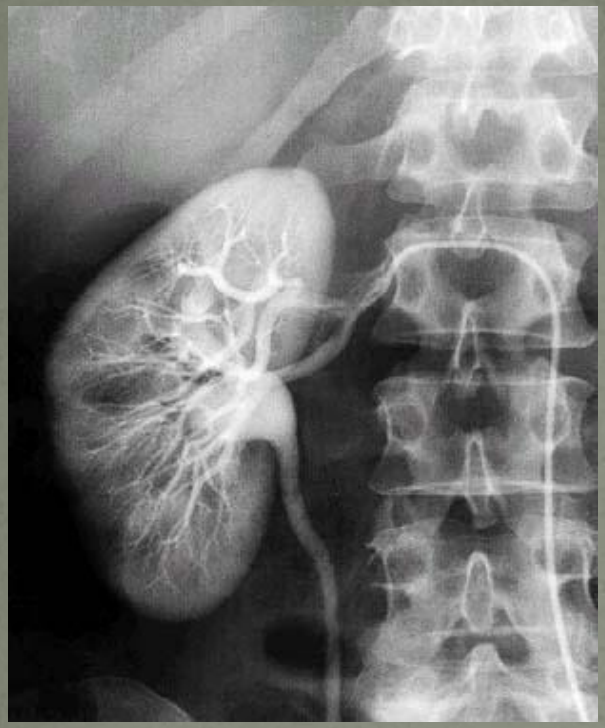
Renal arteriography

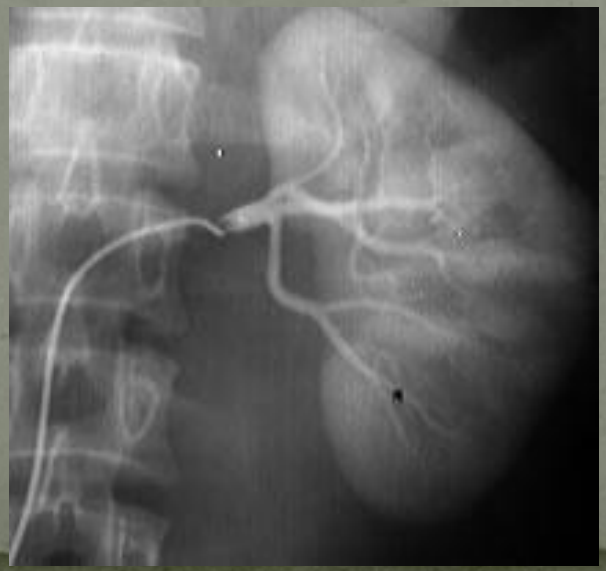


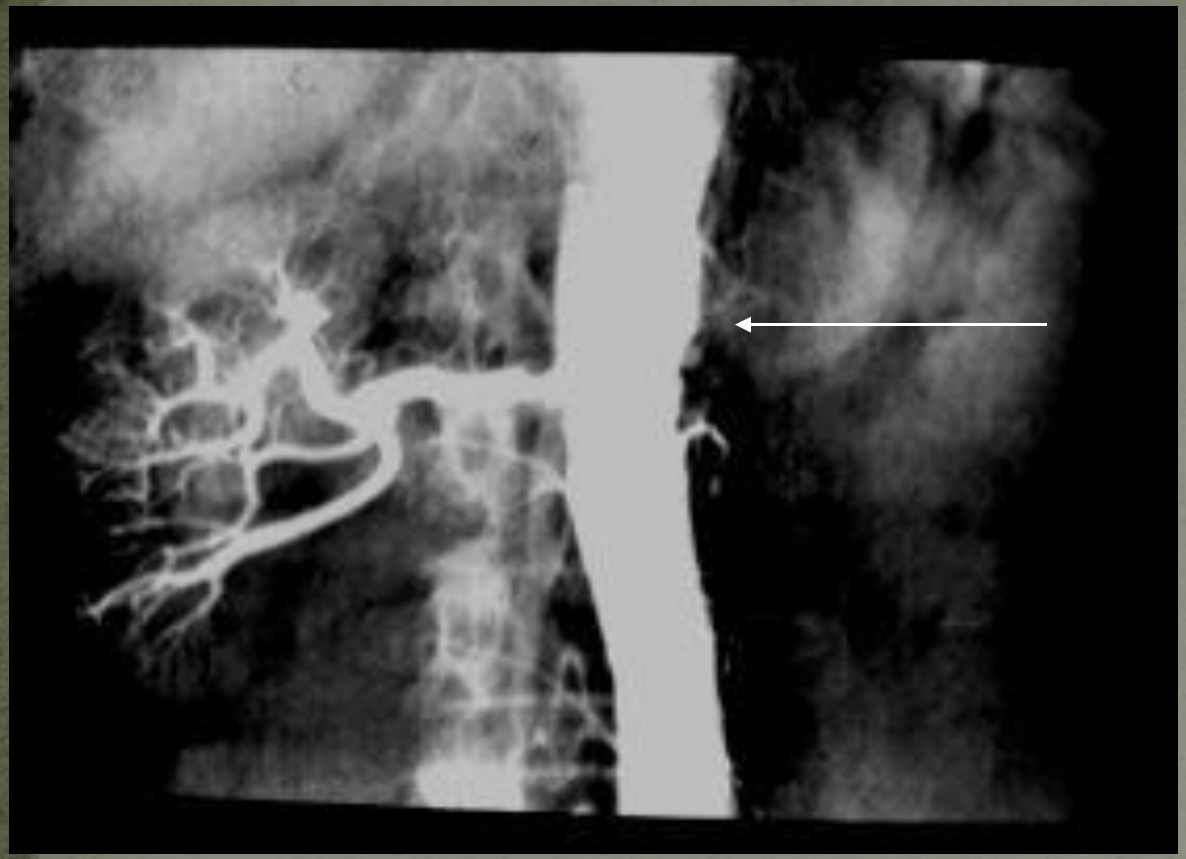




Selective arteriography







AORTOGRAPHY: LEFT RENAL ARTERY THROMBOSIS

AORTOGRAPHY & UIV:

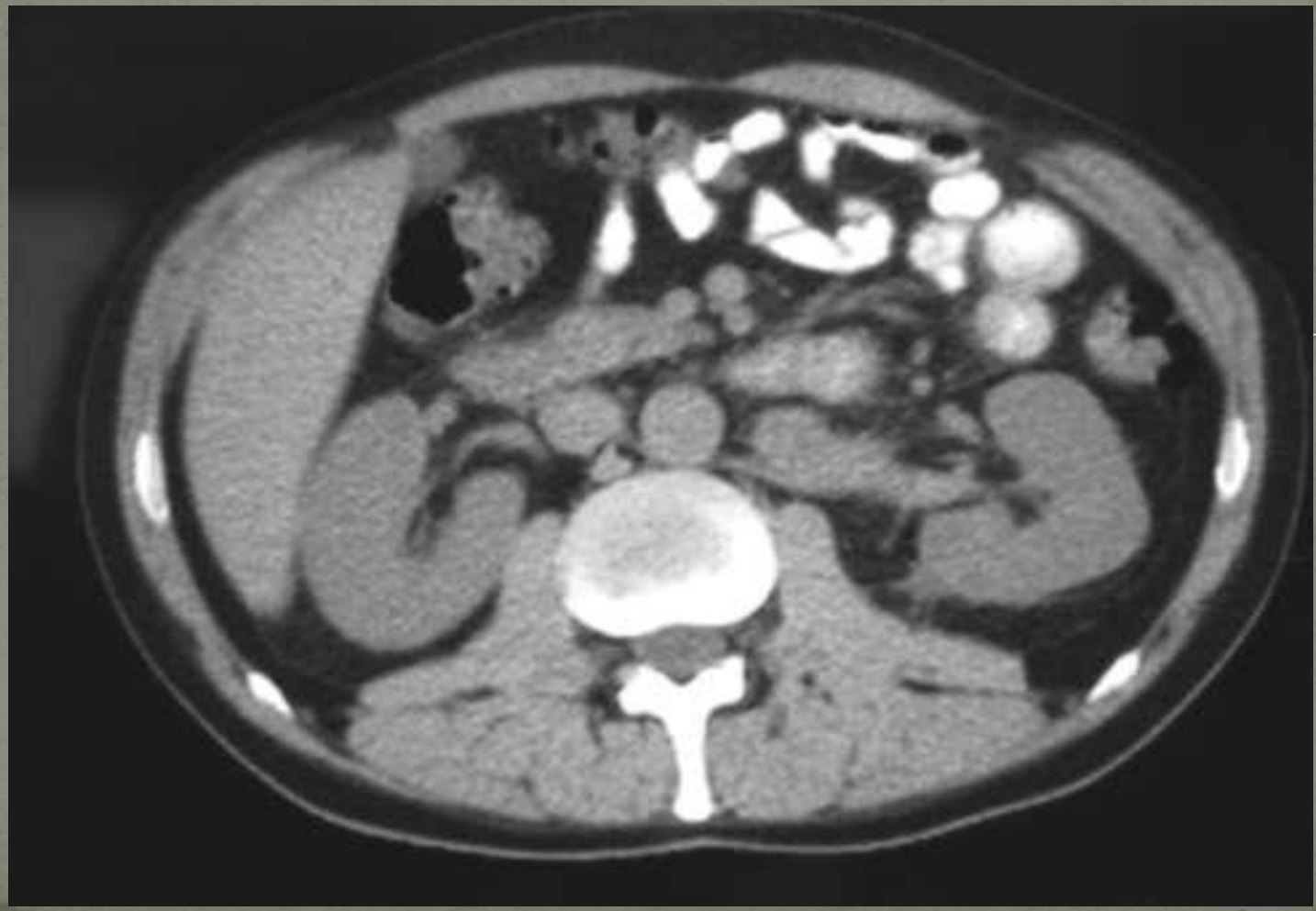
SUPLIMENTARY RENALARTERY AT THE INFERIOR POLE

Computed tomography (CT)

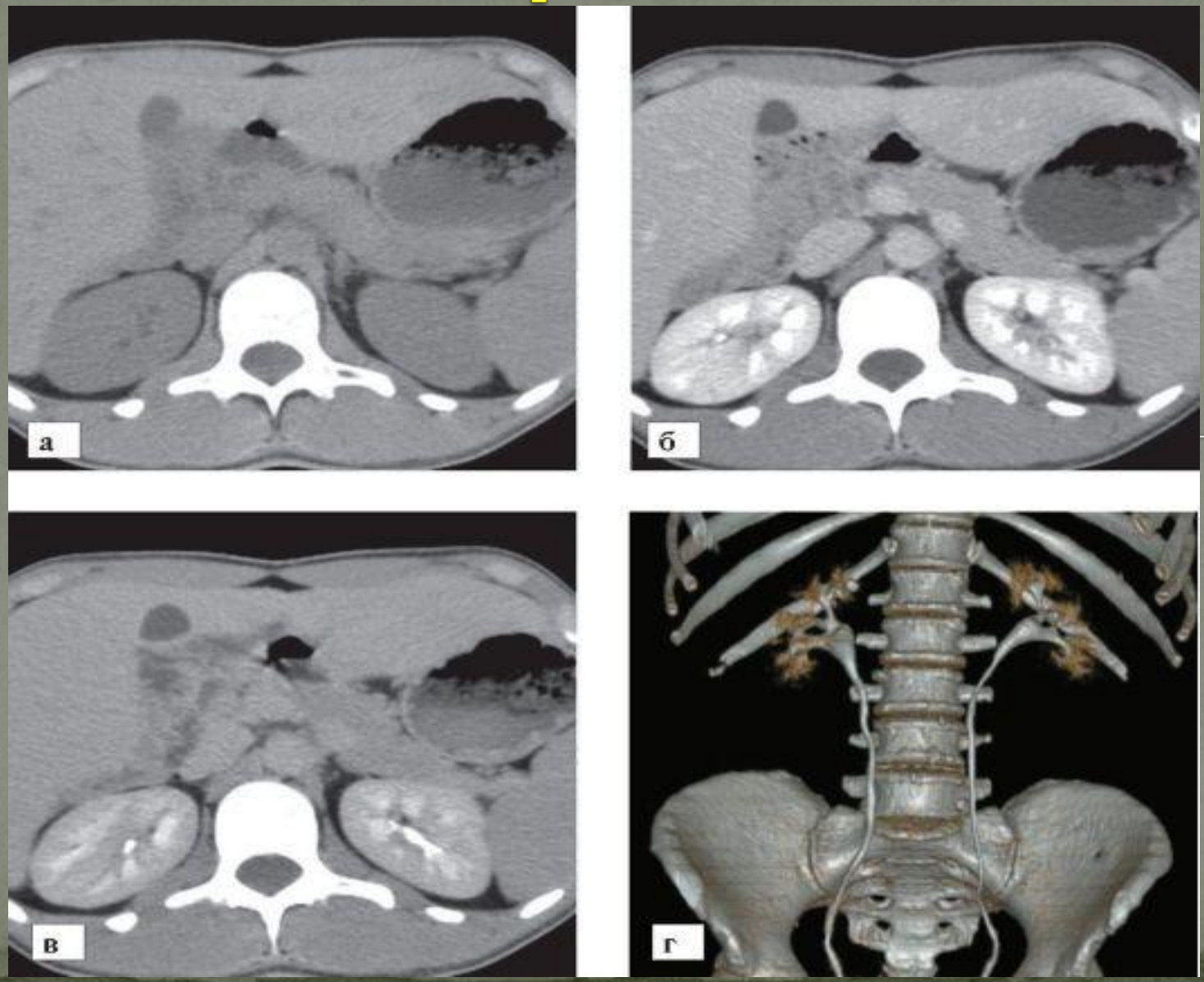
Indicated in all renal pathology, including:

- **Inflammatory diseases;**
- **Congenital malformations;**
- **Trauma;**
- **Positive diagnosis and staging of malignant tumors;**
- **Post-nephrectomy control after cancer;**
- **Guiding punctures / percutaneous drainage;**
- **Detection of uretheral stones;**
- **Study of the renal vessels.**

Normal kidney at CT scan

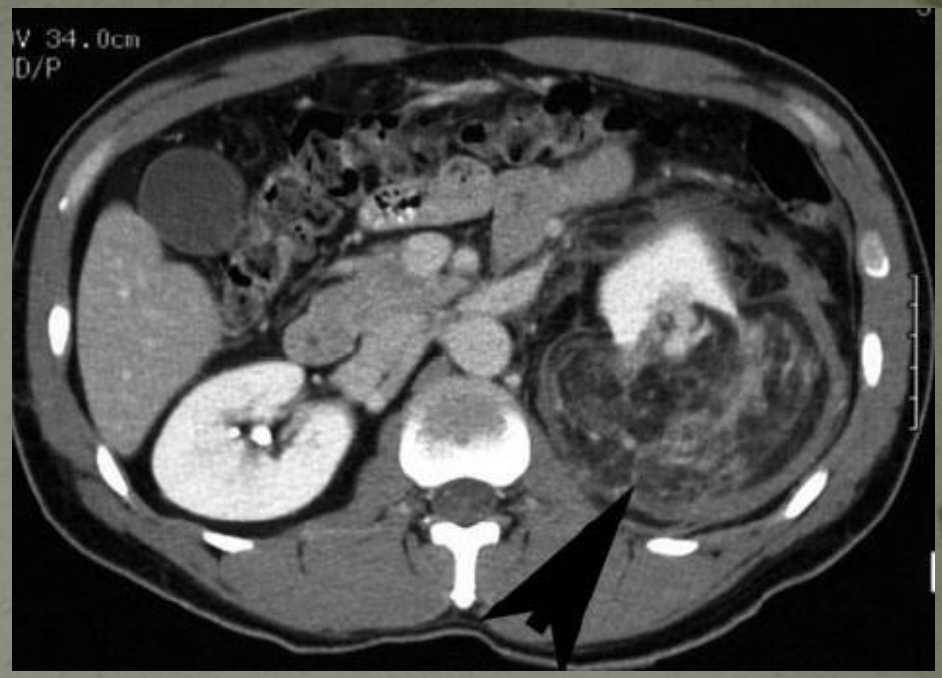


Scan phases



CT

Trauma



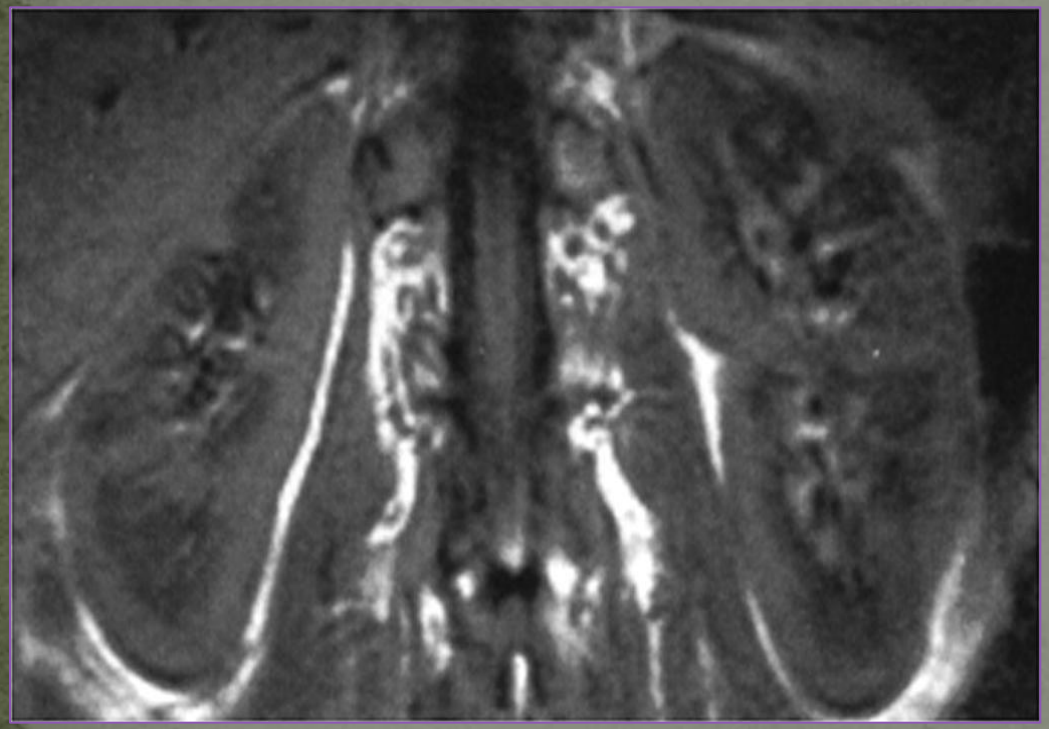
Tumor

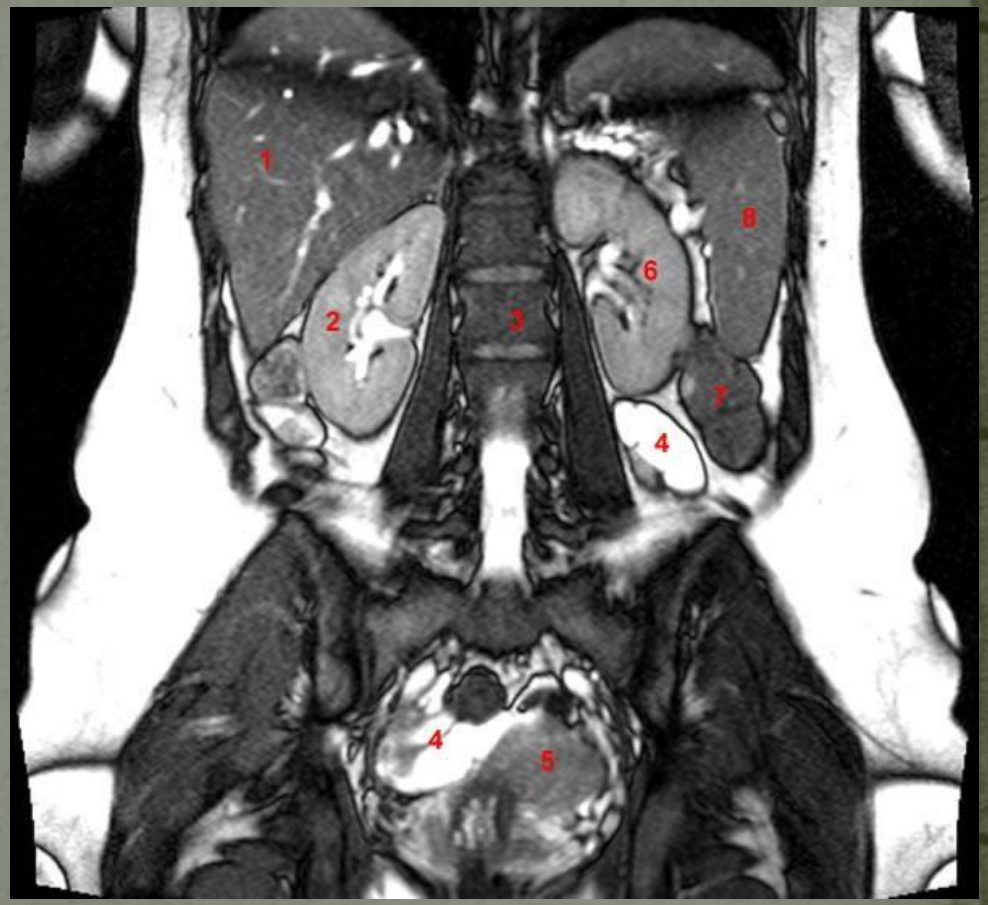
Magnetic resonance imaging (MRI)

Indications:

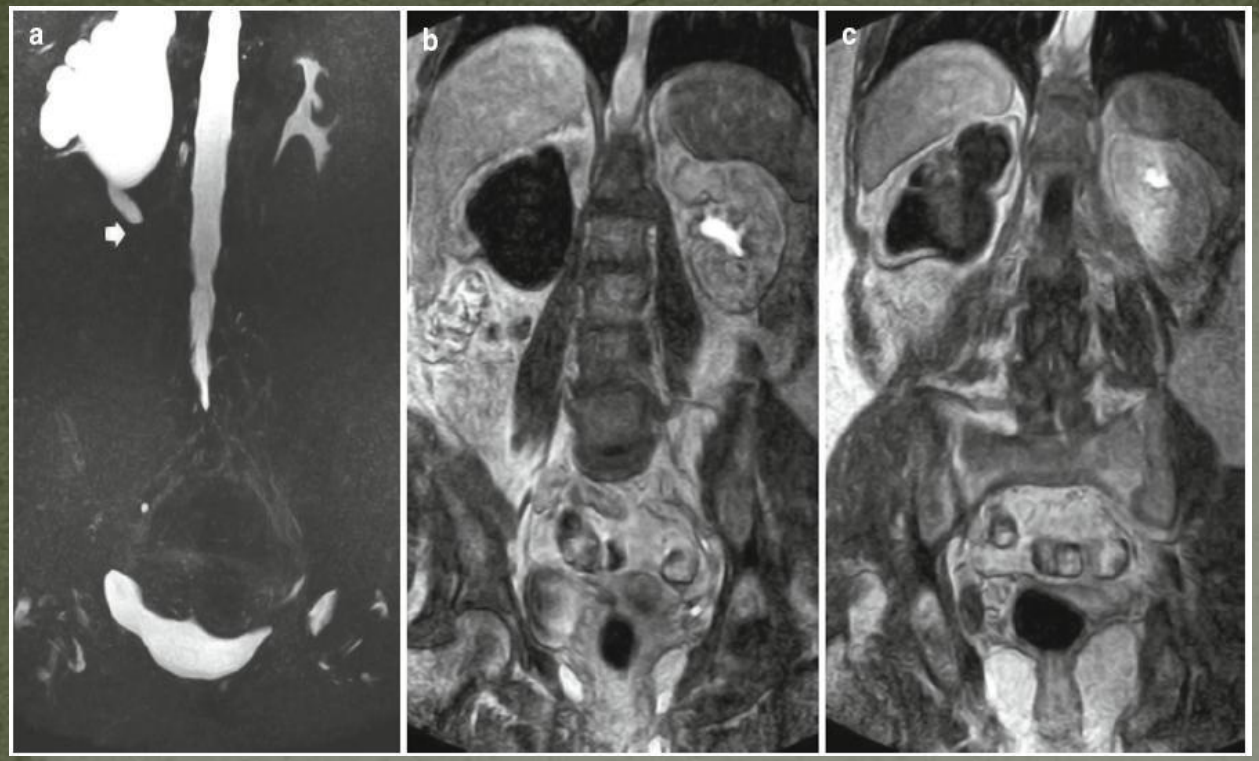
- Diagnosis and staging of malignant tumors;
- The study of renal arteries (Angio-MRI);
- Acute and chronic infections;
-URO-MRI can replace IVU if there is contraindications to iodinated contrast agent injection;
- Excellent assessment of urinary bladder, pelvic and retroperitoneal lymph node.

Magnetic resonance imaging (MRI)

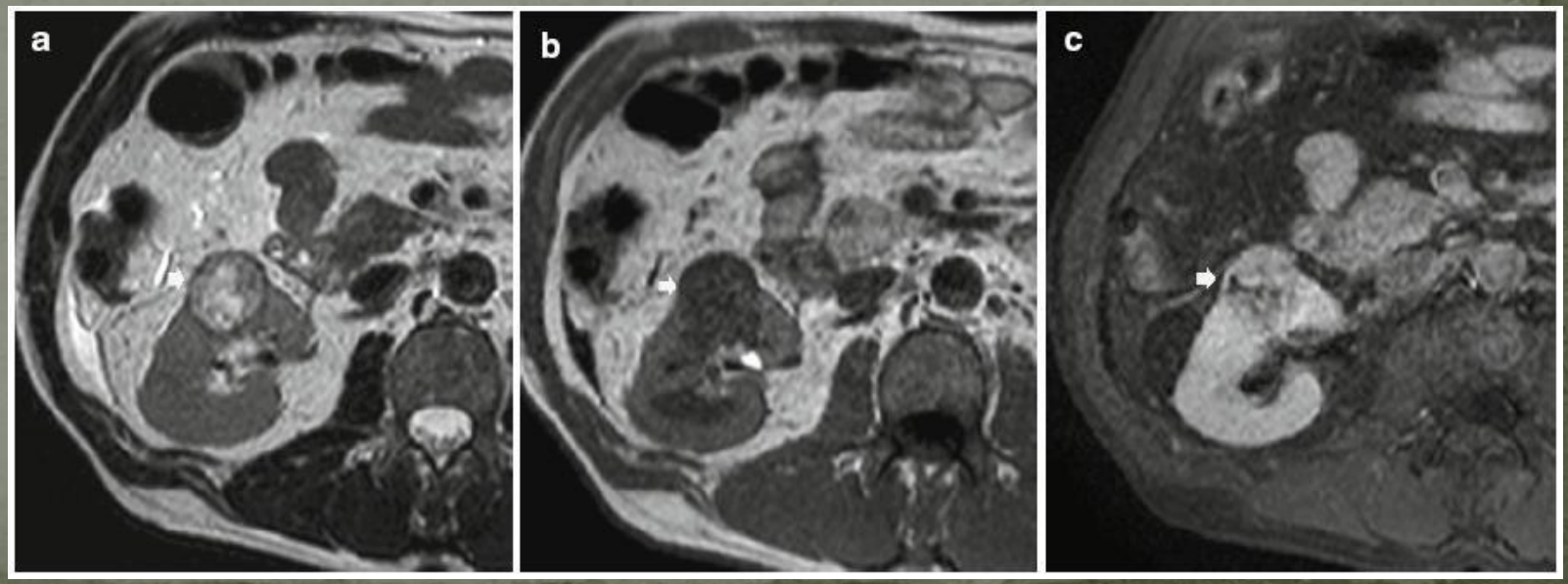




T1, T2 normal kidney



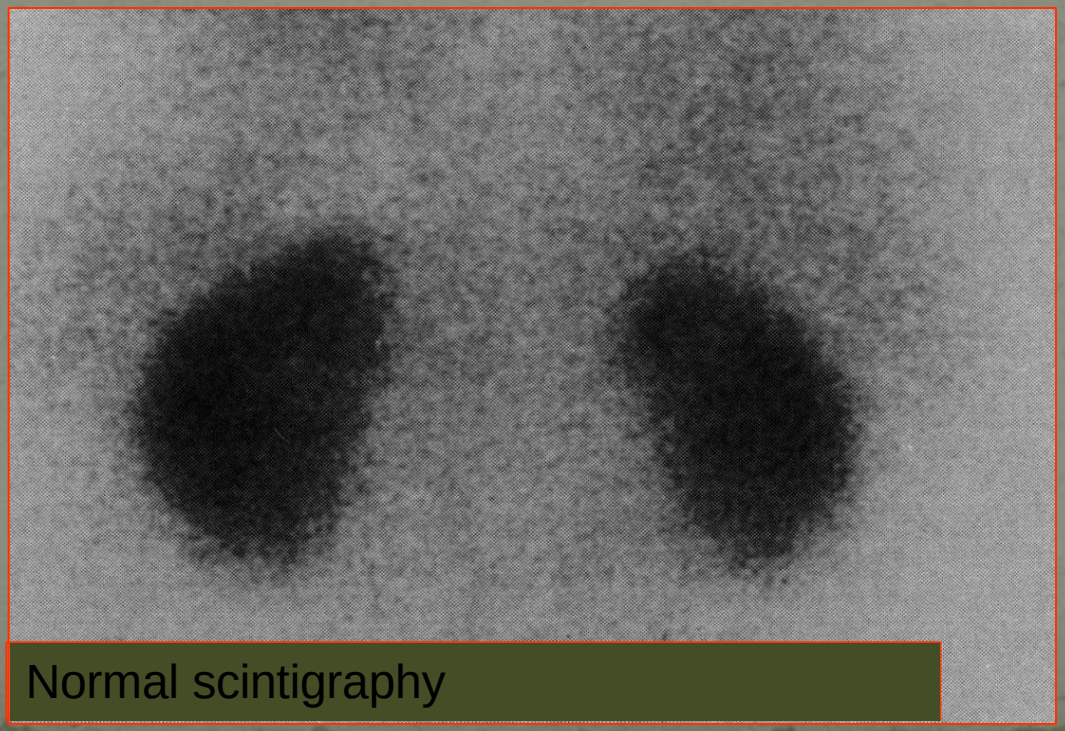
MRI: right hydronephrosis



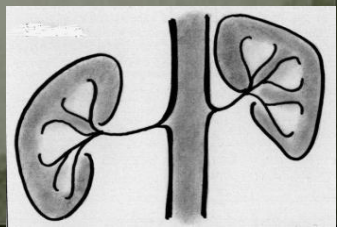
renal carcinoma

SCINTIGRAPHY

- Appreciate the percentage of each kidney that participate in the global renal function;
- Detects areas of hyper- or afixation;



Normal scintigraphy



Indications:

- The renal function and perfusion
- renal obstruction
- kidney infection (chronic and acute pielonephritis)
- kidney transplant
- congenital anomalies
- tumors

Isotopic renogram

The technique involves measuring the scintillation probes the time variation of renal radioactivity after administration of a radiotracer with predominantly renal elimination. The pulses are processed and recorded as the renogram. That is a dynamic study of kidney function.

It is the renogram curves that show transit of tracer through the kidneys, so the curves are more important than the images.

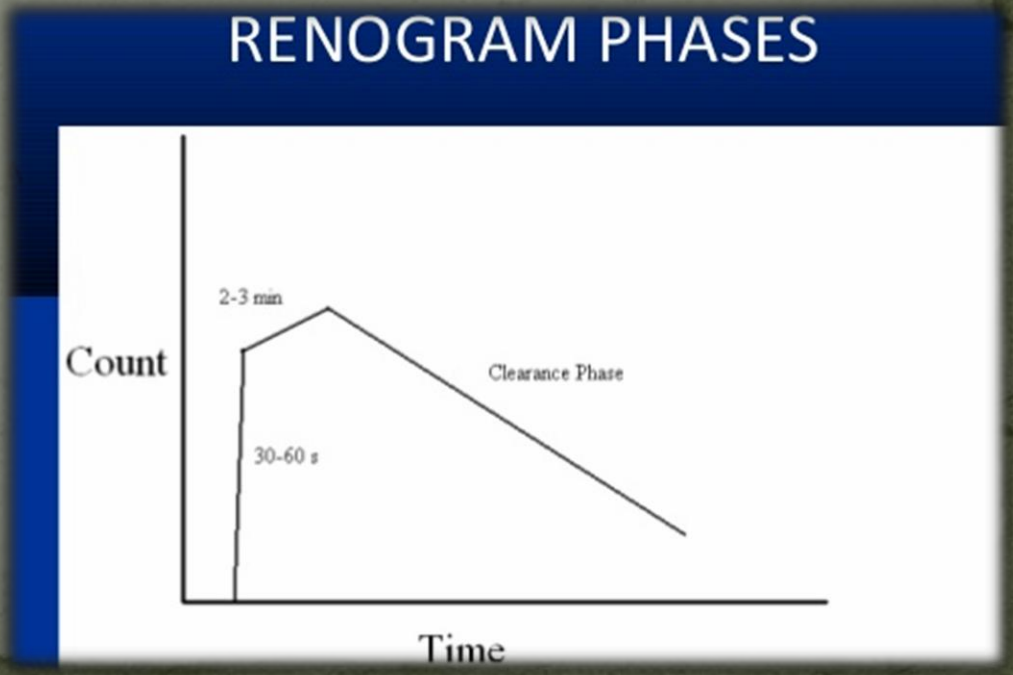
Upslope of curves demonstrate kidney uptake.

Downslope of curves demonstrate elimination.

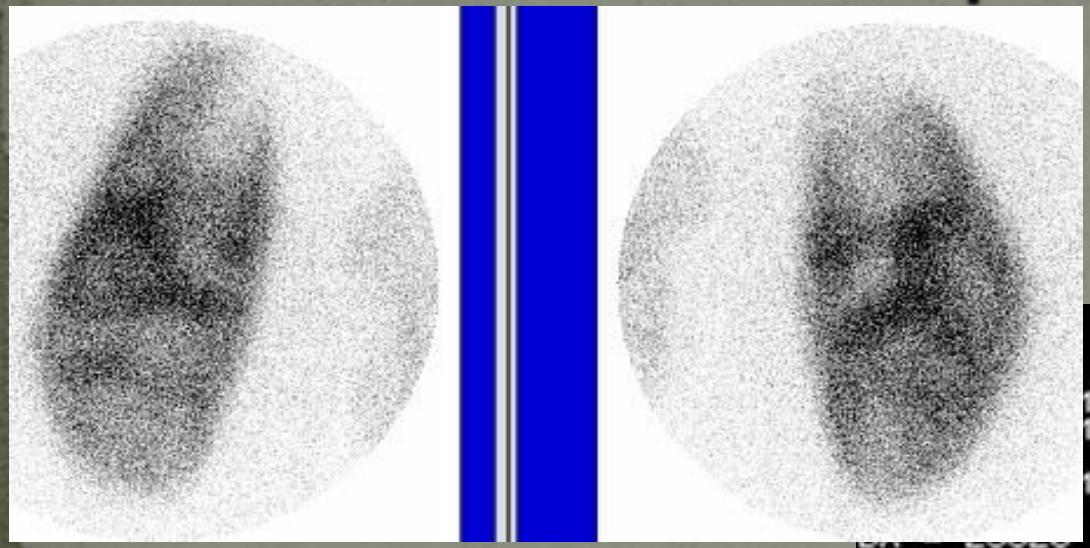
The curve has three segments:

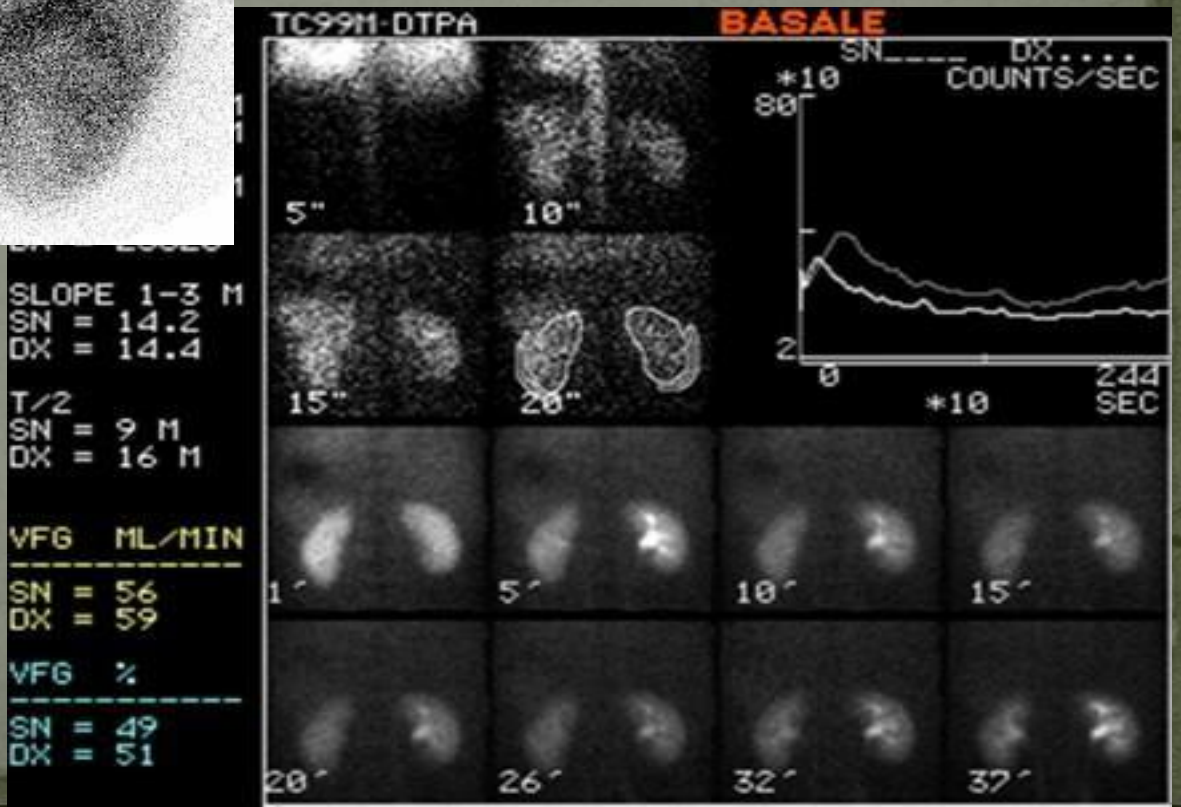
- ascending segment steep, short duration = vascular time;
- slow upward slope = parenchyma time (capture, secretion);
- progressive downward slope = renal elimination.

!!! The technique has the disadvantage of poor specificity results.



Normal radioactive substance capturing





Pyelonephritis

Pyelonephritis are classified into acute and chronic.

By acute pyelonephritis means suppurative- inflammatory process of kidneys with varying degrees of intensity, which extends from the renal tubules to cortical.

Chronic pyelonephritis may follow an acute pyelonephritis or may have started as a quiet allure.

Chronic pyelonephritis is inflammation of the renal parenchyma that develops slowly, with periodic worsening and with kidney sclerosis in final phase.

Imaging diagnostic of acute pyelonephritis

Clinical:

-violent beginning - chills, fever, unilateral or bilateral back pain,

-piuria, terminal hematuria.

-polakiuria, pain in urination, oliguria,

-headache, asthenia, nausea, vomiting.

Ultrasonography:

-enlarged kidney, hypoechogenyc parenchyma,

-cortico-medullary differentiation is absent,

-moderate enlargement of calyx and renal pelvis.

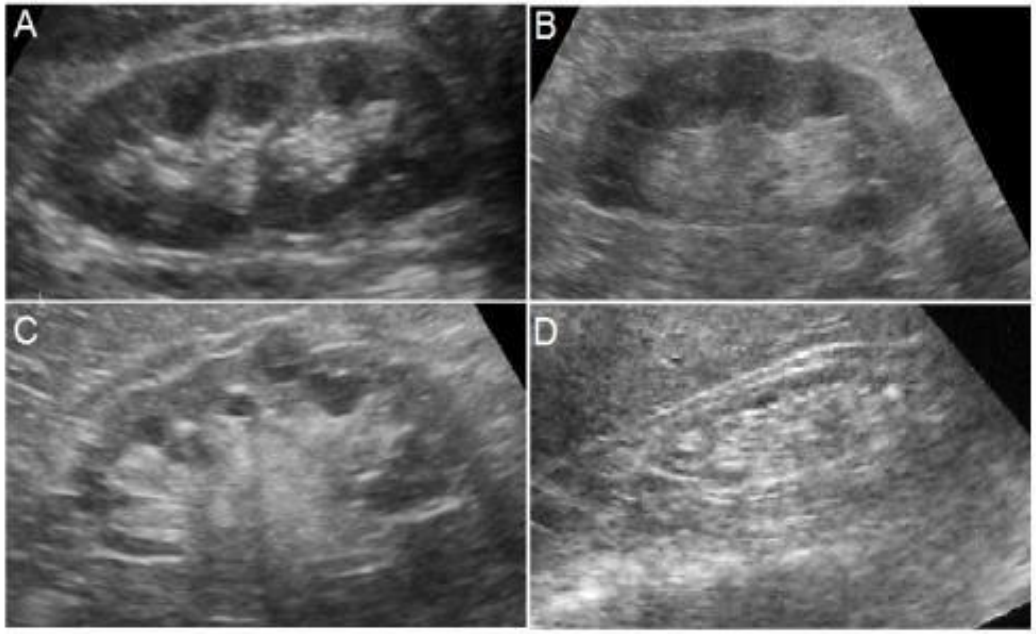
!!! IN ACUTE PYELONEPHRITIS I/V UROGRAPHY IS NOT MADE, IT ALLOWS FEW DAYS AFTER ONSET.

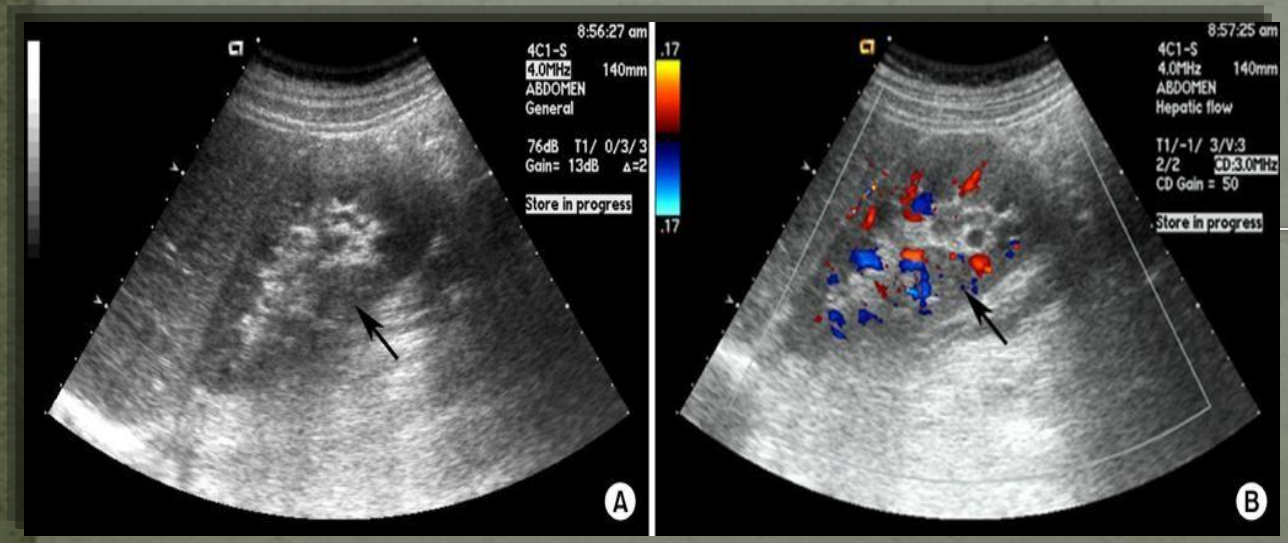
I/v urography:

-syndrome of "white" kidney - is due to accumulation of contrast in glomeruls, without accumulate in calyx;

-contrasting of calyx and pelvis is late and less intensive, with clear contours;

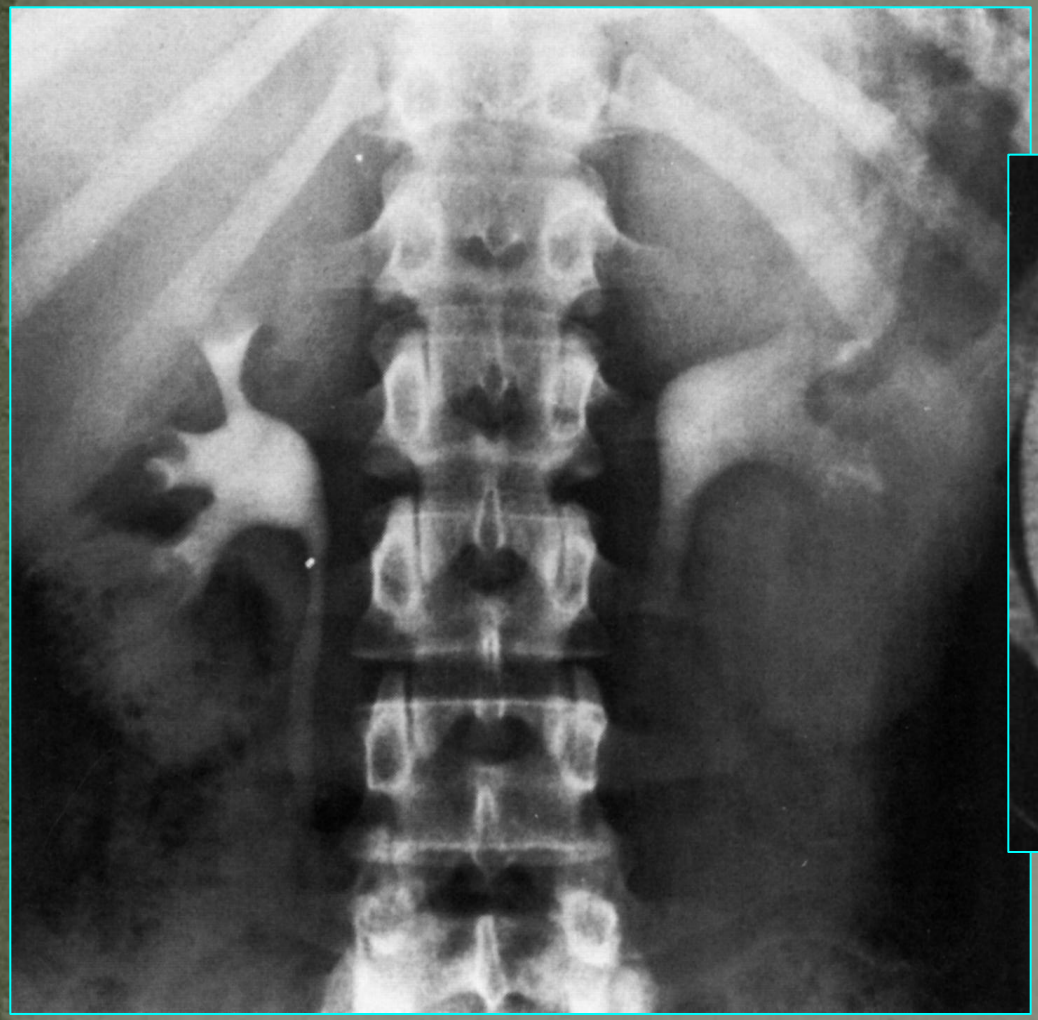
-contrasting of pelvis without visualization of contrast in calyx (due to spasm).





Arrow indicate areas of edema and hypoechogenyc areas, confirming the diagnosis of acute pyelonephritis.

Acute pyelonephritis

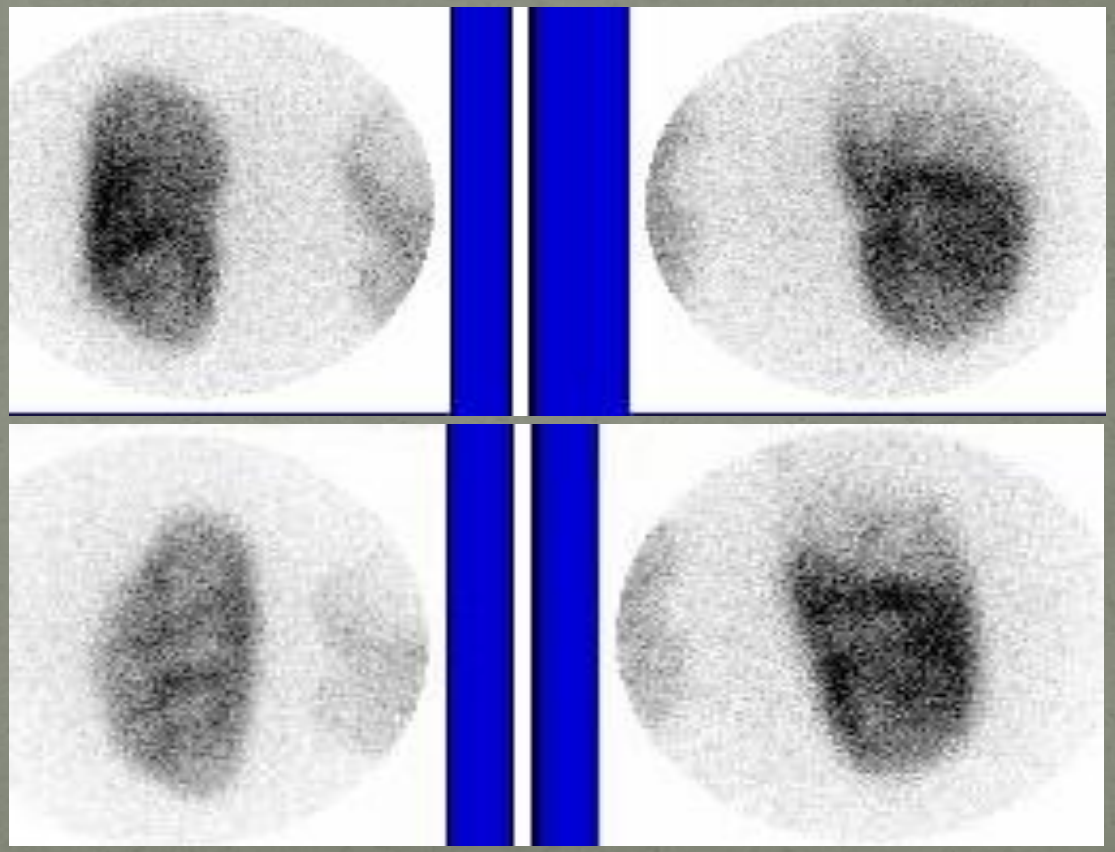


IVU :
enlarged left kidney, delayed nefrograma, narrowed calyx

CT:
bilateral enlarged kidneys, ribbed nefrograma, cortico-medullary layer is tickened, reduced contrasting, perinefral tissue opacity.

Renal cortical scintigraphy in acute pyelonephritis

“Cold" catchments - single or multiple, renal border clear, regular, low diffuse absorption.



Imaging diagnosis of chronic pyelonephritis

Clinical picture depends on phase process: active, latent or remission.

In general, patients have:

- lumbar pains, exacerbated by efforts;

- unclear urine, urinary frequency;

-subfebrility, fatigue, asthenia, hypertension.

Ultrasonography: - kidney border is irregular,

-reduced parenchyma index,

- hyper echoic parenchyma +/- transonic zone.

Intravenous urography:

-the kidney are increased in size because of inflammatory infiltration;

-the calyx are elongated, dilated, deployed, spasms of calyx rods;

- tubular-parenchyma low tide;

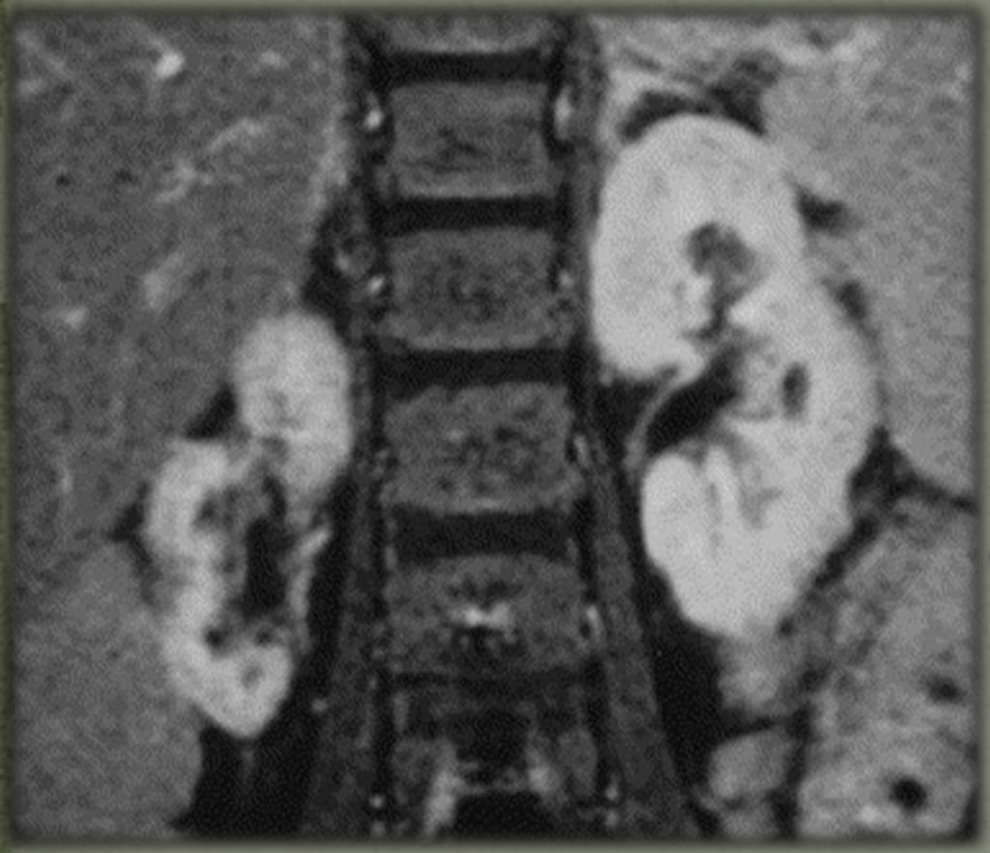
- heterogeneous contrasted renal pelvis because of mucosal edema; sometimes it is hypotonic, widened;

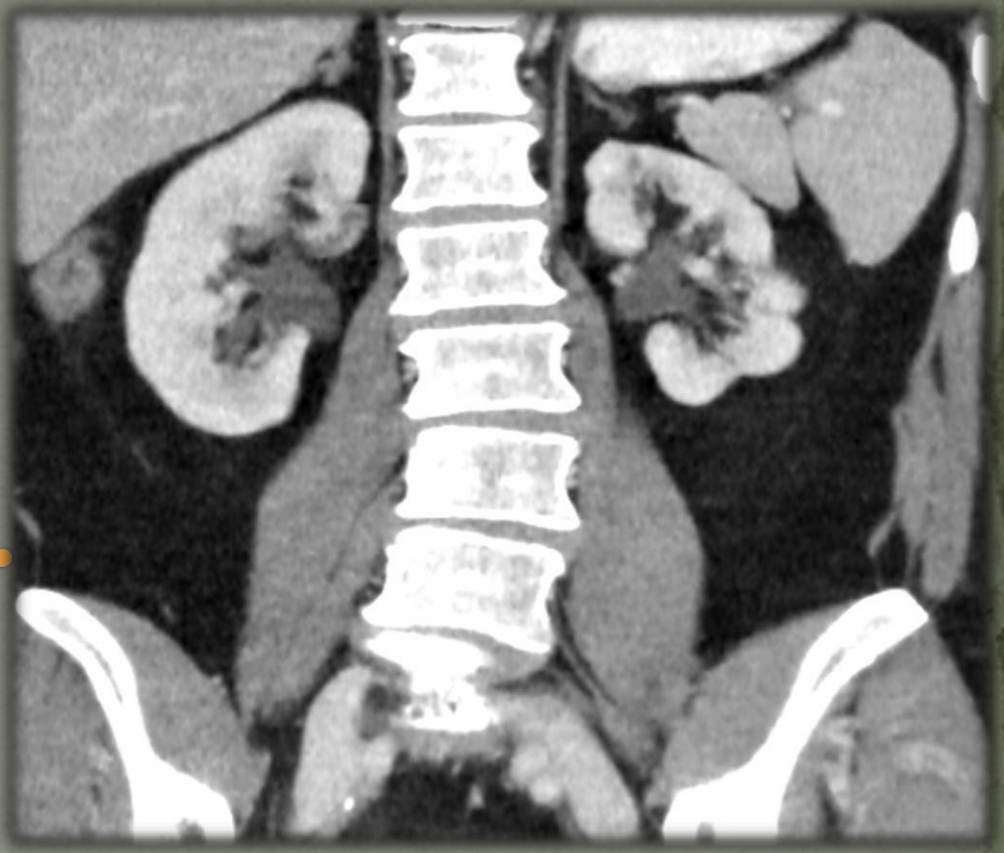
-hypotonic urethers and bladder;

-in terminal stages kidney shrinks in volume.

IVU: *CPN* - Cortical thinned, calyx deformed, hypotonic

Chronic pyelonephritis





MRI- shrinked kidney with irregular border, thickened cortical-medullar layer, calyx-pelvical system deformed.

CT- shrinked kidney with irregular border, thickened cortical-medullar layer, calyx-pelvical system deformed, perirenal adipose tissue endured.

Glomerulonephritis

Glomerulonephritis is inflammation of the renal glomerules. This inflammation will cause damage to the glomerular membrane and renal capillary endothelium. One of the most feared complication is the evolution of glomerulonephritis towards chronic kidney disease!

From an evolutionary standpoint, glomerulonephritis can be: acute, sub-acute (rapidly progressive), chronic.

Clinical:

- **nephritic syndrome with edema, oliguria (decreased 24 hours urine at 200-500 ml), hypertension, hematuria (blood in urine);**
- **nephrotic syndrome with hematuria, frothy urine (due to elimination of increased urinary protein), soft edema which at the pressure will leave a trace.**

Glomerulonephritis

- Because of the low density of urine and low kidney function, X-ray imaging investigations (RRVS, intravenous urography, CT with and without contrast) or magnetic field investigations (MRI) are less informative.
- USG can be used to determine the dimensions of kidneys (kidneys become enlarged in size) and parenchyma changes (sometimes appear small cysts).
- The most specific investigations are the laboratory one.

Kidney failure

- **Renal failure is defined by the rapid decline (acute renal failure) or slow decline (chronic renal failure) of renal function, resulting in inability to maintain electrolyte balance and excrete nitrogen products. Serum creatinine is a convenient marker for evaluation of renal function: creatinine value increase by 1-1.5 mg/ dL / day (acute RF).**
- **Renal failure can be described also as a decrease in glomerular filtration rate.**

Acute renal failure

- ARF appear usually after an exacerbation of pre-existing renal disease, such as chronic glomerulonephritis, kidney diabetic or hypertensive damage, drug abuse (especially painkillers), or can be caused by an acute event (acute glomerulonephritis, autoimmune disease, infections, surgery, sepsis, etc).
- Acute renal failure is in most cases reversible.
- Symptoms that may occur in case of acute renal failure are:

- anuria (ceasing production of urine);
- oliguria (decreased production of urine below 400 ml/day);
- hematuria (blood in urine);
- lower extremities edema;
- thirsty, lack of appetite, nausea and vomiting;
- headache, abdominal pain;
- drowsiness, confusion, anxiety;
- heart rhythm disorder;
- convulses, coma.

Chronic renal failure

- Chronic renal failure develops over several years. Symptoms usually appear at an advanced stage.
- The most common causes of chronic kidney disease are high blood pressure, type 2 diabetes and polycystic kidney disease.
- Ultrasonography:

-reducing kidney size;

-thinning cortical layer with increased echogenicity;

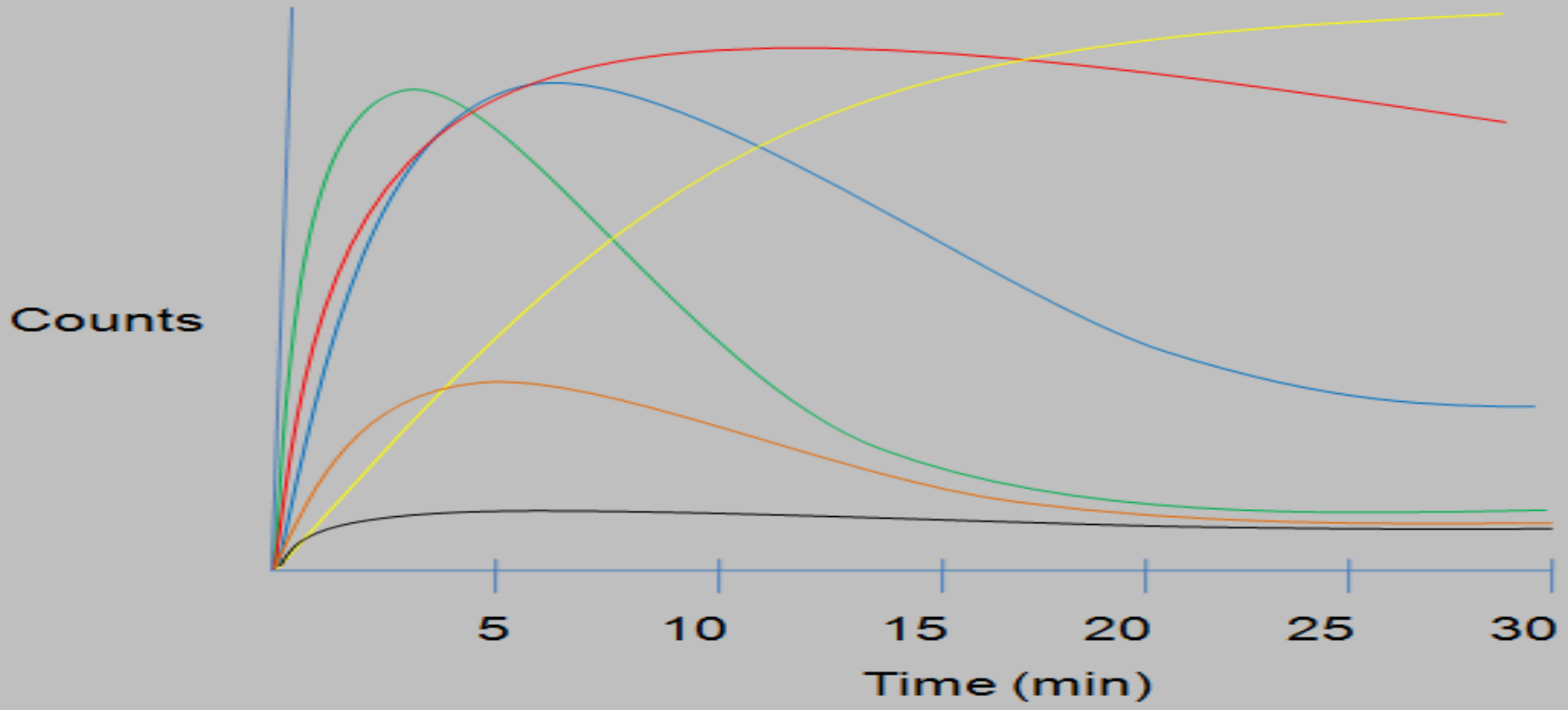
-renal pyramids low differentiation;

- papillary calcifications;

-cysts.

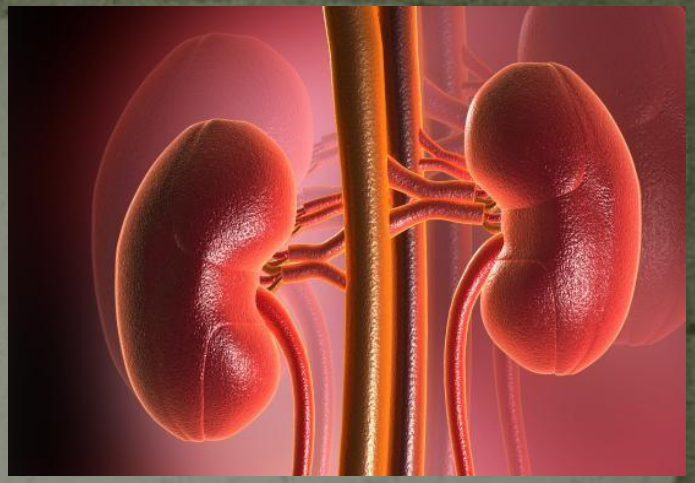
- X-ray imaging investigations (RRVS, intravenous urography, CT with and without contrast) or magnetic field investigations (MRI) are less informative in the early stages, the use of contrast is a contraindication to the final stages.

Grade0 = normal
Grade1 = dilated but unobstructed vs partial obstruction
Grade2 = dilated and high grade obstruction
Grade3 = persistent nephrogram (no excretion)
Grade4 = renal failure with measurable renal fxn
Grade5 = renal failure with no sig renal fxn



Medical imaging in nephrology.

1. Computed tomography in the diagnosis of renal pathology. Scanning phases. Indications.
2. Imaging methods of investigation in renal pathology of inflammatory origin.
3. Acute pyelonephritis, chronic pyelonephritis. Differential diagnosis.
4. Imaging diagnosis in acute and chronic renal failure.
5. Imaging evaluation of renal transplant.



THANKS FOR

KEEPING SILENCE