Ministry of Health of Ukraine
Kharkiv National Medical University

MAIN CLINICAL, LABORATORY AND INSTRUMENTAL METHODS OF KIDNEYS EXAMINATION

Methodical instructions for students

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INQUIRY

The most common complaints of the patients with renal diseases are: pain, deranged urination (dysuria), and edema.

Pain. The patients with urinary organs diseases complain on pain of various location and character. Location of the pain depends on the site of urinary tract affection. Pain of renal origin is usually felt in the lumbar region, pain of ureter origin – along their course, pain of bladder origin – is suprapubical.

The renal tissue is free from pain receptors. The pain in the diseases of the urinary organs can be caused by distension of the renal capsule, or by spasmodic contraction and distension of the pelvis, ureter, and urethra.

Loin pain was described by Hippocrates and remains an important symptom. The classic form is ureteric colic, often misnamed 'renal colic'. This is acute, usually severe, often indescribably so, and waxes and wanes in a typical colicky patter; the suffer thrashes about, unable to find comfort, sweats with the agony, and is often pale. Pain is usual unilateral and radiates from the loin into the abdomen, and down into the testicle, labium, or upper thigh. Colic pain ca be provoked by taking much liquid, jolting motion. Sudden relief may occur if the stone, blood clot, sloughed papilla, or whatever is causing the obstruction moves on, only to recur when it impacts again. Atropine sulphate, hot water bottle or warm bath can lessen or remotes renal colic.

Renal pain, as opposed to ureteric colic, is usually static, dull, constant, and felt in the loin. Sometimes there is obvious renal swelling, with or without tenderness, and heat if the infection is present. The commonest causes of this dull and boring pain are acute glomerulonephritis, renal abscess, 'congestive kidney' (in heart failure). Acute pyelonephritis will also give rise to similar unilateral pain, and a rare differential diagnodid is of renal infarction by in situ thrombosis or embolism in the renal artery tree. Less severe and uncommon renal pain may a symptom of chronic glomerulonephritis.

Table 1.1. Pain in selected urinary diseases

Disease	Location Radiation	Character
Nephrolithiasis	Loin pain, by the ureters course, more frequent unilateral, downward radiation	Periodic, intense, renal colic

Pyelonephritis	Loin pain, bilateral, without radiation	Dull, constant, increasing in intensity, accompanied by irregular fever
Renal abscess	Loin pain, unilateral	Pain and muscular tension, accompanied by fever, chills, headache, and symptoms of bacterio-toxic shock
Renal infarction	Loin pain, unilateral	Occur suddenly, intense, accompanied by excretion of red urine
Nephroptosis (movable kidney)	Loin pain, unilateral, inconstant pain location	Periodic, sometimes renal colic like, intensified in upright position, in physical exertion, in jolting motion, relieved in lying posture at rest
Acute glomerulonephritis	Loin pain, bilateral, without radiation	Dull, of insignificant intensity, in some patients the pain is absent
Congestive kidney	Loin pain, bilateral, without radiation	Dull, depend on degree of edematous syndrome
Cystitis	Suprapubical, increased in palpation	Pain is provoked by urination, most intense and burning at the end of it. Imperative increasing of urination by small portions of urine
Urethritis	Urethra region	Burning pain in urethra, increasing in urination, accompanied by ample, purulent excretions from the urethra and painful and

		frequent erections

In the patients with cystitis the pain is provoked by urination; in stranguria – difficult and tenderness urination is typical; in urethritis – is characterized by burning pain in the urethra that arises during or after urination.

Deranged urination. Healthy person excretes approximately 1-2 liters of urine in 24 hours; urination rate is 3-6 times a 24 hours; ratio of daily and nightly amount of excreted urine is 3:1 accordingly. Urination is free and painless.

Urine volume

The volume of urine passes varies greatly from day to day in normal individuals, under very precise stimuli, to maintain an essentially constant body fluid volume.

Polyuria describes the excretion of larger than normal volume of urine (exceed 2l/24 h). Polyuria is most commonly caused by a habitual high fluid intake, but is also a feature of the glycosuria of diabetes mellitus and initial stage of renal failure. Less common causes include diabetes insipidus of cranial (defective secretion of arginine vesopressin – pituitary diabetes insipidus) or nephrogenic (failure of the renal tubules to respond normally to arginine vasopressin – nephrogenic diabetes insipidus) origin and hypokalaemia and hypercalcaemia (Tab. 1.2).

Table 1.2. Polyuria causes.

Causes		
Extrarenal		Renal
Physiologic	Pathologic	
• High fluid intake • Neurogenic factors	• Resolution of: -edema -transudate -exudate • Diabetes mellitus • Diabetes insipidus (to 4-6 l and more)	• Chronic renal disease at initial stage of renal failure

Some patients suffering from frequent urination may complain of passing excessive amounts of urine, and it is thus important to distinguish true polyuria from frequency of micturition in such cases.

Oliguria, arbitrarily defined as the production by an adult of less than 500 ml of urine/24 h. Oliguria is normal in hot climates or where intake has been restricted. Oliguria is abnormal when the kidney is damage and unable to excrete water – as in obstruction, acute renal parenchymal disease, or failure of renal perfusion (Tab. 1.3). In any oliguric patient the first steps in diagnosis are to establish whether the patient has had an adequate intake, has had excess extrarenal losses, is already overloaded because of failure to excrete a normal amount of intake, or has urinary tract obstruction at some level with an enlarged bladder or dilated upper tract. The composition of the urine, the state of the circulation and renal perfusion, as well as the history if available, will help in differentiated the various possibilities.

Table 1.3. Oligyria causes.

Causes		
Extrarenal		Renal
Physiologic	Pathologic	
• Limited fluid intake • Loss of fluid with sweat in hot weather or during physical exertion	• Decreased cardiac output • Loss of large amount of fluid by non renal way: - pronounced sweatiness in fever, - profuse diarrhea, - intense vomiting, - bleeding • Shock, collapse	• Acute nephritis (to 200-300 ml/24h) • Nephrotic syndrome in edematous phase • Acute renal failure (hemolytic, toxic kedney) • Amyloidosis • Obstruction of the ureter, bladder, or urethra

Anuria is defined as complete absence of urine secretion and/or excretion. Anuria can be caused by damage of the renal parenchyma – secretory anuria, or by obstruction of urinary tract (ureters, bladder, or urethra) – excretory or obstructive anuria (Tab. 1.4). Reflex anuria can be arises in severe pain of various origins. If anuria persists several days, uraemia can be develops or even fatal outcome.

Table 1.4. Anuria causes.

Causes

Secretory anuria	Excretory anuria
• Acute renal failure • Terminal stage of the chronic renal failure • Acute glomerulonephritis • Nephrosclerosis • Sepsis • Poisoning with nephrotoxic substances • Severe heart failure • Collapse • Shock • Transfusion of incompatible blood • Dehydration (profuse bleeding, vomiting, diarrhea) • By reflex in severe pain	• Mechanical obstruction of the ureters or urethra by: - stones - inflammatory edema of the mucus membrane - proliferation of the malignant tumor - prostate adenoma - prostate tumor

Anuria should be differentiated from ischuria, when the secretion of the urine is normal but the urine is retained in the bladder because patient is unable to evacuate it. Ischuria is observed in the patients with compression or other affection of the spinal cord, and also in unconsciousness state.

Nocturia (nycturia) is defined as passing of more than one-third of the total 24-h urine volume by night.

In health there is a diurnal variation in renal function, with relative retention of both water and solute by night. Normal adult excrete between 1 and 2 liters of urine in 24 hours, of which 60 to 80% is passed by day. This diurnal rhythm may be abolished or even reversed in edematous states, in chronic renal diseases, malabsorption, adrenal insufficiency, and in some cases after head injury or renal transplantation (Tab. 1.5). It is therefore sometimes useful to record day and night urine volumes separately. It should be noted, however, that normal elderly subjects tend to pass almost the same amount of urine during the night and the day.

Table 1.5. Nocturia causes.

Causes	
Renal	Extrarenal

• Chronic renal diseases at renal dysfunction (nocturia with polyuria): - chronic glomerulonephritis, final stage - chronic pyelitis - vascular nephrosclerosis, etc	• Heart failure (cardiac nycturia – nycturia with oliguria during day time) • Prostate adenoma • Diabetes insipidus

Urination frequency

Healthy individuals urinate from 3 to 6 times a day. The volume of urine passed during one micturition is from 200 ml to 300 ml. These patterns can be change depend on various physiological and pathological causes.

Pollakiuria is traditionally defined as frequent, more than 6 times a day, urination. Pollakiuria with polyuria can be observed in cold climate and in high fluid intake. It should be noted that pollakiuria is not always associated with polyuria. Pollakiuria with excretion of meager quantity of urine (oliguria) is typical to cystitis. Frequent desire to urination is also characteristic of prostatitis, urethritis, stones in the urine bladder, prostate adenoma, decreased volume of the bladder, and diuretics taking.

Ollakiuria is rare micturition that not always associated with oliguria. The commonest causes of ollakiuria are limited fluid intake, eating of much salted food, excessive sweating in hot climate or fever, and neuroreflex disorders.

Enuresis is involuntary urination without desire. Enuresis observes in organic damage of central nervous system and spinal cord, urinary tract defects, and functional disorders in children.

Dysuria is painful urination, which is frequent symptom of inflammatory diseases of urinary tract, such as cystitis and urethritis.

Isuria – urination at about equal intervals with passage of about equal amounts of urine is common symptom of chronic renal failure.

Stranguria is defined as passage of small amounts of urine (by drops). This symptom can be caused by pathological processes in the urethral sphincter, stricture (after operative) of the bladder cervix, strangulation of stones or foreign bodies in the urethra, bladder tumor, and phimosis.

Definition and causes of urination disorders are summarized in Tab. 1.6.

Table 1.6. Disorders of urination.

Term	Definition	Causes
Polyuria	Urine volume exceed 2l/24h	High fluid intake Diabetes mellitus Renal failure initial stage
Oliguria	Urine volume is less than 500ml/24h	Hot climate Restricted fluid intake Obstruction Acute renal parenchymal diseases Failure of renal perfusion
Anuria	Complete absence of urine secretion and/or excretion	Renal failure Acute glomerulonephritis Nephrosclerosis Sepsis, collapse, shock, poisoning by nephrotoxic substances Dehydration By reflex in severe pain Mechanical obstruction of the urinary tract
Ishuria	Absence of urine excretion	Damage of the spinal cord Loss of consciousness
Nocturia	Passing of more than one-third of total 24-h urine volume by night	Chronic renal diseases with renal dysfunction Heart failure Prostate adenoma Diabetes insipidus
Pollakiuria	Frequent more than 6 times a day micturition	High fluid intake Cold climate Cystitis Prostatitis Urethritis Stones in the bladder Prostate adenoma Diuretics taking Decreased volume of the urine bladder
Ollakiuria	Rare micturition	Low fluid intake After much salted food Excessive sweating (hot climate, fever)

		Neuroreflex disorders
Enuresis	Involuntary urination without desire	Organic affection of the central nervous system and spinal cord Urinary tract defects Functional disorders in children
Dysuria	Painful urination	Cystitis Urethritis
Isuria	Urination at about equal intervals of about equal amounts of urine	Chronic renal failure
Stranguria	Passage of small amounts of urine (by drops)	Stricture (after operative) of the bladder cervix Strangulation of the stones or foreign bodies in the urethra Bladder tumor Phimosis

Edema is important and common symptom of the urinary organs diseases. Renal edema has following peculiarities. Patients complain on edema that initially arises on the face. In disease progression renal edema spreads from the face downward, up to anasarca. Edema is characteristic of acute and chronic glomerulonephritis, especially in nephrotic syndrome presence, amyloidosis, and acute renal excretory dysfunction (anuria).

Complaints concerning general condition. Patients with chronic renal diseases (glomerulonephritis, pyelonephritis) complain on general weakness, fatigue in development of functional disorders.

Fever can indicate infectious inflammatory affection of the kidneys and the urinary ducts, or can be the sign of the main disease, which cause damage of the kidneys. Hectic fever accompanied by chills and profuse perspiration is typical to acute pyelonephritis or aggravation of chronic pyelonephritis. High temperature (to 39-40˚C) observes in the patients with renal abscess, acute paranephritis. Subfebrile temperature (37-38˚C) can be detected in nephrolithiasis during attack of renal colic. In urinary ducts obstruction and congestion of the urine, the fever is constant. Recurrent fever is the sign of kidney tuberculosis. Insignificant elevation of body temperature arises in the patients with acute

glomerulonephritis, in chronic glomerulonephritis fever, usually, is absent.

Itch of the skin occurs in the patients with severe renal failure.

Perspiration arises in the patients with renal inflammatory diseases. Considerable perspiration is common symptom of purulent destructive damage of the kidney and perirenal cellular tissue, and specific tubercular process.

Change of body mass, as a rule, weight loss may occur as a consequence of chronic renal failure, in tuberculosis and tumor of the kidneys, polyps, and in tumor of the urine bladder.

Nervous system. Patients with urinary organs diseases may complain on decreased work capacity, impaired memory and attention, deranged sleep (insomnia), headache, dizziness, flashing lights before eyes, weakness in the extremities. All these symptoms are the result of elevated blood pressure, or encephalopathy and polyneuropathy that arise as complication of the chronic renal failure. Deranged vision and hearing are due to hypertension in the patients with acute and chronic glomerulonephritis, pyelonephritis, nephropathy, and in renal vascular pathology presence.

Respiratory system. The common complaints of the patients with renal diseases are cough with insignificant amount of the sputum and dyspnoe that increase in intensity corresponding to worsening of the renal function. These complaints are characteristic of chronic glomerulonephritis, pyelonephritis, and are due to the accompanied pneumonia. Pronounced breathing disorders observe in the patients with chronic renal failure, so-called “uremic lung” is formed. Patients complain on dyspnoe in insignificant physical exertion, and asthma attacks. In case of uremic pleurisy, dyspnoe develops quickly up to acute respiratory failure with circulatory disorders.

Cardiovascular system. Pain in the heat region, retrosternal pain, palpitation, dyspnoe, suffocation by cardiac asthma type are typical to acute glomerulonephritis, and also to other diseases, which are accompanied by elevated blood pressure. All these complaints are revealed in chronic renal failure, and are caused by metabolic disorders that lead to formation of cardiomyopathy.

Digestive system. Loss of appetite and pain in the upper part of the abdomen are early signs of renal dysfunction. Dyspeptic disorders, such as dryness and unpleasant taste in the mouth, nausea, vomiting can also be observed. At the final stage of chronic renal failure, meteorism, diarrhea alternated with constipation arises that suggest enterocolitis. These symptoms are the result of uremic gastroenteropathy.

Anamnesis morbi. In acute renal diseases it is necessary to establish time of diseases onset, possible connection with previous in/factious diseases, such as tonsillitis, scarlet fever, otitis, acute respiratory disease, etc. It should be note consequence and dynamic of symptoms occurring. Edema arising, blood pressure elevation, and changes of the clinical urinalysis 2-3 weeks after infectious diseases is typical to acute glomerulonephritis. Dysuria on the base of toxicosis (elevated temperature, chills) after cold is characteristic of pyelonephritis.

It is important to ask patient about possible industrial or domestic poisoning, and taking of nephrotoxic drugs (antibiotics, sulpha preparations, preparations of bismuth, silver, etc).

Chronic affection of the kidneys and urinary ducts can for a long time be latent, and are revealed occasionally. In such cases it is difficult to establish the onset of disease. Therefore the patient should be asked about previous edema, or possible dysuria, and loin pain. In established previously disease, it should noted character of the disease course, frequency and cause of exacerbations, consequence of clinical symptoms, results of previous examination and treatment.

Anamnesis vitae. It necessary to note previous infectious diseases (scarlet fever, influenza, etc), presence of infectious center (otitis, tonsillitis, adnexitis), and diseases with disorders of urine passage (prostate adenoma). Such diseases as diabetes mellitus, tuberculosis, collagenosis, hemoblastosis, and infectious diseases of genitals can cause renal affection. In the patients with long- standing chronic purulent pulmonary diseases, tuberculosis, osteomyelitis, rheumatic arthritis, Bekhterev's disease secondary amyloidosis of the kidneys can occur. Primary amyloidosis is of congenital character. Nephrolithiasis can be also inherited, thus it is important to know about diseases of the urinary organs and hypertension presence in the relatives of the patient.

Chronic poisoning - narcotics, smoking and alcohol abuse are accompanied by the kidneys damage.

When questioning women, it should be remember that in pregnancy difficult urine passage can observes, and frequently pyelitis and pyelonephritis occur. Women should be asked about edema and elevation of blood pressure during pregnancy – so-called nephropathy of pregnancy.

GENERAL INSPECTION

General condition of the patients with urinary organs pathology is usually satisfactory or of moderate gravity. In renal colic,

significant toxicosis, in transition of the disease to renal failure, the condition of the patient is grave; in severe renal failure and uraemic coma – very grave.

Consciousness of the patients is as a rule clear. Developing of uraemia is accompanied by consciousness disorders: stupor, sopor, and coma.

Posture of the patients at initial stage of renal pathology is commonly active. In uraemic coma passive posture of the patients is observed. In paranephritis the patient assumes forced posture: lying on affected side with flexed leg, bringing the knee to the abdomen (right leg – in right-sided paranephritis, left leg – in left-sided). During the renal colic the posture of the patient is also forced: he is restless, tosses in the bed, try to find posture that can relieve pain, groans or even cries from pain.

Skin is pale, waxy due to anemia and spasm of skin arterioles by edematous fluid. In renal failure dryness of the skin can be detected. It is possible to observe scratches on the skin in consequence of itch. The skin of the face, neck and hands may be of dirty-gray color due to urochromes formation in the skin. In uraemia unpleasant smell of ammonia is felt from the mouth and skin of the patient.

Face of the renal patient has peculiarities. Facies nephritica – is swollen, pallid face with edematous and narrowed eye-slits.

Renal edema. Development of edema of renal origin is quite specific (Fig.1). Initially edema appears on the face in the morning, has descending character, and can develop very quickly (in few hours). Edema spreads on extremities, loin region, then fluid accumulates in cavities (ascitis, hydrothorax, hydropericardium), and general edema (anasarca) can arises. The skin over edema is glossy. Renal edema should be differentiated from cardiac edema (Tab. 1.7).

Fig. 1.1. Facies nephritica

Tab. 1.7. Symptomatic features in the differential diagnosis of renal and cardiac edema

Features	**Renal edema**	Cardiac edema
Location, character	Descending character, starts from the face and spreads downward	Ascending character, starts from low extremities and spreads upward
Time of arising	More pronounced in the morning	More pronounced in the evening
Colour of the skin	Pallor	Cyanotic
Temperature of the skin over edema	Warm	Cold

Inspection of the loin region and abdomen usually not allows determining any changes. Only in paranephritis and considerable tumor of the kidney protrusion of abdominal wall or loin on the corresponding side is detected. In overfilled bladder due to retention of urine, protrusion in suprapubical region is revealed.

PALPATION

Kidneys are not usually palpable because of their posterior extraperotoneal location; anterior approach is interfering by the costal arch. Normal kidneys may be palpable in thin persons with well-relaxed prelum, and in nephroptosis. To palpate kidneys it is possible only in considerable their enlargement (at least 1,5-2 times). Causes of unilateral kidney enlargement include hydronephrosis, formation of cyst or tumor. Bilateral enlargement of the kidneys suggests polycystic diseases. The kidneys may also be palpable in cases of their displacement by tumor, or in cases with a floating kidney.

Palpation of the kidneys according to Obraztsov-Strazhesko

The patient should be in lying posture with stretched legs, and placed on the chest arms (Fig. 1.2). Sit by the right side of the patient.

During palpation of the right kidney, place your left hand on the patient's loin just below and parallel to the 12th rib so that the fingertips are near the spinal column. During palpation of the left kidney move your left hand to the patient's left lumbar region. Place your right hand on the abdomen just below corresponding costal arch, lateral and parallel to the rectus abdominis muscle. Ask the patient to relax the abdominal muscles and to breathe deeply and regularly. With each expiration press by right hand firmly and deeply to reach the posterior wall, while lift your left hand, trying to displace the kidney anteriorly. Try to "capture" the kidney between your two hands. Ask the patient to breath deeply by "the abdomen". If kidney is slightly descended or enlarged, the lower pole of the kidney in inspiration reaches the fingers of your right hand to slide back into its expiratory position. Slightly press kidney toward posterior abdominal wall and slide over the anterior surface of the kidney bypassing its lower pole.

Fig. 1.2. Palpation of the right kidneys in lying posture.

The left kidney is rarely palpable. If the kidney is palpable, describe its shape, size, surface, tenderness, consistency, and mobility.

The right kidney, if it is located more anteriorly, must be distinguished from the liver. The liver edge extends farther medially and laterally; it cannot be capture. The lower edge of the liver tends to be sharper, the lower pole of the kidney is rounded. The kidney must also be distinguished from overfilled large intestine, tumor of pararenal cellular tissue (lipoma, fibroma), gall bladder, or displaced spleen, with which it is sometimes confused.

In contrast to these organs, enlarged or ptosed kidney tosses up by ballottment – so-called Guyon's symptom. When you capture the kidney, by the left hand strike rapidly in the loin region, by the right hand try to feel vibration of the kidney. Guyon's symptom is considered to be positive if you feel this vibration. Enlarged, due to accumulated urine or pus, kidney can give fluctuation in palpation.

Palpation of the kidneys according to S. Botkin

Sit on a chair, patient should stand facing you with slightly inclined toward trunk (Fig. 1.3).

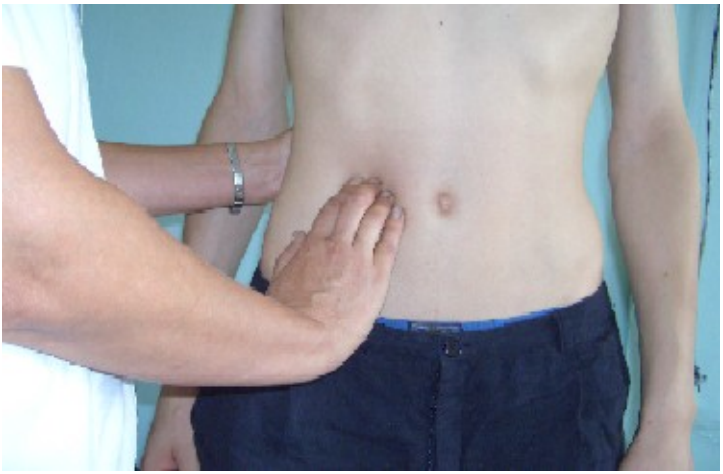

Fig. 1.3. Palpation of the right kidneys in standing posture.

During palpation of the right kidney, place your left hand behind the patient parallel to the 12th rib, with your fingers just reaching the costovertebral angle. Right hand place parallel to the lateral edge of the right rectus muscle, with your fingertips just reaching the costal arch.

During palpation of the left kidney, place your right hand in the lumbar region just below and parallel to the 12th rib. Left hand place parallel to the lateral edge of the left rectus muscle.

During relaxation of abdominal muscles in expiration press by both hand as close to each other as possible. Ask the patient to inspirate deeply by "the abdomen". The kidney descends, try to capture it between your two hands and slide over the surface.

Palpation is used to diagnose ptosis of the kidneys. Three degrees of the *nephroptosis* are differentiated (Fig. 1.4):

I degree – **palpable kidney** (Ren palpabilis): the lower pole of dense elastic consistency, rounded, and tenderness is palpated;

II degree – **movable kidney** (Ren mobilis): the entire kidney is palpated, it freely moves, but do not displaced on the opposite side of the abdominal cavity;

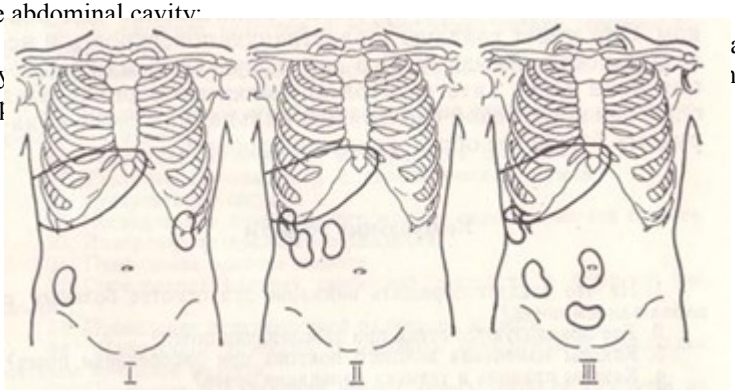

Fig. 1.4. Nephroptosis degrees.

Enlarged due to tumor kidney is dense, tubercular, slightly mobile, and Guyon's symptom is positive.

PERCUSSION

Percussion of the kidneys has no diagnostic significance, because dullness over them can only be determined in pronounced enlargement of these organs. Normally, it is impossible to percuss kidneys as the intestine that gives tympany covers them.

Percussion is used in a form of tapping. Pasternatsky proposed this method mainly for establishing nephrolithiasis.

Pasternatsky's symptom

Place your left hand in the costovertebral angle and moderate strike it with the ulnar surface of the right hand palm (Fig. 1.5).

Pasternatsky's symptom is considered to be positive, if the patient feels pain in tapping. In a normal healthy person the kidneys are painless in tapping – negative Pasternatsky's symptom. Pain with percussion in the costovertebral angle suggests nephrolithiasis, paranephritis, annd inflammation of the pelvis. It should be remembered that this symptom might be positive in myositis and radiculitis that decrease its diagnostic value.

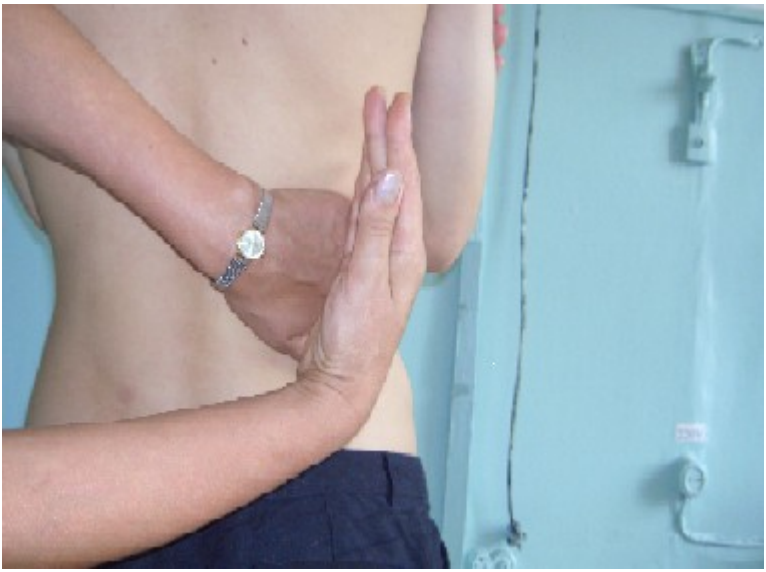

Fig. 1.5. Pasternatsky's symptom.

LABORATORY METHODS

The investigation of the patient with suspected renal disease usually requires assessment of both structure and function of the kidneys. Structural evaluation includes imaging studying and microscopic examination of tissue samples acquired by biopsy. Function is assessed by examination of urine and biochemical determinations on plasma samples.

Clinical blood analysis

Syndrome of acute renal failure and chronic renal failure are characterized by anemia, erythropenia, leukocytosis, and increase of accelerated ERS

Biochemical blood analysis

Nephritic syndrome: hypoproteinemia (the level of protein less then 60 g/l; albumines 20-30 % with α- and β-globulines increase); hypercholisterinemia (more then 6,6 mmol/l).

Chronic renal failure: increase of creatinin and ammonium levels, hyperuricemia (non-constant sign). Blood electrolytes detection: – decrease of sodium and calcium concentration, the level of chloral normal or decreased, the level of potassium normal or increased, concentration of magnum and phosphorus increased. Specific is development of metabolic acidosis.

Determination of the glomerulus's filtration rate:

– method of Galt-Cockroft – calculation by formula, where:

$$\text{Creatinin clearance} = \frac{140 - \text{age (years)} \times \text{weight (kg)}}{\text{Creatinin in plasma (mmol/l)} \times 810}$$

Decrease of glomerulus's filtration – is the earliest sign of renal failure.

INSTRUMENTAL METHODS

Ultrasonography. This is now the initial investigation for the m
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Fig.1.6 Renal ultrasonography, signs of chronic pyelonephritis.

Tissue density is the major determinant of acoustic impedance and when sound waves are passed into tissues of widely different acoustic impedances most of the waves are reflected, for example tissue/gas 99 per cent echo, tissue/bone 70 per cent echo. Fat is highly reflective and thick subcutaneous tissues lengthen the distance from the probe to the kidney, making ultrasonography difficult and occasionally impossible in obese patients.

Fig.1.7 Renal ultrasonography, renal stone

Ultrasound findings are independent of renal function. They can therefore be used to study patients with renal failure, measuring with considerable accuracy the shape, depth from the surface, and internal architecture of the kidney and upper urinary tract. Ultrasound generally detects the dilated calyces, pelvis, and ureter of the obstructed kidney, although in the presence of very recent obstruction the calyceal system may not have dilated sufficiently to make a firm diagnosis on ultrasound, and other investigations such as retrograde ureterography may be necessary. In unexplained renal failure, ultrasound is very useful to assess renal size and cortical thickness, with the presence of small kidneys suggesting chronic renal disease and enabling the renal physician to make appropriate decisions about whether or not renal biopsy is indicated.

Ultrasound is often helpful in identifying the cause of abnormalities detected on the IVU. It may show whether an enlarged kidney is the site of hydronephrosis, an infiltrative process, or a space-occupying lesion. It is particularly useful in deciding whether a localized swelling detected on IVU is cystic (and probably benign) or solid (and probably malignant). However, solid lesions may undergo some cystic change and therefore if a cystic lesion is not absolutely classical (unilocular, uniformly thin walls) then further investigation is indicated. This may be by CT scanning, MRI, invasive cyst puncture, or biopsy.

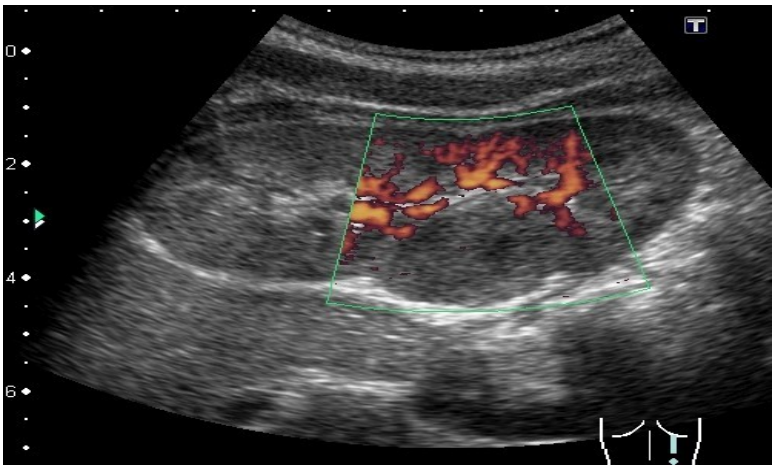

Fig.1.8 Color Doppler of renal

Ultrasonography has replaced excretion urography as the screening test for polycystic disease; the two techniques are comparable in accuracy but ultrasonography is faster, cheaper, and devoid of the risk of contrast injection and irradiation. However, cysts and tumours below 5 mm in diameter are not detected reliably by either ultrasound or excretion urography so polycystic disease cannot be excluded with certainty below the age of about 30 years.

Perinephric lesions are readily displayed by ultrasound; it is used to detect extravasation of blood after trauma or renal biopsy, although CT scanning may provide more accurate information in this regard. Ultrasonography is the first test for radiolucent calculi; it is also used for detecting radio-opaque calculi, but straight radiography remains the first investigation.

Finally, ultrasound is very useful in the assessment of complications of renal transplantation, particularly the surgical complications of extrarenal collections of blood, pus, and lymph, and in the identification of an obstructed transplant kidney. An ultrasound-guided percutaneous nephrostomy can then allow temporary decompression of the obstruction. Doppler ultrasound may have a limited role in the diagnosis of vascular rejection of the transplanted kidney, but at this stage cannot reliably distinguish acute tubular necrosis and cyclosporin nephrotoxicity from acute rejection.

Plain radiography of the urinary tract. A plain radiograph of the kidneys, ureters, and bladder is an essential preliminary to urography (Fig.1.9). It is often possible to trace the renal outlines and measure the renal size. The left kidney is normally about 1cm longer than the right. The length should be recorded in centimetres for comparison with subsequent films. The other main function of a plain abdominal film is to detect calcification in the kidneys or radiopaque calculi in the ureters or bladder, which may be obscured in the subsequent pyelogram. Oblique views and films taken in inspiration and expiration may be necessary to confirm that suspected calculi are in kidneys. The film may yield other diagnostic information; gallstones are often detected and renal osteodystrophy or myelomat

Fig.1.9 Plain radiograph of the kidneys, ureters. renal and ureters stone

Excretion urography (synonyms: intravenous pyelography; IVP; IVU). The older hyperosmolar contrast media, such as diatrizoate and metrizoate, are now being replaced in many centres by low osmolar, non-ionic compounds such as iopamidol and iohexol. The contrast medium is excreted almost entirely by glomerular filtration. A film at 1min after injection gives the best view of renal outlines, with contrast concentrated in the tubules (the nephrogram). Later images, from 2.5 to 30 min will show excretion of contrast into the collecting system (the pyelogram). If calyceal detail is not adequately visible the pelvis and calyces may be distended by applying compression over the lower ureters with an abdominal belt. A film immediately after release of compression will provide detail of ureteric filling. Pre- and postmicturition films of the bladder will provide information on prostatic indentation, space-occupying lesions, and the presence of bladder diverticula and will assess bladder emptying. However, in many centres ultrasound has replaced the IVU for assessment of prostatic volume, bladder capacity, and residual urine volume. Impaired renal function will cause a delayed pyelogram and extra films will need to be taken as late as 12 to 24 h in this situation or in the presence of severe obstruction.

The IVU is clearly the best choice for anatomical detail and filling defects of the collecting system, but it has been largely replaced by ultrasound and computed tomography (CT) scanning for the investigation of abnormalities of renal anatomy, and by nuclear renal scanning or angiography for the investigation of renovascular hypertension.

Retrograde pyelography/ureterography. This technique is very useful for determining the site of complete obstruction to a ureter

and for visualizing the ureter distal to the obstruction. It is particularly useful in cases of poor renal function where the kidneys and ureter show poor opacification on the IVU. A cystoscopy and anaesthetic is required and contrast is injected through a ureteric catheter. If an obstruction, such as sloughed papillae or epithelial tumour, is shown, then the catheter may be left in situ as a temporary drain pending surgery. Complications of the procedure include renal colic, temporary ureteric obstruction from mucosal oedema, infection, and intrarenal or extrapelvic extravasation of contrast.

Renal arteriography. The renal arteries may be opacified either by intra-arterial injection or by peripheral intravenous injection of contrast medium. The latter requires larger doses of contrast and the quality of images obtained is often not sufficient to allow accurate evaluation of renal artery branches and intrarenal vessels. Intra-arterial injection is therefore the preferred method, but is an invasive procedure with a greater risk, including contrast nephrotoxicity, than urography, ultrasound, or nuclear renal scanning. It is performed by retrograde femoral catheterization under local anaesthesia. The narrow catheters now used have reduced the local complication rates substantially, often enabling patients to be discharged from hospital on the same day.

Contrast medium is injected rapidly into the aorta at the level of the renal arteries. Selective catheterization of the renal arteries is often required to evaluate the intrarenal vasculature, particularly in renal tumours and in assessment of living renal transplant donors. Digital techniques have now largely replaced standard angiographic imaging, allowing subtraction of superimposed tissue and contrast enhancement. Digital angiography also allows the use of 50 per cent lower doses of contrast medium, lower flow rates, and smaller catheters.

Current indications for renal arteriography are limited, as refinements of less invasive procedures such as CT scanning and ultrasound may provide appropriate information. The chief use is in the evaluation of renovascular disease. If the renal artery stenosis is amenable to transluminal angioplasty, the dilatation (or renal artery stenting) can be performed at the same time as the arteriogram. Other indications include suspected renal artery occlusion from thrombus, embolus, dissection or trauma, screening for arterial aneurysms in the diagnosis of classical polyarteritis nodosa, and when an intrarenal vascular lesion is suspected, as in persistent haematuria following a renal biopsy. In the latter situation arteriography can confirm an arteriovenous fistula or false aneurysm, and renal embolization via an endovascular catheter at the same time will prevent further bleeding.

Renal angiography is always required in the surgical evaluation of the renal vasculature of potential live donors of kidney grafts. CT and magnetic resonance imaging (MRI) scanning have now largely replaced arteriography in the evaluation of renal tumours.

Renal venography. Few indications now remain for this procedure as new imaging techniques such as MRI and CT allow easier detection of renal vein thrombosis. However, an iliocavagram may be necessary to document caval extension of a renal vein thrombosis. Selective catheterization of the renal veins for renal vein renin levels in renovascular hypertension has now largely been replaced by the more reliable and quicker technique of nuclear renal scanning.

Computed tomography (CT scanning) of the trunk displays the kidneys particularly well in contrast to the surrounding perinephric and peripelvic fat. It can reveal abnormalities of the retroperitoneal and perirenal spaces that cannot be shown with conventional techniques. Contrast media used in CT scanning are the same as those used for intravenous urography.

The prime indications for CT scanning of the kidneys are to detect renal mass lesions and suspected renal trauma. Generally, simple renal cysts and polycystic renal disease can be equally well diagnosed with the cheaper technique of ultrasound. However, CT is the method of choice for the diagnosis of renal tumours, since it can confirm the solid nature of the tumour and allow determination of its local extension. Central calcification is very suggestive of a malignancy, as is contrast enhancement due to hypervascularity of the tumour. Extension of renal cell carcinoma has implications for prognosis and surgical intervention. CT is the best technique for documenting tumour thrombus in the renal veins. Lymph node involvement by tumour can be detected if the nodes are greater than about 1 cm in diameter.In renal trauma, CT scanning is clearly the best technique for demonstrating parenchymal damage, subcapsular haematoma, and perirenal urinary collections, as well as assessing damage to other organs such as the liver and spleen.

Finally, CT scanning is useful in the investigation of retroperitoneal fibrosis, which may be idiopathic or secondary to the use of drugs. The appearance of the fibrous plaque, which starts below the level of the aortic bifurcation and extends upwards, often enveloping the ureters, can usually be distinguished from lymphoma or sarcoma involving this region.

Magnetic resonance imaging (MRI) is a digital tomographic imaging system where tissue contrast depends on the manipulation of intrinsic magnetic fields. The technique employs a strong uniform

magnetic field combined with transient oscillating magnetic fields to create images without the use of ionizing radiation. MRI offers very superior soft-tissue contrast and the ability to distinguish easily simple renal cysts, complex cysts, and solid renal masses. Like CT scanning, it is particularly useful in detecting tumour (Fig.1.10) extension into veins. MRI angiography of the renal circulation is yet to be assessed but may have a future role in renovascular disease. Presently, MRI is mainly indicated to clarify equivocal CT findings in renal tumours.

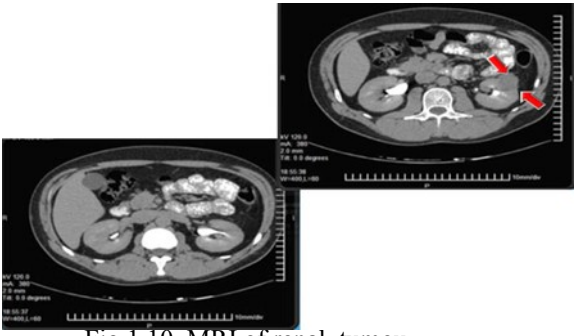

Fig.1.10. MRI of renal, tumou

Nuclear renal imaging. The value of radiolabelled tracers in the investigation of renal disease lies in the ability to obtain important information about organ function as opposed to the predominantly structural information obtained from the previously described imaging procedures. In particular, nuclear imaging of the kidneys provides the on dney function. to compounds tha excretion, or a co ompounds can th nctions of the ki

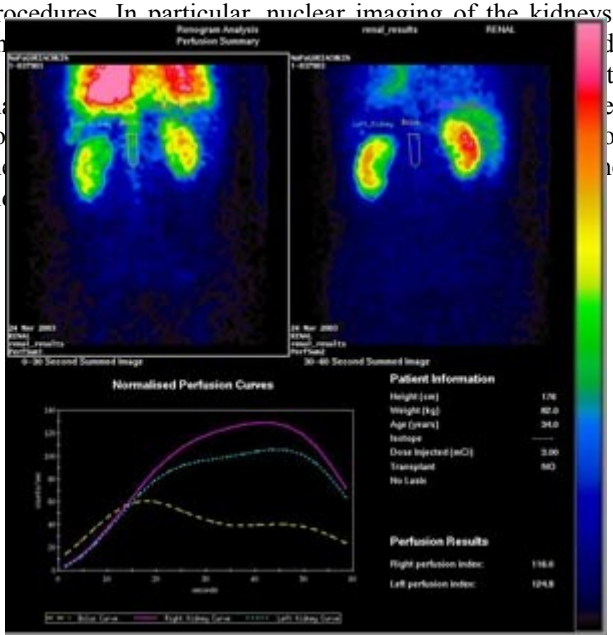

Fig.1.11. Nuclear renal imaging.

Tests

1. A 20-year old patient developed edema of the face, pain in the lumbar area 3 days after tonsillitis. Changes in the urine were revealed. Which system can be involved?
A. Nervous
B. Respiratory
C. Cardiovascular
D. Genitourinary
E. Digestive

2. A 50-year old patient has been suffering from kidney disease for 15 years. Examination revealed paleness, dryness of the skin, ammonia odor from the mouth, the pupils are narrow. What diagnosis can be supposed?
A. Uremia
B. Atropine poisoning
C. Myxedema
D. Thyrotoxicosis
E. Itsenko-Cushing syndrome

3. Morning edema of the face is typical in:
A. Pericarditis
B. Acute glomerulonephritis
C. Heart failure
D. Liver cirrhosis
E. Thyrotoxicosis

4. The patient, 19 years, the mechanic, complains of a blunt pain in right lumbar region, frequent urination, rising temperature up to 37,8◦C.

A condition become worth 2 days ago after overcooling. At the review a lumbar site symmetric, skin hyperemy, oedema are absent. Positive Pasternaysky symptom. Your previous diagnosis?
A. Acute pyelonephritis
B. Acute glomerulonephritis
C. Acute cystitis
D. Intercostal neuralgia
E. Nephrotic syndrome
5. The patient, 22 years, complains of face and eyelid oedema, general weakness, rise in temperature of a body up to 37,2 C. Anamnesis: was ill sharply, 2 weeks ago has carried quinsy. Inspection: face is pale, bloated, eyelid oedema, shins and fingers of hands. Arterial pressure is 140/95 mm hg. Pasternatsky symptom is negative from both sides. Your suggested diagnosis?
A. Acute pyelonephritis
B. Acute glomerulonephritis
C. Acute cystitis
D. Intercostal neuralgia
E. Nephrotic syndrome
6. Leukocyteuria is more typical for:
A. Tumor of urine bladder
B. Paranephritis
C. Pyelonephritis
D. Acute glomerulonephritis
E. Renal amiloidosis
7. Presence of unchanged erhythrocytes in urine is typical for the patients with:
A. Acute pyelonephritis
B. Chronic pyelonephritis
C. Glomerulonephritis
D. Nephrotic syndrome
E. Urethritis
8. Positive Pasternatsky' syndrome is typical for the patients with:
A. Acute glomerulonephritis
B. Chronic glomerulonephritis
C. Uremia
D. Cystitis
E. Renal colics
9. For the patients with chronic

glomerulonephritis is typical following changes in the urine:

A. Leukocyteuria and proteinuria

B. Cylindruria and leukocyuria

C. Hematuria and leukocyteuria

D. Proteiunuria and hematuria

E. Leukocyteuria and hematuria

10. Polyuria is ?

A. arbitrarily defined as the production by an adult of less than 500 ml of urine/24 h.

B. traditionally defined as frequent, more than 6 times a day, urination.

C. defined as complete absence of urine secretion and/or excretion.

D. describes the excretion of larger than normal volume of urine (exceed 2l/24 h).

E. is defined as passing of more than one-third of the total 24-h urine volume by night.

12. The patient, 22 years, complains of face and eyelid oedema, general weakness, rise in temperature of a body up to 37,2 C. Anamnesis: was ill sharply, 2 weeks ago has carried quinsy. Inspection: face is pale, bloated, eyelid oedema, shins and fingers of hands. Arterial pressure is 140/95 mm hg. Pasternatsky symptom is negative from both sides. Your suggested diagnosis?

A. Acute pyelonephritis

B. Acute glomerulonephritis

C. Acute cystitis

D. Intercostal neuralgia

E. Nephrotic syndrome

Tests: 1D, 2A, 3B, 4A, 5B, 6C, 7C, 8A, 9B, 10 D.

Methodical instructions

MAIN CLINICAL, LABORATORY AND INSTRUMENTAL METHODS OF KIDNEYS EXAMINATION

Methodical instructions for students

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