ODESSA NATIONAL MEDICAL UNIVERSITY

Department of Radiation Diagnostics, Therapy, radiation medicine and Oncology

METHODICAL RECOMMENDATIONS FOR STUDYING THE TOPIC:

«Methods of radiological examination and radiological anatomy of the CNS. Radiological signs of the CNS pathology and injury.»

(for 2nd year students of the medical faculty)

Approved
at the methodical meeting of the departmer
on «30» August 2022
Protocol No.1
Department Head______ Sokolov V. M.

ODESA - 2022

"Radiation methods of research and radiation anatomy of the central nervous system. Radiation signs of diseases and injuries of the central nervous system." - 2 h.

1. **Relevance of the topic.**

Modern research of the central nervous system is not limited to classical X-ray examination. Scientific and technological progress contributed to the development and introduction into medical practice of new highly informative methods of instrumental research, which raised the diagnosis of diseases of the brain and spinal cord to a new qualitative level. On the basis of the achievements of physi electronics, mathematics, installations for CT, emission and positron tomography, NMR and advanced ultrasound devices were developed.

The study of this topic is based on the knowledge of the physical and technical foundations of modern methods of radiation research and the anatomy and physiology of the central nervous system.

1. It should be emphasized that the choice and correct application of various radiation methods allows one to accurately distinguish the nature of various diseases of the central nervous system, especially in the early stages of the pathological process, to assess the effectiveness of treatment, and to plan radiation therapy.

2. Objectives of the lesson:

2.1. Common goals:

- to distinguish normal radiation anatomy of the central nervous system from pathological;
- choose a method of radiation research for various pathologies of the central nervous system
- draw up an algorithm for radiation examination for various pathologies of the central nervous system

2.2. Educational purposes:

- to get acquainted with the contribution of domestic scientists to the study of diagnostics of diseases and injuries of the central nervous system. To be able to explain to the patient the need for this or that radiation examination.

2.3. Specific goals:

- ***to know, learn***:
- how to choose a method of radiation research for various pathologies of the central nervous system
- be able to draw up an algorithm for radiation examination for variou pathologies of the central nervous system.

2.4. Based on theoretical knowledge on the topic,

- master:

- to distinguish normal radiation anatomy of the central nervous system from pathological;

- to analyze the radiation symptoms of diseases of the central nervous system
- to evaluate the results of the used method of radiation examination of the central nervous system.

2. Classroom self-study materials (interdisciplinary integration).
3.

№№ п.п.	Disciplines	To know	Be able to
1	**2**	**3**	**4**
I	1. Biological physics	Physical and technical foundations of the X-ray method, CT, ultrasound, MRI.	Use protective measures when conducting radiation research methods.
	2. Normal anatomy	Normal anatomical structure of the skull, spinal column, brain, spinal cord.	Describe the normal anatomical structure of the skull, spinal column, brain, spinal cord.
	3. Normal physiology	Functional features of the spine and spinal cord, brain.	Determine the functional features of the spine and spinal cord, brain.
II	1.Propaedeutics of internal diseases	Pathological process. Methodology for collecting anamnesis. The most common syndromes in the general pathological process.	Analyze the pathological process. Take anamnesis. Establish the main syndrome in the general pathological process.
	2. General surgery	Typical clinical signs of traumatic brain and spinal cord injuries.	To identify the characteristic clinical signs of traumatic injuries of the brain and spinal cord.
	3. Neurosurgery	Typical clinical signs of traumatic brain and spinal cord injuries.	To identify the characteristic clinical signs of traumatic injuries of the brain and spinal cord.
	4. Neurology	Typical clinical signs of traumatic brain and spinal cord injuries.	To identify the characteristic clinical signs of traumatic injuries of the brain

			and spinal cord.
III	Intra-subject integration: Radiology Radiation medicine	X-ray methods of pre-examination, CT, MRI, angiography, ultrasound. Dosimetry and methods for collecting ionizing treatment.	Choose the right research methods. Be able to use ionizing radiation protection devices.

4. Content of the topic:

Radiation anatomy of the central nervous system

Non-contrast techniques for examining the skull are quite informative and allow you to study the shape, size, shape and structure of the bones of the skull, to identify pathological changes in it.

In the skull, two sections are distinguished - the bones of the skull itself and the face.

The former form a cavity that contains the brain. The upper (vault) and lower (base) parts of the skull are also distinguished. The outer plate of the cranial vault is smooth; in children and young people, seams are clearly traced on it. The inner lamina is uneven, its relief is determined by finger presses - imprints of cerebral twists, grooves of the middle meningeal artery and venous sinuses. The granulation fossae are located parallel to the sinuses.

The inner and outer surfaces of the skull base have a complex relief. On the inner basis are the anterior, middle and posterior cranial fossa.

Non-contrast spondylograms allow you to obtain diagnostic information about the state of the vertebrae, intervertebral discs, as well as the bone canals formed by the vertebrae.

The vertebral column is made up of vertebrae and intervertebral discs that are joined together by joints and ligaments. In the vertebral column itself is the spinal canal, which continues directly into the cavity of the cerebral cranium, and which contains the spinal cord with membranes and vessels. In accordance with th anatomical and functional features, the spine is divided into five sections:

- cervical;
- chest;
- lumbar;
- sacral;
- coccygeal.

A characteristic feature of the spinal column is its bends. In the spine of an adult, there are four of them in the sagittal plane:

two anteriorly - lordosis (cervical and lumbar)

two posteriorly - kyphosis (thoracic and sacrococcygeal).

All true vertebrae, with the exception of the first two cervical vertebrae, are built in the same way - they have a body and an arch. The arches bear articular, transverse and spinous processes.

The cranial and caudal surfaces of the adjacent vertebral bodies are covered with hyaline cartilage plates, between which the intervertebral discs are located. In the middle thoracic region, they are 1/6, in the upper and lower thoracic regions - 1/5, in the cervical - 1/4, and in the lumbar - 1/3 of the total length of these sections, that is, the more mobile the section, the higher the discs.

The process of forming the spine is very complex. It goes through thr successive stages - membranous, cartilaginous and bone. At the time of birth, there are three centers of ossification of the vertebrae, separated by large cartilaginous layers. Within 1-2 years of a child's life, each half-arc becomes ossified, forming transverse and articular processes. Up to three years, both half-arcs are connected, forming a spinous process at the confluence. The arcs of the sacral vertebrae merge later - at 10-14 years old, at 16-17 years old, all vertebrae ossify.

In the elderly, degenerative-dystrophic changes in the vertebral bodies, intervertebral discs and joints are often observed.

Features of ultrasound images of the brain of infants.

The image of the brain structures during ultrasound scanning is studied at standard levels in the coronary (frontal), sagittal and axial planes.

Of course, for a complete understanding of the state of the brain structures or to clarify the pathological process, it is necessary to obtain a complete set of ultrasound images in all three planes.

The differentiated image of the anatomical structures of the brain is due to their different echogenicity, which largely depends on the physical and technical conditions of scanning, the state of the brain parenchyma, as well as the amount of fluid in its hollow formations.

The bones of the skull are hyperechoic because they have the highest acoustic impedance and reflect more ultrasound waves. They are depicted as bright stripes of the corresponding shape.

Cerebrospinal fluid gives an anechoic (dark) image. The parenchyma of the cerebral hemispheres and cerebellum give an image that has approximately the same range of gray tones - structures of medium echogenicity. The cerebral structures of high echogenicity include the grooves of the brain, the longitudinal slit with the cerebral sickle, the cerebellar tent and the cerebellar worm, and the intraventricular vascular plexus.

Internal carotid arteries and their branches (cerebral arteries) are visualized as linear or circular pulsating structures of increased echogenicity. The veins of the brain do not pulsate, and therefore they can only be determined using Doppler ultrasonography.

CT scan of the spine and spinal cord.

The vertebrae on axial CT scans have a high optical density in relation to the surrounding soft tissues of the skeleton and spinal cord. The image of the vertebrae changes according to the slice level. The dura mater of the spinal cord appears as a smooth, thin strip of increased density. The spinal cord looks like an ellipsoidal homogeneous structure with a slight increase in optical density compared to cerebrospinal fluid. Therefore, the spinal cord on unenhanced CT scans is detected only when it is surrounded by a sufficiently thick layer of cerebrospinal fluid.

The intervertebral discs normally have the smallest height (~ 3mm) in the cervical spine, and the largest (5-7mm) in the lumbar. They gradually increase in the cranio-caudal direction. On CT, the gelatinous (pulpous) nucleus does not differ from the annulus fibrosus and hyaline plates. The ligamentous apparatus is also not differentiated.

MR anatomy of the spine and spinal cord.

The MRI image of the spinal column depends mainly on the signal from the bone marrow.

The spongy substance of the vertebral bodies gives a high, at times inhomogeneous signal. The vertebral arches and articular processes give a signal of medium intensity.

Intervertebral discs on T1 weighted images give a signal of medium intensity. The anterior and posterior longitudinal ligaments of the spine and the dura mater, like the cortical substance of the vertebrae, do not give a signal.

The spinal cord is better visualized on sagittal MR slices. On T1 weighted images, it produces a high intensity signal that is clearly distinguished from a low signal from the spinal cord. A gradual increase in the diameter of the spinal cord from the level of C3 to Th2 of the vertebra and from T9 to L2 is well defined, where the roots of the brachial and lumbar plexuses branch off, respectively.

MR - angiography. Recently, a non-invasive non-contrast magnetic resonance imaging study of cerebral vessels (MR-angiography) has been developed. With the help of MRI programs (3D), it is possible to obtain not only an image of blood vessels in three standard projections, but also their volumetric reconstruction. The latter allows you to examine the vessels from different angles, which greatly facilitates the recognition of small changes and lesions.

Radiation diagnosis of diseases of the central nervous system.

The choice and sequence of application of various methods of radiation research is determined by clinical data.

Рентгенологические методики исследования ЦНС.

С помощью бесконтрастных методик рентгенологического исследования удается получить необходимую информацию о конфигурации, размерах черепа, толщине костей, сосудистых изменениях, аномалиях развития, патологических процессах в полости черепа и краниовертебральном участке.

При выборе проекции для рентгенографии за ориентиры принимают основные плоскости черепа (сагиттальная, горизонтальная, фронтальная) и костные анатомические образования.

Обзорная рентгенография черепа {краниография) проводится в трех взаимноперпендикулярных проекциях: прямой (передний, задний), боковой (правой, левой), аксиальной (теменной, подбородочной).

Рентгенография черепа в прямой проекции может быть выполнена как с задне- передним, так и с передне-задним направлением рентгеновских лучей. В рентгенологической практике чаще используют прямую переднюю проекцию: больного кладут ничком на стол, сагиттальной и горизонтальную плоскость черепа ориентируют точно перпендикулярно плоскости кассеты, а центральный рентгеновский луч направляют на внешний затылочный выступ. Такое положение не рекомендуется для обследования детей младшего возраста и тяжелобольных. В этом случае краниография может быть выполнена в прямой задней проекции, при которой больной лежит на спине, прилегающие затылком к кассеты, фронтальная плоскость черепа направлена перпендикулярно к ней, на уровне надбровных дуг. Чаще всего данную проекцию используют для диагностики травматических повреждений черепа.

Во время выполнения рентгенографии черепа в боковой проекции больного кладут на живот, голову поворачивают в сторону таким образом, чтобы сагиттальная плоскость располагалась параллельно плоскости кассеты, центральный рентгеновский луч направляют перпендикулярно ей на проекцию турецкого седла.

После анализа основных обзорных рентгенограмм при необходимости выполняют и дополнительные.

Полуаксиальные проекции (переднюю, заднюю) применяют для раздельного исследования переднего (лицевого) и заднего (затылочного) отделов черепа. При этом его фронтальная плоскость располагается под углом 45 ° относительно плоскости кассеты. Дополнительные обзорные рентгенограммы, выполненные под другими углами фронтальной плоскости головы относительно плоскости пленки, получили названия носо-лобной, носо-подбородочной и затылочной согласно анатомических образований, прилегающих к кассете. В этих проекциях изучают состояние дна передней, средней и задней ямок черепа: спинки турецкого седла, каменистой части височных костей.

Стоит заметить, что краниография дает лишь приблизительное представление о состоянии содержания черепа - головного мозга, оболочек, сосудов. Для изучения состояния сосудистой и ликворной систем применяют более сложные рентгенологические методики исследования с искусственным контрастированием сосудов и ликворных пространств головного мозга.

X-ray techniques for studying the central nervous system.

Using non-contrast methods of X-ray examination, it is possible to obtain the necessary information about the configuration, size of the skull, bone thickness, vascular changes, developmental anomalies, pathological processes in the cranial cavity and craniovertebral area.

When choosing a projection for radiography, the main planes of the sku (sagittal, horizontal, frontal) and bone anatomical formations are taken as landmarks.

Plain radiography of the skull (craniography) is performed in three mutually perpendicular projections: direct (anterior, posterior), lateral (right, left), axial (parietal, chin).

X-ray of the skull in frontal projection can be performed with both anterior-anterior and anteroposterior direction of X-rays. In X-ray practice, a direct front projection is often used: the patient is placed prone on the table, the sagittal and horizontal planes of the skull are oriented exactly perpendicular to the plane of the cassette, and the central X-ray beam is directed to the external occipital protuberance. This position is not recommended for examining young children and seriously ill patients. In this case, craniography can be performed in a direct posterior projection, in which the patient lies on his back, adjacent the back of the head to the cassette, the frontal plane of the skull is directed perpendicular to it, at the level of the eyebrows. Most often, this projection is used to diagnose traumatic skull injuries.

During the X-ray of the skull in the lateral projection, the patient is placed on his stomach, the head is turned to the side so that the sagittal plane is parallel to the plane of the cassette, the central X-ray beam is directed perpendicular to it to the projection of the Turkish saddle.

After analyzing the main plain radiographs, additional ones are performed, if necessary.

Semi-axial projections (anterior, posterior) are used for separate examination of the anterior (facial) and posterior (occipital) parts of the skull. In this case, its frontal plane is located at an angle of 45 ° relative to the plane of the cassette. Additional survey radiographs, performed at different angles of the frontal plane of the head relative to the plane of the film, were named naso-frontal, naso-chin and occipital according to the anatomical structures adjacent to the cassette. In these projections, the state of the bottom of the anterior, middle and posterior fossae of the skull is studied: the back of the sella turcica, the stony part of the temporal bones.

It is worth noting that craniography gives only an approximate idea of the state of the contents of the skull - the brain, membranes, vessels. To study the state of the vascular and cerebrospinal fluid systems, more complex X-ray research methods are used with artificial contrasting of the vessels and cerebrospinal fluid spaces of the brain.

X-ray examination of blood vessels and cerebrospinal fluid system.

Cerebral angiography allows consistently monitoring the phases of cerebral circulation and recognizing pathological changes in the vessels of the brain (abnormalities, thrombosis, hemorrhages) and plays an important role in the diagnosis of tumors of this localization.

The brain is supplied with blood by branches of the internal carotid and vertebral arteries. Therefore, contrasting of its vessels is usually carried out using the external carotid (carotid angiography) or vertebral arteries (vertebral angiography). In clinical practice, carotid angiography is more commonly used. The study is carried out under local anesthesia. After percutaneous puncture, 10-12 ml of a contrast agent (gipak, urografin, verografin, etc.) heated to body temperature is injected into the external carotid artery with a special injector. Radiographs are taken sequentially with an interval of 1-1.5 s, which makes it possible to trace the arterial, capillary and venous phases of angiography. Research is facilitated by the use of a seriograph, which allows you to instantly perform radiographs in two projections at a speed of 2-6 images per second.

In recent years, Seldinger selective angiography has become widespread - by percutaneous puncture of the femoral artery. The passage of the probe into the main vessels of the head is carried out under the control of fluoroscopy. This technique allows you to study individual vascular regions of the brain.

Contraindications to cerebral angiography are hypersensitivity of the patient to iodine-containing drugs, pronounced atherosclerosis, accompanied by an increase in blood pressure. In children, angiography is used only for strict indications: for suspected brain tumors, certain vascular diseases, and sometimes for skull injuries.

The cerebrospinal fluid system of the brain consists of intracerebral cavities and subarachnoid space.

Ventriculography is based on filling the voids of the ventricular system of the brain with a high-atomic radiopaque substance. This technique provides high radiopacity and does not increase intracranial pressure, which makes it possible to use it in the diagnosis of pathological processes accompanied by intracranial hypertension (occlusive hydrocephalus, tumors, etc.). Now, due to the use of computed tomography and MRI, ventriculography is performed very rarely.

X-ray examination of the spine and spinal cord.

Clinical diagnosis of spinal cord diseases is based on a comprehensive assessment of the dynamics of the disease, neurological symptoms, data of liquorological and radiological studies: survey spondylography, contrasting of the spinal subarachnoid space and the vascular system using various techniques, computed tomography, magnetic resonance imaging.

The examination of patients always begins with a plain radiography of the spine (spondylography) in two mutually perpendicular projections. If necessary, spondylograms are performed in oblique projections, as well as sighting radiographs or tomograms at the level of the alleged localization of the pathological process.

To study the state of the intervertebral discs, the spinal cord and its roots, it is advisable to use the axial CT scan of the affected segments. MRI is informative for the study of the structures of the spinal canal. Given this, X-ray contrast studies have lost their relevance.

The choice of additional methods for assessing pathological changes in the spine and spinal cord depends on two factors: clinical symptoms and the availability of modern research methods.

Selective spinal angiography reveals the features of blood circulation in various pathological changes in the spinal cord. The technique is especially informative for arteriovenous spinal aneurysms and spinal cord tumors. When contrasting the vessels of its cervical spine, the transfemoral retrograde pathway is used according to the Seldinger method. Depending on the purpose of the study, selective contrasting of the branches of the subclavian arteries is carried out. When examining the vessels of the thoracic and lumbar spinal cord, catheterization and contrasting of the intercostal or lumbar arteries are used. The subtraction method is used to improve the contrast of the image.

CT and MRI studies of the brain.

Computerized X-ray (CT) and magnetic resonance imaging (MRI) of the head can be performed at any age, but only if the patient is in a calm (motionless) position for a considerable time (from 30 to 40 minutes). Therefore, children and agitated patients are given sleeping pills and sedatives.

Computed tomography of the skull is performed in bone mode in the axial or frontal plane. Depending on the area of study, the number of sections and their thickness (from 1 to 0.2 cm) are determined. A complete head examination consists of 12-17 sections, depending on their thickness. Sometimes, to obtain additional information about the lesion focus, the contrast enhancement technique is used: the subject is injected with a water-soluble contrast agent intravenously or endolumbar.

To study the structure of the skeleton of the head, a special bone study mode and the corresponding visualization window are used. In this case, dense (light) end plates and a less dense (dark) spongy diploitic substance of the skull bones are well defined, which are surrounded by a loose (dark) soft tissue covering of the head.

Magnetic resonance imaging allows you to obtain a differentiated image of the soft structures of the brain and spinal cord, in particular gray and white matter, blood vessels, nerve roots in all three spatial dimensions, which makes this method of radiation research a leading role in the diagnosis of cerebral lesions.

MRI examination of the brain is performed in different sequences on T1, T2 weighted images and proton density. Special programs and research protocols are used, and, if necessary, contrasting with paramagnets (Omniscan, Magnevist).

CT and MRI studies of the spine and spinal cord.

In CT, the structure of the bodies and arches of the vertebrae is studied in bone mode. To study discs, spinal cord, nerve ganglia and roots, the study is performed in soft tissue mode.

For MRI of the spinal cord, the standard T2 weighted image is most often used.

Indications for MRI and CT are the presence of degenerative changes in the disc, herniated disc and body, metastases, tumors affecting the spinal column.

Ultrasound of the brain (neurosonography - NSG) is the main method f diagnosing CNS lesions in newborns and infants. This is a harmless method of radiation examination, does not require special drug preparation and can be applied regardless of the clinical condition and position of the infant.

Ultrasonography of the brain is possible only in newborns and infants, when there are still fontanelles in the cranial vault. In this case, the detector of the ultrasonic apparatus is installed above the front crown.

Indications for this study are gestational age up to 32 weeks, body weight up to 1500g, chronic intrauterine hypoxia, asphyxia in childbirth, the presence of seizures, micro- or macrocephaly, craniocerebral trauma, inflammatory diseases of the brain and meninges, suspicion of a tumor, anomalies development and some others. In adults, it is possible to use the A-method (echoencephalography), when the location of the median structures of the brain - its ventricles and trunk - is determined through the temporal bone. Doppler ultrasonography is used to examine the speed of blood flow in the vessels that feed the brain.

Radionuclide studies of the central nervous system.

In clinical practice, 4 methods of radionuclide studies of the central nervous system have been used:

1. Radioencephalography.
2. Encephaloangioscintigraphy.
3. Encephaloscintigraphy.
4. Myeloscintigraphy.

Radioencephalography.

Indications: identification and localization of a brain tumor; diagnosis of tumor recurrence after surgical or conservative intervention; identification and determination of the localization of cerebral infarctions, inflammatory processes and hemorrhages; screening test for suspected vascular abnormalities.

RFP: 99mTc-pertechnetata.

Equipment: multi-detector installations of the KPRDI-1, UR 1-3 type.

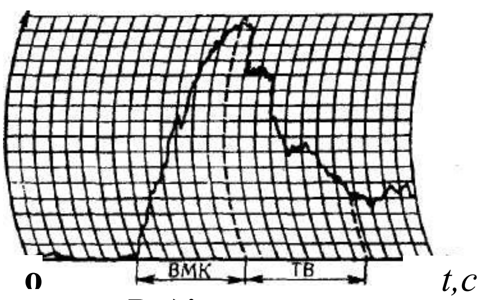
The principle of the technique: registration of the rate of passage of the RFP through the right and left hemispheres of the brain in order to determine the disorders of cerebral circulation.

Research methodology: the research is carried out with the patient lying or sitting. The detectors are installed over symmetrical areas of both hemispheres. After intravenous administration of a "bolus" RFP with an activity of 20-50 MBq, the recorders are immediately turned on.

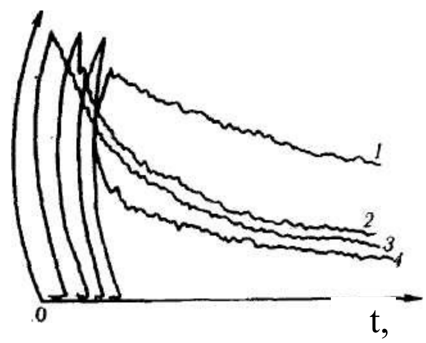
Qualitative interpretation of the radioencephalogram.

There are several types of curves:

1. Normal (3) - activity over the study area decreases during the first minutes.



Радіоциркулограма мозку в нормі:



N, imp./c **N, imp./c**

2. Hyperemic (2) - fast and steep decline of the first exponent.
3. Curves in the presence of the phenomenon of arteriovenous shunting (4) - lightning-fast decrease in activity (not less than 10% of the initial).
4. Ischemic (1) - a slow decrease in activity.

Quantitative interpretation of radioencephalograms.

1. Time of cerebral circulation (5-8s).
2. Time of RFP withdrawal (7-9s).
3. Time of full circulation of the RFP (13-16s).

Gamma topography of the brain.

Brain scintigraphy is performed in two dynamic modes - *(encephaloangioscintigraphy)* and static *(encephaloscintigraphy).* Static imaging can be performed as a stand-alone study or as a continuation of the angiographic phase.

Encephaloangioscintigraphy.

Indications: determination of cerebral blood flow disorders.

RFP: 99mTc-pertechnetata.

Equipment: gamma camera with computer processing.

The principle of the technique: the registration of the kinetics of the RFP is carried out continuously for the first 40 seconds with a frame duration of 0.3 to 1 second after its intravenous administration with an activity of 555-700 MBq.

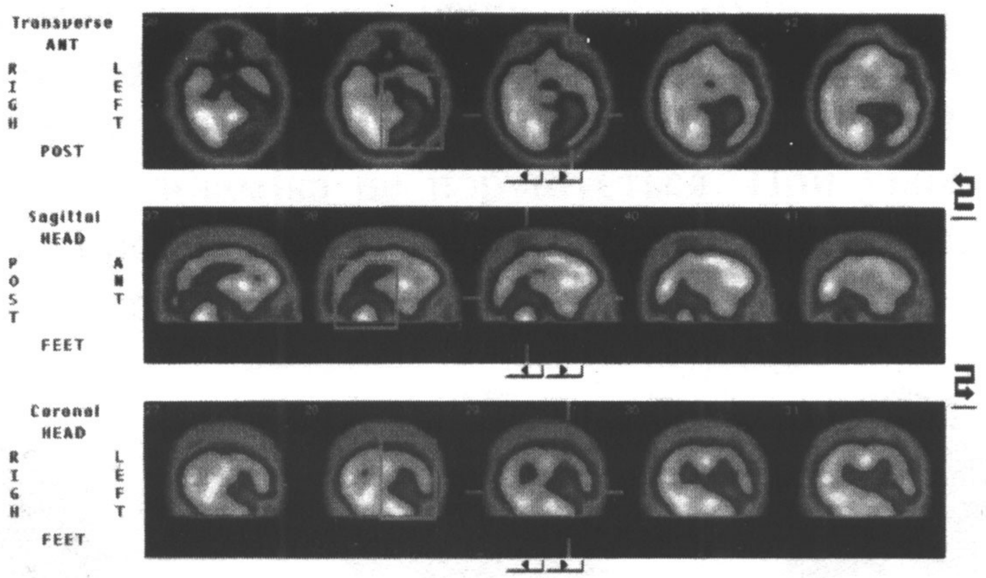
Then, after 3-4 minutes, we perform static scintigraphy.

Encephaloscintigraphy

It is carried out in 4 projections: front, back, right and left lateral. Th distribution of RFP is determined after 30 minutes, 1.5 and 2:00 after intravenous administration with an activity of 200-240 MBq. Currently, these techniques are performed using SPECT and PET.

SPECT uses perfusion radiopharmaceutical 99mTc-GEMPAO, which selectively accumulates in ischemic foci.

The circulation of cerebrospinal fluid is examined on a series of scintigrams 4, 24, 48 and 72 hours after subarachnoid administration of RP. The drug replenishes the entire subarachnoid space of the spinal cord and brain, cisterns of the brain. Its half-life is 12-24 hours and depends on the age of the subject: in young people, the radionuclide is excreted faster, in older people - later. If the RFP enters the cerebral



ventricles and remains there after 24 hours, it is indicative of hydrocephalus.

The main radiation signs of CNS pathology.

X-ray semiotics of brain diseases.

Pathological processes in the brain on non-contrast craniograms are manifested in the form of intracranial calcifications and various changes in the bones of the vault and base of the skull.

Intracranial calcifications on radiographs are defined as shadows of increased intensity, of various shapes and sizes. Calcifications of normal anatomical formations (pineal gland, choroid plexuses of the ventricles of the brain, dura mater) ar asymptomatic and can occur accidentally. Pathological calcifications of the brain and its membranes have different localization, shape, size and are divided into two groups:

- *calcification of tumors (craniopharyngioma, meningioma)*
- *calcification of non-neoplastic formations (post-inflammatory and post-traumatic lesions, tuberculosis, parasitic diseases, atherosclerotic changes in cerebral vessels).*

Hyperostosis - a thickening of the bones of the skull as a result of increased periosteal bone formation - is recognized on plain radiographs. Widespread hyperostosis covers the vault or base of the skull, and *local hyperostosis* is characteristic of meningiomas.

Thinning of the bones of the cranial vault is established on the lateral X-ray by measuring the distance between the outer and inner plates. *Total thinning* of these bones is observed with intracranial hypertension, *local* - as a result of brain tumors, hematomas.

The expansion of the sutures of the skull is observed with hydrocephalus and intracranial tumors in persons under 20 years old, caused by increased pressure of the medulla.

Strengthening of digital impressions indicates intracranial hypertension and occurs in brain tumors and internal hydrocephalus.

Changes in the size of the sella turcica are recognized on an overview craniogram in lateral projection, sighting radiographs and tomograms. An increase in these sizes is a consequence of pituitary neoplasms and brain tumors located next to it.

Computed tomography diagnostics is based on the assessment of direct and indirect signs of pathological changes in the brain. Direct symptoms include changes in the density of the brain matter in comparison with the norm. They are determined visually and by measuring the absorption coefficients. An increase in these coefficients relative to the normal values of the density of the gray and white matter of the brain is characteristic of the acute period of cerebral hemorrhages, as well as tumors originating from the meninges, etc. tumors, etc. The absence of changes in density, despite the pronounced clinical manifestations of brain damage, is noted in some primary and metastatic tumors, subdural hematomas 2-3 weeks after the onset of the disease. The presence in the zone of pathological changes at the same time high, low and normal values of absorption coefficients, occurs in hemorrhagic infarctions and certain types of primary brain tumors.

Indirect symptoms of pathological changes in it include various types of dislocation and deformation of brain structures and cerebrospinal fluid system, as well as changes in the size of the ventricles, furrows of the cerebral hemispheres and cerebellum.

Radiation semiotics of brain diseases.

Intracranial pathological processes in ultrasound, CT and MRI images can manifest themselves in direct and indirect signs. Direct signs include changes in echogenicity (US), optical density (CT) and proton density (MRI) of pathological formations relative to normal brain structures. As indirect signs are considered: atrophy and edema of the brain, changes in the cerebrospinal fluid system an displacement of anatomical structures (dislocation syndrome).

Increased echogenicity is characteristic of blood clots, heart attack, necrosis, cerebral edema, tumors, and lesions of pathological formations. Echogenicity decreases with fluid accumulation and the development of cystic formations (pseudocysts).

An increase in optical density is observed with fresh hemorrhage, calcifications of anatomical and pathological formations (aneurysm, parasitic cyst, tumor). A decrease in optical density is characteristic of most fluid formations (cysts), ischemic heart attacks, obsolete hematomas, certain stages of encephalitis, some tumors, and multiple sclerosis.

An increase in the strength of the MR signal is observed in fluid formations (cysts), with edema (T2), in adipose tissue, and hemorrhages in the chronic phase.

A decrease in the strength of the MR signal is characteristic of areas of calcification, vessels with a rapid flow of blood.

X-ray semiotics of spinal cord diseases.

Pathological processes in the spinal cord on non-contrast spondylograms are manifested by various changes in the spinal column and paravertebral soft tissues.

*Expansion of the diameter of the spinal canal and narrowing of the roots of the staples (Elberg-Dyck symptom) a*re due to atrophy from pressure and are an indirect sign of an extramedullary tumor of the spinal cord.

The expansion of one vertebral foramen is observed in neurogenic tumors of the spinal cord.

Pathological changes in the pedicles of the vertebral arches are recognized on spondylograms and tomograms performed in the posterior projection. Epidural tumors are characterized by a depression of the inner contour of the pedicle of the vertebral arch. Hemangioma is manifested by collar rearrangement of the structure and double contour of this anatomical formation.

The paravertebral shadow is caused by a pathological process in the paravertebral tissues and on radiographs is manifested by the darkening of the soft tissues of the paravertebral area, it is observed when the inflammatory or tumor process spreads to the surrounding soft tissues. For the location of the tumor in the thoracic or lumbar spine, the paravertebral shadow is especially clear. Calcifications are well manifested on spondylograms in lateral projection as intense shadows of various shapes and sizes. Lime salts can be deposited in the tissue or capsule of some tumors (psamomatous meningiomas, dermoids, teratomas, etc.).

Craniocerebral and spinal injuries.

Any craniocerebral or spinal cord injury is an indication for performing plain radiographs of the skull, or a specific part of the spinal column in two mutually perpendicular projections.

Fractures of the bones of the cranial vault can be linear, depressed, splinter, etc. X-ray detection of a fracture helps to know the site of damage. Linear fractures of the cranial vault appear on the roentgenogram in the presence of a thin linear band of enlightenment with clear, somewhat uneven edges, zigzag shape ("lightning" symptom), sometimes bifurcates ("rope" symptom), which is caused by the passage of the fracture line along the outer and inner plate of the vault. The extension of the fracture line to the cranial suture can cause its discrepancy. Violation of the integrity of only one plate of the cranial vault is difficult to determine on a roentgenogram, but it is clearly distinguished on a computed tomogram.

Fractures of the bones of the base of the skull are less common than fractures of the fornix and are, as a rule, their continuation. Fractures of the skull base are more often detected by indirect signs: shading of the air sinuses and cells due to hematoma, as well as a symptom of pneumocephalus - the presence of air bubbles on the surface of the brain or in the ventricles of the brain. Fractures of the base of the skull themselves most often occur in the middle cranial fossa as a result of opposition in the atlanto-occipital joint upon impact in any part of the head. Direct and indirect signs of a fracture of the base of the skull are better detected on CT.

Intracranial hemorrhages (hematomas) are common in head injuries and are better identified with computed tomography, magnetic resonance imaging, and angiography. A fresh hematoma on CT appears as an area of increased density (+ 50 + 80 HU), the shadow of which increases during the first 3 days, and then weakened within 2 weeks. The position, shape and size of the hematoma depends on the source of the hemorrhage. Sub- and epidural hematomas have a linear, ribbon or lenticular shape, directly adjacent to the bones of the skull and have clear, even contours. In the subdural hematoma, in contrast to the epidural, the inner edge is serrated. Intracerebral hematomas have a rounded or irregular shape and irregular contours, often surrounded by a zone of reduced density corresponding to edematous brain tissue. Large hematomas push back adjacent brain structures.

MRI signs of acute hematoma are indistinct, especially in the case of its subarachnoid location. After 3 days, the brightness of the hematoma image on MRI increases, which is due to the transition of oxyhemoglobin to dioxyhemoglobin, and later to methemoglobin and hemosiderin.

On angiograms with acute intracerebral hematomas, a displacement of cerebral vessels is observed, and in the late period after injury, the presence of post-traumatic aneurysm can be detected. Brain contusion is angiographically revealed by varying degrees of displacement and spasm of cerebral vessels in the area of injury.

Cephalohematoma - post-traumatic accumulation of blood between the periosteum and the outer surface of the cranial vault in a newborn - is better detected ultrasound. On the sonogram, it looks like a lenticular echo-negative strip between echogenic skin and hyperechoic bone.

With injuries of the spinal column, spinal deformities, fractures and dislocations of the vertebrae are radiologically detected.

Physical overload of the spinal column is often accompanied by a herniated disc, due to compression of the roots of the spinal nerves, causing vertebral pain syndrome. In the acute phase of the hernia, a slight decrease in the height of the intervertebral disc or unevenness of the intervertebral space is observed radiographically. Later, calcifications along the edge of the hernia join these signs. In the case of penetration of the cartilaginous tissue of the intervertebral disc into the spongy substance of the vertebral body, the so-called Schmorl's hernia is formed, which is characterized by the presence of a rounded enlightenment in the vertebral body surrounded by a thin sclerotic rim. Herniated discs occur mainly against the background of degenerative-dystrophic lesions of the spinal column.

Recently, CT and MRI have played a leading role in the radiological study of spinal column injuries, which make it possible to detect changes in the vertebrae, intervertebral discs, spinal cord, spinal cord sheaths and spinal nerve roots.

Inflammatory diseases of the brain.

Most often, the infection spreads to the brain by contact from the focus of inflammation in the ear, paranasal sinuses, or with open traumatic brain injury, less often - hematogenously from a distant focus.

The inflammatory process can affect the parenchyma of the brain (cerebritis with the formation of an abscess), the meninges of the brain (meningitis), or be combined.

When the parenchyma of the brain is damaged, a focus of inflammation of the brain tissue (cerebritis) is first formed within 3 days with the formation of a central focus of necrosis and surrounding edema, and in the next 7-14 days, encapsulation and formation of an abscess occurs.

X-ray examination for the diagnosis of inflammatory diseases of the brain and its membranes is not very informative, it is prescribed mainly to determine the consequences of the transferred diseases. An abscess can be easily detected with MRI and CT. On MRI scans, cerebritis appears as a rounded necrotic center along an annular edema, indistinctly separated from the surrounding unchanged parenchyma. The phenomena of cerebral edema around the inflammatory focus are better detected on MRI.

On CT, the abscess manifests itself as a rounded focus of reduced densitometric density, which over time acquires a clearer outline and is limited by a thick capsule. Around the focus, a perifocal zone of reduced densitometric density of the inflammatory brain tissue can be observed. During ultrasound examination in infants, cerebritis is detected as a round-shaped focus of increased echogenicity, later an anechoic abscess with a perifocal zone of increased echogenicity forms.

Leptomeningitis affects the soft and arachnoid cerebral saplings. In the first 2-3 days, edema of the membranes is observed, later exudate is formed, which accumulates in the cisterns and furrows of the brain. High body temperature, vomiting, headache, photophobia are clinically observed. CT and MRI reveal edema of the meninges in the first phase only under the condition of contrast, when an increase in the image of the pia mater and cerebral cortex is detected at the site of the lesion. The appearance of exudate is easily detected without contrast on CT, MRI, and in newborns - using ultrasound.

Due to the development of the inflammatory process on computer and magnetic resonance tomograms, there may be a displacement towards the median structures of the brain, limitation of the expansion of the subarachnoid spaces (cystic arachnoiditis), as well as calcification after the inflammation subsides (especially of tuberculous etiology). Infection from Obolon often spreads to the brain parenchyma, as a result of which cerebritis develops.

An epidural abscess occurs as a result of the development of an inflammatory process between the dura mater and the inner lamina of the bones of the cranial vault, which in CT and MRI scans looks like a volumetric fluid formation. With a significant size, an epidural abscess can pass through the midline to the opposite side of the brain, in what way it differs from a subdural abscess.

Brain tumors.

Depending on the size and location of a brain tumor, it can clinically manifest with general cerebral symptoms (recurrent headaches, dizziness, fainting, etc.) and local neurological symptoms (impaired vision, hearing, movement, sensitivity, etc.).

Tumors of the brain are manifested by radiation research methods for direct and side signs. Direct signs include direct detection of a tumor, side effects - perifocal edema, mass effect (displacement of adjacent brain structures and deformation of the ventricles), calcification in the tumor, destructive changes in the bones of the skull and some others. With the help of CT and MRI, the tumor manifests itself in the form of an area of altered densitometric density (there is hyper- or hypodense), or the strength of the MR-signal (is hyper- or hypointense). The shape of the site is often irregular, the structure is heterogeneous. Isodense and iso-intensive brain tumors are detected by indirect signs, as well as by intravenous contrasting with a radiopaque substance (CT) or gadolinium (MRI), in which the densitometric density or intensity of the tumor signal increases to a greater extent than that of healthy brain tissue.

Due to the violation of the blood-brain barrier and increased accumulation of RP in the tumor, it manifests itself as a "hot focus" on scintigrams, single-photon emission tomograms and positron emission tomograms.

Carotid angiography reveals the following signs of neoplasm: vascular displacement by the tumor, dilatation of the vessels feeding the tumor, their straightening.

Non-contrast X-ray of the skull reveals side symptoms of brain tumors associated with increased intracranial pressure and mass effect. Intracranial pressure increases due to an increase in the size of the tumor, edema of the medulla associated with the accumulation of free intercellular or associated intracellular fluid, and the resulting compression of the ventricles and venous outflow tracts from the cranial cavity. An increase in intracranial pressure is also observed in inflammatory diseases of the brain and its membranes.

X-ray symptoms of prolonged intracranial hypertension are an increase in the size of the skull, expansion of the channels of the diploic veins and venous graduates, an increase in the pattern of digital impressions and changes in the sella turcica (enlargement, osteoporosis, straightening of the back, destruction of parts). An increase in intracranial pressure is more pronounced in children: the size of the skull increases due to the expansion of the cranial sutures and thinning of the bones of the vault, while the skull acquires a spherical shape.

Changes in the position, shape, size of the ventricles and subarachnoid spaces in the early stages of the development of hypertensive syndrome are detected using CT, MRI, echoencephalography and radionuclide cisternography.

Among the tumors of the pituitary gland, adenomas that develop from the anterior lobe of the pituitary gland predominate. Radiographically, pituitary adenomas appear when they reach sizes exceeding the size of the sella turcica. On the craniogram, an increase in the size of the saddle is determined (normally the sagittal size does not exceed 14 mm, the frontal size does not exceed 18 mm), thinning of its back, osteoporosis of the bones. On computed tomograms, adenomas larger than 3-4 mm are revealed; they have a high densitometric density.

Craniopharyngiomas, developing from the remnants of the embryonic pharyngeal-pituitary pocket (Rathke), are located mainly above the diaphragm of the sella turcica near the visual tract. Therefore, its growth quickly leads to visual impairment. X-ray examination in 80% of patients reveals tumor calcifications, widening of the entrance to the pituitary fossa, symptoms of intracranial hypertension.

Spinal cord tumors occur mainly in the thoracic region. They appear better with MRI. With CT, the densitometric density of spinal cord tumors is often equal to the density of the tissues from which they originate, therefore, contrasting is used to detect them with this method. On the roentgenogram, a tumor can be detected by indirect signs: deformation of the legs of the arches of the vertebrae, pressing on the vertebral body, expansion of the intervertebral foramen.

The list of basic terms, parameters, characteristics that the student must learn in preparation for the lesson:

Term	Definition
1. Transcranial duplex echography	The method of ultrasound examination of the vessels of the brain through the bones of the skull with the simultaneous use of two modes of operation of the apparatus.
2. Distal acoustic shadow.	An ultrasound artifact that occurs behind very dense structures and indicates that the entire amount of sound energy has been reflected from the front surface of the structure.
3. Echo-negative formations.	Ultrasonic is a term used for fluids with very little reflection of ultrasonic vibrations.
4. Hyperostosis of the bones of the skull.	A volumetric increase in bones, accompanied by an increase in its mass due to enhanced periosteal bone formation.
5. Strengthening of digital impressions.	An increase in the depth of the imprints of the cerebral convolutions and grooves of the cerebral hemispheres on the cerebral surface of the cranial vault, which exceeds the norm.

5. Materials for methodological support of the lesson

5.1. Students are provided with textbooks, methodological developments, tests. The audience was attended by negatoscopes, a large number of X-rays, computer and MR tomograms. Prepared test items and situational tasks.

5.2. The information necessary for the formation of knowledge and skills can be found in textbooks:

Recommended literature.

-basic:

1.Kovalsky A.V. Radiology. Radiation therapy. Radiation diagnostics: textbook. for stud. higher. honey. study. prl. IV level of accreditation / V. Kovalsky, D. S. Mechev, V. P. Danilevich. - 2nd ed. - Vinnitsa: New book, 2017 .-- 512 p. Radiology (radiation diagnostics and radiation therapy). Kiev, Kniga plus, 2017.-743 p.

2. Radiology (radiation diagnostics and radiation therapy). Test tasks. Part 1. Kiev, Book plus. 2016.-104 p. 3. Radiology (radiation diagnostics and radiation therapy). Test tasks. Part 2. Kiev, Book plus. 2016.-168 p.

-additional:

3. Radiation medicine: Textbook for medical universities 3-4 rubles. approved by the Ministry of Education and Science, ed. M.I. Pilipenko -K., 2015, 232s, ed. "Medicine".

4. Collection of test tasks in radiology for practical exercises of module "Fundamentals, principles and methods of radiology" and the final modular control for 3rd year students of medical faculties Visual aid to practical exercises in radiology for 3rd year students of medical faculties. -Zaporozhye: 1 1 1 1 153 ZSMU, 2016. -74 p. N. V. Tumanska, K.S. Barskaya approved by the Central Methodological.

6.3. Orientation map for independent work with literature on the topic of the lesson.

№№ п.п.	**Main tasks**	**Directions**	**Answers**
1	**2**	**3**	**4**
	1.Kovalsky A.V. Radiology. Radiation therapy. Radiation diagnostics: textbook. for stud. higher. honey. study. prl. IV level of accreditation / V. 2.Kovalsky, D. S. Mechev, V. P. Danilevich. - 2nd ed. - Vinnitsa: New book, 2017 .-- 512 p. Radiology (radiation diagnostics and exchange therapy). Kiev, Kniga plus, 2017.-743 p.	Pages .. 411-439	Watch the tutorial

7. Materials for self-control on the quality of preparation

A. Questions for self-control:

1.Ray methods of studying the central nervous system:

• X-ray techniques for examining the skull, spine, brain and spinal cord (X-ray of the skull and spinal column, ventriculography, angiographic techniques for examining the central nervous system);

• CT and MRI of the brain and spinal cord;

• ultrasound of the brain

• radionuclide studies of the central nervous system (static scintigraphy, SPECT, PET).

2. Radiation anatomy of the skull, brain. Radiation anatomy of the spine and spinal cord.

3. The main radiation signs of the pathology of the central nervous system.

4. Radiation diagnosis of traumatic injuries of the skull and brain, spine and spinal cord.

5. Radiation diagnostics of vascular diseases of the brain (cerebrovascular accident, stroke, intracerebral hematomas).

6. Radiation diagnosis of inflammatory diseases of the brain, hypertensive syndrome.

7. Radiation signs of brain tumors.

8. Radiation diagnosis of vertebrogenic pain syndrome.

B. Tasks for self-control:

1. A 30-year-old man came to the neurosurgery department with the following history: two days before the visit, there was a fall from the stairs with a short-term loss of consciousness. On the next day, the pains were localized in the area of the nose, the phenomena of hemorrhage around the eyes began to increase (symptom of "glasses"). Nausea, vomiting, bleeding from the nose, ears were not observed.

What research method is the most informative for the diagnosis and the choice of treatment tactics in this case?

1) X-ray (multiaxial) of the skull bones.
2) CT.
3) MRI.
4) Transcranial duplex echography.
5) Diagnostic lumbar puncture.

2. The victim in a car accident was taken to a neurosurgery clinic, as there are signs of traumatic brain injury.

Objectively: symptoms of focal brain damage, suspected contusion.

What research method should be used in this case?

1) Angiography of cerebral vessels.
2) MRI.
3) CT.

4) X-ray of the bones of the skull.
5) ultrasound of the vessels of the brain.

3. A newborn child with clinical signs of birth trauma underwent neurosonography. The sonogram reveals an echo-negative strip between the echogenic skin and the hyperechoic bone.

Indicate the probable diagnosis.
a) fracture of the bones of the cranial vault;
b) fracture of the bones of the base of the skull;
c) cephalohematoma;
d) intracranial hematoma;
e) subdural hematoma.

4. A patient with clinical symptoms of cerebrovascular accident underwent CT examination of the brain. At the same time, an area of increased density of an irregular shape with uneven contours was found in the left hemisphere.

Make a conclusion.
a) cerebral ischemia
b) subdural hematoma;
c) epidural hematoma;
d) fresh intracerebral hematoma;
e) a brain cyst at the site of the hemorrhage.

8. Materials for classroom self-study:

8.1. The list of educational practical tasks that must be performed in a practical lesson:

• Analysis of the results of radiation studies (description of X-rays, computer tomograms, magnetic resonance tomograms, sonograms).
• Draw in the form of diagrams:
• diagnostic algorithm for examining a patient with head trauma;
• diagnostic algorithm for examining a patient with acute spinal trauma;
• diagnostic algorithm for examining a patient with cerebrovascular accident.

9. Materials for self-control, mastering knowledge, skills, skills provided for by this work:

1. What general and additional non-contrast techniques are used for examining the skull? What information can you get when using them?
2. What groups of contrast techniques are used in the study of the brain?
3. Diagnostic capabilities of cerebral angiography. Contraindications to its use.
4. What opportunities in the diagnosis of brain diseases open up with the use of computed tomography?
5. Diagnostic capabilities of MRI in the study of the central nervous system.
6. What diseases cause changes in the thickness of the bones of the cranial vault?
7. When are changes in the size of the Turkish saddle observed? What methods of X-ray examination allow determining these changes?

8. Computed tomographic semiotics of brain lesions.
9. MRI - semiotics of brain diseases.
10. What general and additional radiation research techniques are used in the diagnosis of traumatic injuries of the central nervous system.
11. X-ray and computed tomographic signs of cerebral aneurysms.
12. Radiation diagnosis of brain abscess.
13. What radiation techniques are used in the diagnosis of brain tumors?
14. General radiation symptoms of brain tumors.
15. Radiation diagnosis of intracerebral tumors.
16. Name the radiation methods that are used to diagnose diseases of the spinal cord.
17. What diagnostic information about the state of the spinal cord can be obtained using MRI?
18. What X-ray symptoms of spinal cord injury can be determined on a non-contrast spondylogram?
19. Tactics of radiation examination of a patient with suspected spinal cord tumors.
20. Name the radiological symptoms of extramedullary tumors of the spinal cord, which can be determined on plain radiographs of the spine.
21. What methods of X-ray examination are best used to determine the upper and lower levels of tumor formation in the spinal cord?
22. Myelographic and angiographic symptoms of extra- and intramedullary tumors of the spinal cord.
23. Computed tomography and MRI signs of spinal cord tumors.

10. The topic of the next lesson: “Radiation diagnostics in oncology”.

11. Tasks for UIRS and SRWS on the topic of the next lesson:

UDRS "Radiation diagnostics of strokes":
Algorithm for examining a patient with suspected stroke. Therapeutic window. Patient examination algorithm. Early signs of ischemic stroke: symptom of unilateral non-contrast angiography, with insular tape. Possibilities of endovascular angiosurgical interventions in ischemic stroke. Thrombolysis and thromboextraction. Indications and contraindications. Algorithm for the study of a patient with hemorrhagic stroke.

Methodical recommendations were made by __________ ass. Levitskaya T.G.