MINISTRY OF HEALTH PROTECTION OF UKRAINE
ODESSA NATIONAL MEDICAL UNIVERSITY

Medical Faculty №2

Department of radiation diagnostics, therapy and radiation medicine and oncology

I APPROVE
Vice-rector for scientific and pedagogical work
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METHODOLOGICAL DEVELOPMENT TO THE LECTURES ON THE EDUCATIONAL DISCIPLINE

Faculty, MEDICAL course, 2nd year

Educational discipline RADIOLOGY

Odesa-2023

Approved:

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Lecture No. 1

Topic. Basic properties of ionizing radiation. Biological effect of ionizing radiation. Radioactivity and dose. Dosimetry of ionizing radiation. Physical and technical foundations of radiation research methods.

Actuality of theme:ecological aspect - getting to know the nature of the ionizer radiation convinces of the need to protect the environment from exceeding the natural level of radiation. Knowledge of the main properties of ionizing radiation, units of measurement and methods of determining the radiation dose, the construction of radiometers and dosimeters, features of the structure of radiological and radiological departments. In recent decades, medical radiology has been replenished with new methods (computed tomography, including spiral, ultrasound methods, including duplex dopplerography, positron and single-photon emission tomography, interventional radiology, magnetic resonance imaging), and only 40% of radiological diagnostics remained traditional radiology In this regard, the state industry standards of higher medical education (OKH and OPP) require a graduate of a higher medical educational institution to be able to choose the optimal method for detecting functional and morphological changes in the pathology of various organs and systems from the large number of radiological methods of examination that exist in our time and interpret the data of radiological research methods in relation to clinical diagnosis.

Goal:
Educational:the student's mastery of indications for the use of various radiation methods of diagnosis and treatment of human diseases, possibilities and limitations of each of them, principles of biosafety and bioethics - protection of the patient from unwanted effects of ionizing radiation and magnetic fields. Development of a professionally significant personality structure; education of modern professional thinking in students; ensuring that students learn the leading importance of domestic clinical, scientific and pedagogical schools in the development of problems of modern radiology; acquisition of deontology and medical ethics skills by students.

Basic concepts:ionizing radiation (IR), radiology, SCT, PET/CT, MRI, RND, ultrasound

Content of the lecture material

1. Concept of biological effect of ionizing radiation

Great scientific discoveries of the end of the 19th century - X-ray radiation by V.K. Roentgen (1895) and natural radioactivity by A.A. Becquerel (1896) - initiated the rapid development of new directions in chemistry and physics. The use of ionizing radiation sources began in various spheres of human life and activity: in industry, agriculture, energy, science, and medicine. It became possible to use nuclear transformations as a source of electricity.

A powerful nuclear industrial complex has been created, which now includes military enterprises, more than 400 nuclear power plants are in operation (with a total capacity of about 300 million kW/year), research centers in more than 20 countries.

Mankind has created more powerful weapons: atomic, thermonuclear, cobalt, neutron. And its testing and possible application will lead to mass exposure of the population. Acts of nuclear terrorism are not excluded.

Over the past decades, the effects of atomic radiation on humans and the environment have been reassessed. A ban on the testing and proliferation of nuclear weapons was implemented, and several treaties on the reduction of nuclear weapons were signed. On June 29, 1957, the International Atomic Energy Agency (IAEA) was founded - an autonomous intergovernmental organization for the peaceful use of nuclear energy. The International Commission on Radiation Protection has officially recognized the concept of no-threshold effect of radiation on human health. The high biological activity of ionizing radiation (IR), the potential danger of near-term and distant adverse consequences of its influence on human health determine the need for knowledge of the mechanisms of biological action of radiation. It is also necessary to know in order to assess its impact during radiodiagnostic examinations of patients and during therapeutic use (radiotherapy). Insufficient awareness in this matter, as confirmed by the experience of liquidation of the consequences of the accident at the Chernobyl nuclear power plant, can lead to a violation of the public's perception of the situation that will arise. In most cases, the fear of exposure causes inappropriate reactions and actions in people who would otherwise appear calm and intelligent. Therefore, knowledge is the best antidote to fear and suspicion.

Radiobiology- a science that studies the biological effect of ionizing radiation on living things organisms

Modern radiobiology as a complex discipline is divided into: 1. Radiation cytology.
2. Radiation genetics.
3. Radiation biochemistry.
4. Radiation ecology.
5. Radiation hygiene.
6. Radiation immunology.
7. Radiation protection and therapy.
8. Space radiobiology.
9. Radiobiology of tumors, etc.

Its founder is considered to be E.S. London. He studied the effect of gamma radiation of radium on enzymes, toxins and various tissues of living organisms and showed high sensitivity to irradiation of the hematopoietic system and gonads. London owns the world's first monograph on radiobiology, "Radium in Biology and Medicine" (1911).

The objects of radiobiological research are macromolecules, viruses, protozoa, cell, tissue and organ cultures, multicellular plant and animal organisms, and humans.

The biological effect of ionizing radiation is the reaction of the body in response to irradiation, which manifests itself in morphological, functional and metabolic changes at all levels of its organization: atomic, molecular, cellular, tissue, organ and organismic.

2. Sources of ionizing radiation

The source of IP is an object that contains radioactive material, or a technical device that emits or is capable of emitting (under certain conditions) IP.

Natural and artificial sources of ionizing radiation are distinguished.

Natural sources of ionizing radiation

Ionizing radiation is a natural component of human habitat. It is not something new, created by man. This is an ever-present phenomenon.

This is a natural background that consists of 3 components:

1st- cosmic radiation that comes to Earth from the universe. It was opened inin 1912 by the Austrian physicist V. Hess. Its composition includes protons, neutrons, atomic nuclei and other particles. They have exceptionally high energy (more than 1.02 MeV), but due to the presence of the atmosphere (its mass is about 5 x 10^{15}t) spend it mainly on interaction with air atoms. On the Earth's surface, the intensity of cosmic radiation is relatively low.

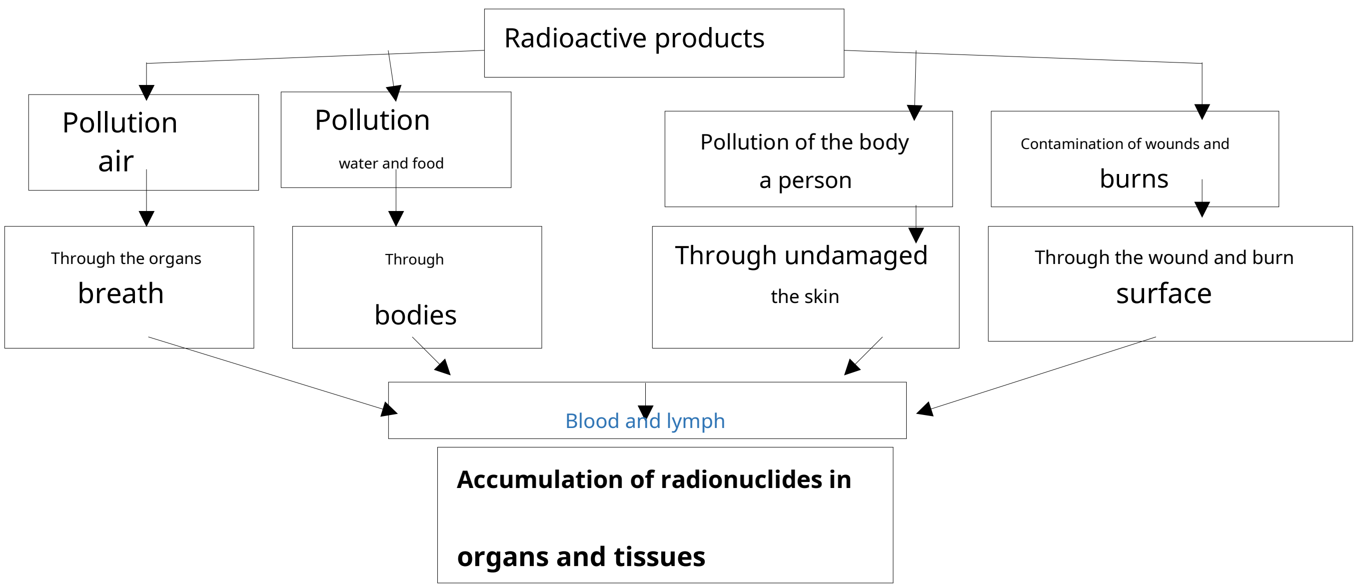
2nd- radioactive elements distributed in the earth's crust. The main radioactive isotopes which found in rocks - potassium-40, rubidium-87 and members of two radioactive families (uranium-238 and thorium-232). The most radioactive granites. In areas where such rocks come to the surface, the radiation background is much higher than natural. There are 5 such main places on our planet where the radiation background ranges from 40 to 400 μR/hour:

Brazil, India (the state of Kerala and Tamil Nadu), France, Egypt, the island of Niue.

The content of radioactive substances in the soil affects the level of radioactivity of building materials, food products of plant and animal origin.

3rd– incorporated radionuclides.

Table 2.1. The main routes of entry of radionuclides into the body



Artificial sources of ionizing radiation

Various technical devices created by man. These include: X-ray tubes, radioactive nuclides and charged particle accelerators. Radioactive nuclides are produced in nuclear reactors, charged particle accelerators or using generators. Accelerators are devices for obtaining charged particles of high energy using an electric field. X-ray tubes are sources of bremsstrahlung (X-ray) radiation.

Table 2.2. Sources of artificial ionizing radiation used in medicine

Radioactive substances		Accelerators of charged particles		
closed	are open		Cyclic	X-ray devices

Gamma-installation therapeutic		Radioactive drugs	Solutions		Suspensions			1. Cyclotrons 2. Betatrons	Synchrophasotrons	remote control dance	Near-distance
1. Static	2. Dynamic	1. Tubes 2. Balls 3. Needles 4. Darts 5. Plastics	Ordinary	Koloydni	Micro	Macro				1. Static 2. Dynamic	

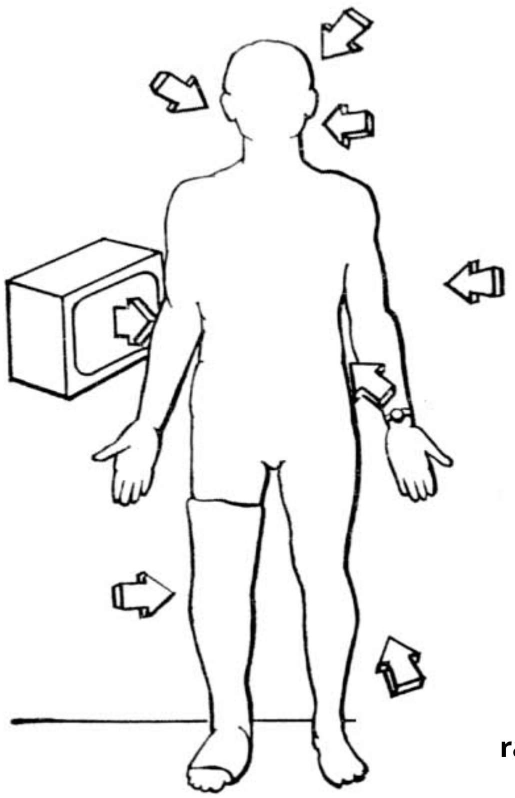


Fig. 2.1. Artificial sources of radiation that affect humans

All the new things created artificially by man are an additional radiation load to which all humanity is subject. These are flights in jet planes at high altitude (during a one-way flight from Moscow to Novosibirsk, a passenger receives a cosmic radiation dose of 0.025 Sv). Radioactive fallout after nuclear weapons tests, as well as as a result of operation (and even more so accidents) of nuclear power plants. In addition, additional radiation is created by medical examinations - X-ray and radionuclide. For example, at present, more than 150 types of research are used in x-ray diagnostics: angiography, coronary angiography, computer tomography, etc. X-ray radiation is used in radiotherapy of some diseases. Various linear, cyclic and γ-radiating installations are also used for this type of treatment.

For comparison:

- 0.1 mSv- one medical examination of the chest using the existing one fluorographic equipment;
- 0.3 mSv- the average annual radiation dose due to cosmic radiation on plain territory of Ukraine;
- 0.6 - 0.8 mSv- the average annual radiation dose due to space radiation for people living in mountainous areas;
- 1.6 mSv- the average annual dose received by the crew of civil aircraft from space radiation;
- 3.0 mSv- the average annual dose received by the population from all natural sources radioactive exposure;

- **20 mSv**- the limit of the effective radiation dose for professionals working with sources of ionizing radiation in Ukraine.

But in order to reach the level of knowledge and experience necessary for the useful use of sources of ionizing radiation, humanity has come a long and hard way. The first scientific data on the possible negative consequences of exposure to radiation were obtained in 1896 and were associated with the use of X-rays. The researchers noted that skin lesions (erythema, epidermitis), hair loss may occur as a result of irradiation. In 1902, the first case of radiation skin cancer was described.

Becquerel himself, who discovered the phenomenon of radioactivity, was affected by new rays, which in many respects are similar to X-rays. He developed an ulcer on the skin under the waistcoat pocket in which he had worn a tube of radium taken for demonstration by Pierre Curie for 6 hours before a demonstration at the Physical and Technical Society.

Marie and Pierre Curie

Frederic (1900-1958) and Irene Joliot-Curie (1897-1956) in the 1930s.

In a message to the Paris Academy of Sciences, Pierre Curie detailed his observations of the skin's reaction to radium radiation. Marie Curie, who first isolated radium and polonium in pure form and studied the properties of unknown radiation, like her daughter Irene, also became a victim of "insidious" radiation (they died of acute leukemia due to exposure).

Since 1903, one of the founders of radiobiology, E.S. London, has conducted a number of studies devoted to the effects of radioactive substances on the body. In his speech "On Radioactive Substances" at the St. Petersburg Medical Society, he demonstrated the effect of radium rays on animals. At the same time, the brain tissue was destroyed and the animals died, and burns and ulcers formed on their skin. The student of London S. V. Goldberg died in 1940 from skin cancer, which arose at the site of radiation burns. In the "Book of Honor", which was published in 1959 in Germany, the names of 360 scientists (chemists, physicists and doctors) who gave their lives in the fight against human diseases were given. It is known that over 40 years of development of radiology, more than 200 researchers died from cancer, which developed against the background of chronic dermatitis. It is impossible without excitement to read the tragic medical histories of such veterans of radiology as Walter Dodd, who died in terrible agony from "X-ray" cancer, after 46 operations (amputations, resections, plastics)!!! In 1936, a monument was erected in Hamburg with the names of 110 scientists who became victims of the first studies of the properties of radioactive rays. Humanity paid a high price for the received data. In 1958, the notebook of Marie Curie was displayed at the World Exhibition in Brussels. Next to her was a radioactivity counter, which counted pulses of radiation from the notebook at high speed. One can imagine the degree of contamination of the hands of an outstanding scientist at that time.

3. Properties of ionizing radiation

How do ionizing rays differ from other types of radiation? **The radiation will be ionizing if it has an energy greater than the binding energy of electrons in an atom and is able to detach them (ionize atoms) and break the chemical bonds of the molecules that make up living organisms. All these processes lead to biologically important changes**.

Ionizing radiation (IR) by its nature is divided into corpuscular and photon. As well as primary and secondary ionizing.

Corpuscularrepresented by particles that move quickly. Some of them carry electric charge (electrons, protons, α-particles), and others - not (neutrons).

Photonicare X-rays and γ-rays. They represent the energy that is transferred to in the form of waves without movement of matter (such as light and heat waves). These radiations do not differ in their properties. The only difference between them lies in the means of their formation - X-ray radiation occurs when electrons are slowed down in the electric field of an X-ray tube, and γ-rays are formed when excited nuclei of atoms are transformed into neutral ones. Electromagnetic IRs are secondarily ionizing. Part of their energy is transformed into the kinetic energy of electrons (which were knocked out of orbit) and which further ionize the environment as electrically charged β-rays.

All ionizing radiation has the following general properties:

1) The ability to penetrate materials of considerable thickness (opaque to visible light).
2) Ionize the air and molecules of living cells of the body (that is why they are called ionizing). This is due to their great energy. For example, the energy of light is 0.5 eV, and α-particles up to 10 MeV, so the latter have the greatest ionizing capacity (up to 20,000 ion pairs/mm), and α-radiation has a strong biological effect.
3) The ability to illuminate photographic materials used in dosimetry.
4) Ionizing radiation causes scintillations, and this property is the basis for the operation of radiodiagnostic equipment.
5) The property of accumulating and causing distant consequences (malignant tumors, genetic mutations, shortening of life).
6) We do not feel the effects of radiation ("slow-quiet action").
7) Ionizing radiation spreads in a straight line, causes the phenomena of interference and refraction. V.K. Roentgen did not detect the latter properties of x-rays and therefore equated them with sound waves, which, unlike electromagnetic transverse oscillations, have longitudinal oscillations.

4. Dependence of the biological effect of ionizing radiation on its type, energy and dose

All ionizing radiations differ in properties and biological action (see Table 1.2., p. 9).

There is such a concept as the relative biological efficiency (RBE) or the radiation weighting factor IR, which is expressed by the coefficient κ. The effect of wave IR (X-rays and γ-radiations), as well as β-rays, is equated to 1. For α-rays, κ reaches 20. Therefore, the lethal physical dose of this type of radiation will be 20 times less, and the biological effect will be 20 times greater. In general, the VBE has a direct dependence on the energy of the radiation mass and the ionization density.

Table 2.3. Average values of the coefficient of relative biological efficiency (K)

Type of radiation	K
X-rays, gamma rays	1
Electrons, positrons, --rays	1
Protons (-10 MeV)	10
Neutrons (-20 keV)	3
Neutrons (0.1-10 MeV)	10
--rays (-10 MeV)	20
Heavy recoil cores	20

The penetrating ability has an inverse dependence on the wavelength, mass of the particle, and a direct dependence on the speed of propagation. Based on this, α-radiation has the lowest penetrating ability (α-particles are completely retained by the surface layer of the skin). Therefore, with external irradiation, these rays do not pose a particular danger to humans. But when internal - they cause significant damage. Beta rays cannot penetrate deep into the human body anymore, than by a few millimeters. Hard X-rays and γ-rays are able to penetrate the entire human body, being absorbed only partially, and their specific ionizing capacity is much lower than that of corpuscular ones (1-2 pairs of ions/cm). Part of their energy is transformed into the kinetic energy of electrons (which are knocked out of their orbits), which further ionize the medium. Neutrinos, on the other hand (they are not used in diagnostics and treatment), even travel all over the globe without stopping completely.

The biological effectiveness of neutrons will also be greater than that of electromagnetic radiation. Why? Neutrons are secondary ionizing corpuscular radiation. They transfer their energy to hydrogen protons (by knocking them out of the boundary of the atomic nucleus). And, as heavy positively charged particles, they will be more densely ionizing and will have a greater VBE (table 2.4.). Therefore, equal doses of different types of IV cause different biological effects.

Table 2.4. Comparative action of fast neutrons and X-rays on different species

animals and humans ($LD_{100/30}$)

Kind of animals	Average cumulative dose resulting in 100% fatality animals for 30 days, Gr	
	Neutrons	X-rays
Mice	4-3.5	8.5-8
Rats	4-3.5	8.5-8
Rabbits	3.5-3	8-7.5
Dogs	3-2.5	7.5-6
Man	2.5	6

Radiation energy- the greater it is, the greater the degree of ionization, excitation and stronger biological effect of ionizing radiation. For example, the energy of light is 0.5 eV, and particles up to 20 MeV. Therefore, they have the greatest ionizing capacity (up to 20,000 pairs of ions/mm) and a strong biological effect.

Dose the greater the dose and its power, the greater the reaction and harm or benefit from ionizing radiation. A dose can be obtained in seconds, minutes, or even in years. With very large doses (up to 100 Sv), death occurs within hours due to damage to the central nervous system (cerebrovascular syndrome). Irradiation with a dose of10 Sv leads to death in a few days as a result of destruction of the mucosa of the intestinal tract (intestinal syndrome). At low levels of 2-5 Sv, without treatment, death can occur as a result of damage to the hematopoietic system (hematopoietic syndrome).

5. Characteristics of the ionization and excitation process

The first stage biological action of ionizing radiation represents physical process interaction of radiation with matter. All ionizing radiations directly or indirectly cause excitation or ionization of atoms of biosystems. As a result, excited and ionized atoms and molecules with high chemical activity appear in the tissues. They interact with each other and with the surrounding atoms, while a large number of highly active free radicals and peroxides appear.

The absorption of the energy of ionizing rays and primary radiation-chemical reactions occur almost instantaneously - in millionths of a second.

How do these processes take place?

Ionization is the separation of an electron from a free or bound atom of the organism (for this, see an average of 34 eV is required). In this way, 2 ions are formed: negative (electron) and positive (the nucleus of the atom with the remaining electrons). Molecules with at least one electron removed from their atoms will also have a (+) charge. One quantum or particle, with an energy of tens of MeV, ionizes many atoms. If the energy transferred to an atom is not enough to detach an electron, then it, having received excess energy, will move further from the nucleus and such an atom (as well as the molecule that contains it) will become excited. It doesn't last long (thousandths of a second). Electron returns to its orbit and at the same time emits energy in the form of a quantum of various sizes. If a molecule is given a lot of energy, it can break into fragments, forming 2 radicals with unsaturated bonds (this process is called**radiolysis**).

Table 2.5. The sequence of processes that lead to radiation damage

Phenomenon	Time range
1. Initial interaction: Indirectly ionizing radiation*. Direct ionizing radiation**.	10^{-24}- $10^{-4}$with 10^{-16}- $10^{-14}$with
2. Physico-chemical stage: Energy transfer in the form of ionization on the primary trajectory.	10^{-12}- $10^{-8}$with
3. Chemical damage: Free radicals, excited molecules to thermal equilibrium.	10^{-7}s - several hours
4. Biomolecular damage: Proteins, nucleic acids, i.e.	Microseconds are several hours.
5. Early biological effects: Death of cells, animals.	Hours - weeks.
6. Remote biological effects: Tumors, genetic effects.	Years - centuries.

*- X-ray and γ-radiation, neutrons

**- electrons, protons, α-particles

Radiolysis of water. During the radiolysis of water, the molecule is ionized by a charged particle, losing at this electron:

$$- N_2O - N_2AT^+ + e$$

An ionized water molecule reacts with another neutral water molecule, resulting in the formation of a highly reactive hydroxyl radical OH*:

$$N_2AT^+ + N_2O - N_3AT^+ + ON^*$$

The "torn" electron very quickly interacts with the surrounding water molecules, resulting in a highly excited H molecule$_2$AT*, which, in turn, dissociates with the formation of two H radicals*and ON*:

$$N_2AT^+ + e - N_2AT^* - N^* \text{and } ON^*$$

These free radicals contain unpaired electrons and are therefore extremely reactive. Their life time in water is no more than $10^{-5}$with. During this period, they either recombine with each other or react with the dissolved substrate. Therefore, the second stage of radiation damage (primary chemical changes) occurs almost instantaneously.

In the presence of oxygen, other radiolysis products are formed, which are oxidizing properties - hydroperoxide radical HO* $_2$, hydrogen peroxide $H_2AT_2$and atomic oxygen:

$$N^* + O_2 - BUT^*_2$$

$$BUT^*_2 + BUT^*_2 - N_2AT_2 + 2O$$

In the cells of the body, this process is much more complicated than when water is irradiated, the absorbing substance here is large organic molecules that are damaged by the direct action of radiation or by the products of radiolysis of water. The resulting organic radicals also have unpaired electrons and are therefore extremely reactive. Having great energy, they easily break chemical bonds in vital macromolecules. It is this process that occurs most often in the intervals between the formation of ion pairs and the formation of final chemical products.

The second stageof biological action is a radiation-chemical process that leads to change location and structure of molecules and, as a result, to disruption of cell biochemistry. Morphological and functional changes of cells are manifested already in the first minutes and hours after irradiation. The formation of products that are not characteristic of the body leads to its intoxication. With large doses of irradiation, the mass of ions can

lead to death "under the beam". Considering that the human body consists of 50-60% water, the same amount of ionizing radiation energy will be spent on its ionization. The second molecules absorb the amount of energy according to their amount in the body. It should be remembered that 75% of water is not only a solution, but a solvate and hydrate shell of polyatomic compounds, which also change their properties. Complex molecules can break apart not only at the point of impact of the beam. Energy can migrate along the molecule and cause a break at the point of the weak bond.

A split polyatomic molecule loses its properties, and the radicals formed can join other intact molecules and lead to their splitting with the formation of the next two radicals capable of interacting with other molecules. This is a self-accelerating chain reaction. The more molecules there are, the more likely they are to be ionized, excited, or split. Due to the fact that not all body molecules are functionally equivalent, damage to different molecules will have different consequences. The most important proteins (nucleoproteins), which regulate the processes of cell division, metabolism and which are the structural part of the gene. Its damage can lead to the loss of the cell's ability to divide and its death.

Table 2.6. Dependence of the number of mitoses on the dose of ionizing radiation

Irradiation dose, Gr	**Total number of cells examined**	**Mitosis, %**
CONTROL	72330	46.4
1.5	39517	34.6
3.0	29851	17.0
4.5	18426	3.0
6.0	24761	1.1

The connection of one or two strands of DNA can be broken, especially under the action of densely ionizing radiation (α-rays, protons), and its synthesis decreases. Disintegration, depolymerization and violation of the DNA genetic code may occur. Changes in the chromosomal apparatus of the cell are reflected in its hereditary properties and lead to radiation mutations (point mutations, chromosome breaks and chromosomal aberrations, etc.). Violation of the microstructure of cell membranes and mitochondria leads to a change in the sequence of enzymatic reactions and oxidative phosphorylation. Damage to lysosomes can cause cell autolysis. They can develop in somatic cells, reducing the viability of future generations.

In some cases, the cell can acquire the ability for more active uncontrolled division, which leads to the appearance of malignant neoplasms and leukemias (not only radiation, but also chemical and other physical influences have this property). At a lethal dose of radiation (for a person it is 6-8 Gy), each gram of tissue produces 10^{15}ion pairs. If we consider that large molecules consist of 100-1000 atoms, and about 50% of them are in the cell, then the total number of molecules in a gram reaches 10^{21}. And if we assume that the ionization of molecules of all sizes is uniform, then it turns out that 10 is ionized^{15}molecules (and this is only one millionth of the atoms in the body). And this is enough for a person to die!

What's up? The fact is that during the passage of ionizing radiation throughout living organisms, the absorbed energy is not distributed evenly, but in separate "bunches". As a result, a large amount of radiation energy is transferred to certain areas of some cells and very little to others. The insignificance of the amount of absorbed energy that causes severe consequences can be demonstrated by some means. The lethal dose of ionizing radiation in general exposure can be compared with thermal or mechanical energy.

For example, thermal energy is absorbed in tissues equally and uniformly. Therefore, to cause damage in a living organism, energy of this type is required much more than the energy of ionizing radiation.

6. Mechanisms of action of ionizing radiation

The following mechanisms of action of ionizing radiation are distinguished **:**

Direct action of ionizing radiation- cases where radiation directly causes changes: ionization, excitation, radiolysis of water and formation of radicals.

The total amount of energy absorbed in the human body (weighing 70 kg) that received a lethal dose of 4 Gy, is only 67 cal.

Absorbed energy: 70x4=280 (J) = 67 (cal)

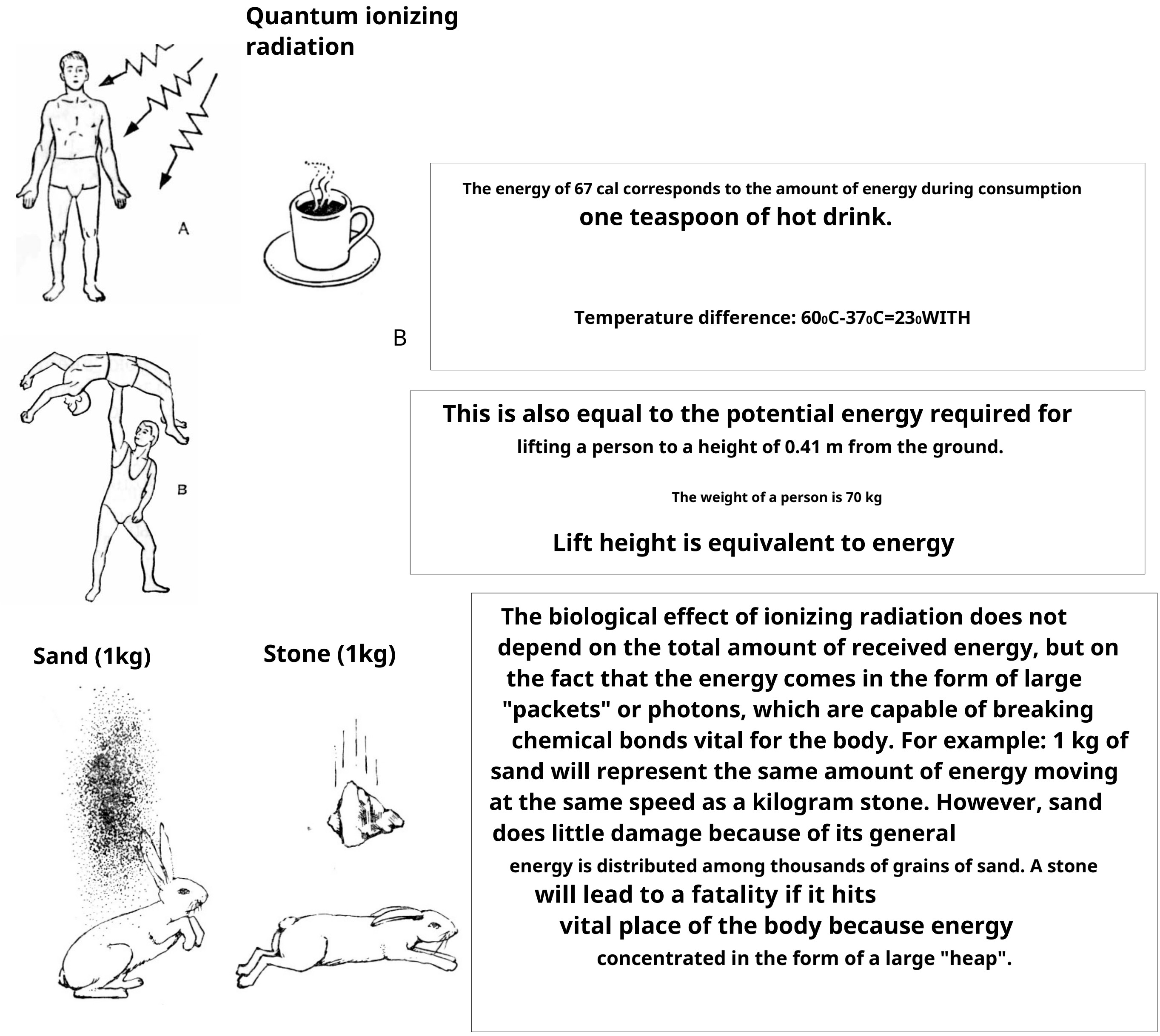


Figure 2.4. Dependence of the biological effect of ionizing radiation not on the amount of absorbed energy, but on the energy of the quantum or the size of the "bunch"

The direct effect of radiation is explained by the fact that radiation damage to the cell is a consequence of the direct impact of an ionizing particle or γ-quantum on a particularly sensitive volume of the cell, primarily on the cell nucleus, which will lead to its inactivation and death. It can be other cell organelles.

Indirect (mediated) effect of ionizing radiation– when fragments of molecules, oxidizing radicals OH, H_2AT_2, BUT_2, ions, primary radiotoxins such as lipid peroxide and hydroperoxide compounds, quinones interact with intact molecules, joining them and changing their structure and properties. Sulfhydryl groups of enzymes and DNA are easily exposed to the oxidizing action of radicals. And this can lead to their rupture not at the point of joining, but at another with the formation of two active radicals. As a result, a chain self-accelerating reaction is possible. For example, 1 molecule disintegrated and 2 radicals were formed. They interact with 2 intact molecules, which in turn disintegrate into 4 radicals, etc. Therefore, a small amount of primary energy causes such great consequences in the body. These are physical, chemical and biochemical levels of damage. These processes take place in body cells, tissues and organs.

7. Metabolic changes in the body at all levels of its organization as a result of the action of the ionizer radiation

The theoretical basis for understanding the biological action of ionizing radiation is the conditional division of the pathogenesis of radiation injuries into 2 phases:

1) the primary action of ionizing radiation at the molecular-cellular level (this is the ionization of atoms and molecules, the primary physical and chemical processes in the body that are caused by the direct action of radiation and are the starting point for further changes);
2) phases of the following biological processes at the molecular-cellular, tissue, organ, system and organismal levels of regulation.

Table 2.7. Types of radiobiological damage in mammals

Biological level organizations	The most important radiation effects
Molecular	Damage to macromolecules - enzymes, RNA, DNA, effect on metabolic processes.
Subcellular	Damage to cell membranes, nuclei, chromosomes, mitochondria and lysosomes.
Cellular	Suppression of cell division, cell death, malignant transformation.
fabric, organic	Violations of such systems as the central nervous system, bone marrow, and gastrointestinal tract can lead to the death of animals and the emergence of malignant tumors.
Organism	Death, radiation shortening of life.
Population	Changes in genetic characteristics due to gene and chromosomal mutations in individuals.

1. Molecular and cellular level.

Large molecules are more responsible for the structure and functions of the body. For example, enzymes that have a sulfhydryl group, nucleoproteins. Therefore, their damage is more noticeable for the body. If hydrogen is split off, atomic oxygen or peroxide tears off hydrogen from 2 enzyme molecules, then they can connect through sulfur (a disulfide bond is formed). As a result, active groups move to the middle of the molecule and it is inactivated. Therefore, chemical compounds with SH groups are used to protect the body from ionizing radiation. The same enzymes are not in a free state, but in loci made of lipoproteins and, as necessary, gradually pass through a semipermeable membrane. If such a locus is damaged, a defect is formed, due to which enzymes will be released in greater quantities, and this will lead to increased fermentation. As a result, substances peculiar to the body appear, but in large quantities, which is manifested by intoxication. For example, creatinine is a common product of protein breakdown. But if it is not removed with kidney pathology, then intoxication (uremia) occurs. As already mentioned, cells can change under the influence of radiation and even die. But this does not occur during irradiation, but at the second and third stages of division (because daughter cells will not be viable). The sensitivity of a cell to the action of ionizing radiation depends on many factors: the type and dose of radiation (energy of quanta or particles), the stage of the mitotic cycle, the speed of regenerative processes, the degree of oxygenation, free sulfhydryl groups, the functional state of the cell at the time of irradiation. The cell nucleus is more radiosensitive than the cytoplasm. The penetration of just one particle into the nucleus of a fertilized insect egg causes the death of the embryo, while when the same particles pass through the cytoplasm, 15 million of them are needed to achieve the same effect. The degree of radiation reactions is closely related to the partial tension of oxygen in the biosubstrate. This phenomenon was called the "oxygen effect". The less oxygen in the cell, the less radiation damage. A decrease in oxygen saturation of tissues increases the resistance of the cell and the whole body to the action of radiation by 2-3 times.

Table 2.8. The effect of hypoxia on the survival of rats irradiated with X-rays rays

Irradiation dose (Gy)	Survival rate, %	
	air	**5% oxygen**
5,6	63	100
7.4	15	56
9.3	0	21
11.2	0	9
13.0	0	6

Back in 1906, French scientists**Bergognier and Tribondo**established that the sensitivity of cells to radiation directly depends on their ability to divide and inversely on the level of their differentiation. Especially cells that are in a state of increased activity (for example, during DNA synthesis) are affected. Poorly differentiated cells are more sensitive to radiation. Of the cellular structures, DNA and chromosomes are the most vulnerable to the action of ionizing radiation. All this is the basis of the use of ionizing radiation for therapeutic purposes in oncology.

But it should be noted that at the same time, there are restorative systems in cells and reparative processes occur in nuclear and cytoplasmic structures. As a result, mitoses are delayed, some cells die (interphase death), some die after several mitoses (reproductive death), and some are restored (repair). It depends on the total number of stem cells, the intensity of cell proliferation, the state of blood circulation and oxygenation of cells.

When considering the issue of tissue radiosensitivity, it should also be borne in mind that the death of part of the cells is compensated by the activity of cellular renewal systems. On the basis of numerous experiments on animals, radiologists Bleier (1954) and Davidson (1960) developed mathematical methods for calculating the speed of recovery of radiation injuries in animals and humans. They believe that only 10% of the total dose received by a person leads to irreversible changes in the body, the last 90% of the dose causes reversible changes that are gradually compensated by the body. The speed of recovery is determined by the half-life period ($T_{0.5}$), when half of the damage is eliminated. It is different in different animals: in mice it is 3-8 days, in rats 6-9 days, in dogs 14-18 days, in humans 28-30 days.

The difference between the total dose of radiation accumulated by the body and restored for a certain period of time after exposure is called **residual or effective dose irradiation (D_{ef}).** It is believed that this is the radiation dose for multiple exposures determines the severity of the lesion.

Therefore, $LD_{100/30}$ with one-time irradiation, it is less than with fractional irradiation - due to restorative processes.

Table 2.9. Lethal doses with single and fractional DL irradiation $_{100/30}$

Kind of animals	Conditions Irradiation	The average cumulative dose that causes death 100% of animals in 30 days, Gr
Mice	One-time short-term	7.5
	0.1 Gy daily	40
Marine pigs	One-time short-term	4
	0.1 Gy daily	16
Rabbits	One-time short-term	6
	0.1 Gy daily	21

2. Fabric level.

Cells, as you know, form tissues, which in turn will also change under the influence of ionizing radiation. The following changes are especially noticeable in actively proliferating tissues: lymphoid, hematopoietic, endocrine.

They die at low radiation doses of 1-4 Gy. This leads to anemia, leukopenia and other disorders. Radiation damage is less pronounced and occurs in more distant times in tissues that do not recover much (bone, cartilage, muscle, fat). Cells of these tissues die at doses of 30-100 Gy. However, the nervous system, despite the high differentiation of cells, has a high functional radiosensitivity. At the same time, neuroreflex changes are observed.

Table 2.10. Radiosensitivity of normal tissues

according to morphological characteristics

1. Lymphoid cells. 2. Polynuclears. 3. Eosinophils. 4. Epithelium of ovarian follicles. 5. Spermatogonia. 6. Epithelium of hair follicles. 7. Epithelium of salivary glands. 8. Skin epithelium.	9. Epithelium of pulmonary alveoli. 10. Tubular epithelium of kidneys. 11. Endothelium of blood vessels. 12. Endothelium of the pleura. **13. Peritoneal endothelium.** 14. Bone tissue. 15. Connective tissue. 16. Muscles.

3. Organic level.

In the case of radiation damage to certain tissues, changes will be observed already at a higher level - organ level. The degree of radiosensitivity of organs depends on the degree of radiosensitivity of the tissues that make them up. Among the digestive organs, the small intestine is the most sensitive, and the liver is the least sensitive

Table 2.11. Survival of mice after exposure to X-rays with a dose of 9.5 Gy under conditions of shielding of various organs for 30 days

Shielded part of the body	Survival up to 30 days, %
General exposure without shielding	0
Kidneys	0
Hind paw	13
Liver	33
Head	26
Intestine	29
Spleen	48

As a result, the irradiated organ cannot perform its functions. And the opposite can happen: an organ that is more resistant to the action of radiation secretes the same amount of products (hormones) as before, but the effector organ will be affected and will not react to irritation. Thus, communication between individual bodies will be broken. And this is already an organismic level.

Organs that are most radiosensitive or that accumulate a greater number of incorporated radionuclides are called CRITICAL. An increase in the function of the organ also leads to an increase in radiosensitivity. For example, the mammary gland during lactation is more sensitive to ionizing radiation than in a normal state. If a person has an increased or decreased function of the thyroid gland, then its radiosensitivity also increases. How to explain this? In hyperthyroidism, a high concentration of hormones causes increased metabolism. And in such a situation, there is a higher probability of chemical reactions caused by ionizing radiation - the excitation of the nervous system is observed. With hypothyroidism, reparation is impaired - the nervous system is depressed. The most significant radiation damage to the nervous, immune systems, bone marrow and others performing regulatory functions in the body.

The radiosensitivity of malignant tumors from different tissues is also different. This requires the use of different doses for different neoplasms. For example, a dose of 4 Gy is sufficient for treating patients with lymphoblastoma, and 10 Gy or more for osteogenic sarcoma.

8. Mutagenic properties of radiation

In 1925, H.S. Filipov and G.A. Knudson was the first in the world to establish the effect of X-rays on yeast fungi in which mutation occurred. This work was a forerunner of radiation genetics. In 1927, the American scientist Muller managed to obtain mutations of various types during X-ray irradiation of Drosophila, the frequency of their appearance increased more than 150 times compared to the control.

Mutations- sudden natural or artificially induced changes in genetic material, which are inherited and lead to changes in certain signs of the body.

Conventionally, they are divided into**spontaneous**, which arise under the influence of natural factors or as a result of biochemical changes in the body itself and**induced**, which arise under the influence of special mutagenic factors. For example, ionizing radiation, chemicals. Of them negative more than 99%, and less than 1% positive. Negative ones lead to the death of cells or the emergence of new properties in them - uncontrolled division (malignant tumors).

The effect of ionizing radiation can be presented in the following order:

1) changes in somatic cells that lead to cancer (more often occur with large doses of radiation);

2) genetic mutations that affect future generations (depends on dose and dose strength): a) single gene mutations (point);

b) genetic, associated with a changed number of chromosomes in the cell (more or less of them, chromosomal aberrations);

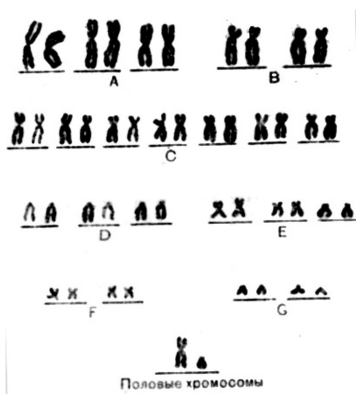
c) more frequent, but small mutations that cannot be identified by special features.

3) impact on the embryo and fetus due to exposure of the mother during pregnancy;

4) death at the moment of exposure.

Mutations in germ cells -**genetic**- are passed on to the next generation. Mutations in any other body cells -**somatic**- are inherited only by daughter cells and affect only the organism in which they originated.

A normal set of human sex chromosomes, collected in groups.



A set of chromosomes of a radiologist who worked with X-rays rays for 25 years.

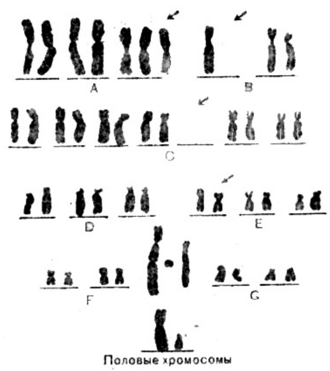


Fig. 2.5. Group A has an additional chromosome; in group B – one chromosome is missing; in group C - two chromosomes are missing; in group F and G - there are aberrant chromosomes.

Genetic mutations are divided into dominant and recessive.

Dominantappear if both genes in the chromosome are damaged. They cause various diseases. About 500 human diseases are known, which are the result of a single dominant gene mutation. These are polydactyly, retinoblastoma, dwarfism, i.e.

Recessiveappear only in cases where the gene of one of the chromosomes is damaged. The dose of radiation required to double the mutation frequency is in the range**0.5-2.5 Sv**! The more people are irradiated, the greater the probability of recessive mutations. That is why there are such strict rules for the protection and standards of exposure of all people. If for professionals (group A) the maximum permissible annual dose in Ukraine is 20 mSv/year, then for the entire population – 1 mSv/year. Accordingly, these processes also occur during therapeutic radiation.

First:it is necessary to remember that the radiation background is constantly increasing (man-made background). At first, it was due to nuclear weapons tests, then the more frequent use of ionizing radiation sources in various industries and the national economy. The therapeutic dose is not regulated - it is determined by the doctor.

Second:when referring patients for radiation examination (X-ray, radionuclide), it is necessary to think about the dose, which is limited by the category of the subject. With malignant tumors, every 4th man and every 5th woman are subject to radiation therapy. The action of ionizing radiation accumulates (it is not fully compensated). It is also very important that the effect of radiation is not felt.

9. Specific and individual varieties of radiosensitivity

All biological objects are sensitive to the action of ionizing radiation, but the degrees of their sensitivity are different. Unicellular organisms die from radiation exposure as a result of irreversible damage to the cell itself (protein denaturation). Highly organized - from disorders of the function of systems and organs. The radiosensitivity (ability to respond to radiation) of various biological objects varies widely. It is known that simple animals are the least sensitive, and mammals are the most sensitive.

A radiation dose of 10 Gy or more is lethal to all mammals. It is very interesting that such a dose is accompanied by the ionization of a tiny fraction of molecules - one ten millionth. For a person, the lethal dose is 6 Gy with total uniform exposure. If a finger is irradiated with a dose of one million Gy, necrosis (self-amputation) will occur. The whole body is practically unaffected. If almost a small part of the body (especially hematopoietic tissue capable of repair) remains unirradiated, then the percentage of survival increases.

And for microorganisms, the lethal dose is MGy (10^6Gr), for viruses it is even impossible to set it. In the structures of one of the American nuclear reactors in Los Alamos, viable bacteria (they were called radio-resistant micrococci) were found, which multiplied so much that the water became thick and stopped the nuclear reactor. After all, the bacteria were in a zone where the absorbed dose of daily radiation was more than 10^6Gr, which is millions of times higher than the absolute lethal dose for representatives of simpler organisms, not to mention mammals.

It is interesting that the internal environment of invertebrates is very rich in amino acids and they are more resistant to radiation than mammals.

. It was established that the more endogenous thiol compounds in the body of mammals, the more they more resistant to ionizing radiation. In addition, parallelism between sensitivity to ionizing radiation and resistance to cyanides was found. This suggests that under their action enzymes that absorb heavy metals (copper, iron) are primarily affected.

Mice and rats with a higher respiratory ratio (k=ChDD/ZV) are more resistant to ionizing radiation than animals with a normal respiratory ratio.

Table 2.12. Radiosensitivity of various biological objects

Biological species	**Dose of γ-radiation that causes 50% death irradiated for 50 days - $LD_{50/50}$(Gr)**
The simplest	1000 - 3000
Plants	10 - 1500
Yeast	300 - 500
Snakes	80 - 200
Insects	10 - 100
Pisces	8 - 20
birds	8 - 20
Hamsters	9 - 10
Rabbits	9 - 10
Mice	6 to 15
Rats	7-9
Monkeys	2.5 - 6
People	2.5 - 3.5
Donkeys	2.0 - 3.8
Dogs	2.5 - 3.0
Sheep	1.5 - 2.5

In addition to the negative effects of ionizing radiation, there are also positive aspects. Marie Sklodowska-Curie was also convinced that radiation is an important stimulus to life. Geneticist Koltsov believed that radiation is a more important factor in evolution. Small doses of radiation stimulate the activity of many systems in the body. For example, infertility can be treated by irradiating the gonads with microdoses. And it can be called if the dose is increased. Everything is the same as in the case of treatment with conventional drugs - a small dose is therapeutic, when increased it becomes poison!

in X-rays

Fig. 2.6. Impact of ionizing radiation on plants

Individual characteristicsradiosensitivity. Different individuals of the same species are differently sensitive to the action ionizing radiation. Blondes are more sensitive than brunettes (as well as to ultraviolet).

Fabric features- it already seemed that the most sensitive are the less differentiated, young, mitotically active cells. Testicles, ovaries, lymphatic tissue, bone marrow, hematopoietic tissue, nervous and endocrine systems have high radiosensitivity. Epithelial, and even less connective and bone tissues are less sensitive.

Age characteristics -the most sensitive embryos and newborns, as well as persons of the elderly age Adults are less sensitive. Why? Because in the cells of babies and embryos divisions are carried out more often, the metabolism is higher, and in old age the repair processes are disrupted.

The development of a child before birth can be divided into 3 main periods:

- **Pre-implantation (up to the 9th day).**The most sensitive embryos to5th day of development (80% death). Radiation at this stage operates on an all-or-nothing basis. Irradiation of embryos from the 6th to the 10th day causes a higher frequency of birth defects: skeletal deformations, pathology of the organs of vision, severe morphological and functional disorders of the brain (even before its absence), heart defects, i.e.
- **Organogenesis (from the 9th day to the 6th week).**Irradiation during this period leads to gross abnormalities of fetal development, growth retardation, neonatal mortality.
- **Fertile period (pregnancy period after 6 weeks).**It is only known that large doses ionizing radiation cause a delay in the development of the body.

There is a "10 DAY RULE" -like research using ionizing radiation prescribed to women of childbearing age during the first 10 days after the start of menstruation (to rule out pregnancy).

Environmental conditions

The sensitivity to ionizing radiation is affected by the content of oxygen in the surrounding environment, and the oxygenation of the body depends on this in turn. With an increase in oxygen tension in the tissues, there is a high probability of the formation of peroxide compounds. Oxygen combines with a hydrogen radical and hydroperoxide is formed - a very strong oxidizing agent. In a state of hypoxia, the body is less sensitive to ionizing radiation. For example, to enhance the effect of radiation on malignant tumors, we saturate the body with oxygen during or before treatment. Or we irradiate in pressure chambers with increased atmospheric pressure. To protect healthy tissues or the whole body, we induce hypoxia, inject drugs (serotonin), breathe a hypoxic mixture (nitrogen with oxygen 10-12%) or by compressing peripheral vessels (covering healthy tissues with pillows made of leaded rubber).

Temperature - in poikilotropic animals, its increase will strengthen the effect of ionizing radiation, and its decrease will weaken it. For example, gophers, hamsters, dormice during winter hibernation are less sensitive to the action of ionizing radiation, because their temperature decreases. Irradiated with an absolutely lethal dose in hibernation, they continue to sleep for weeks and months without showing signs of illness. After waking up, they die of the disease in 2-3 weeks. A very showy experiment on frogs. If they are irradiated with a lethal dose and kept at a temperature of 0atC, then she does not develop signs of radiation sickness. And if she is placed in room temperature conditions, her metabolism will immediately increase and she will develop radiation sickness. A person is negatively affected by the increase and decrease in temperature. Because both contribute to increased metabolism, which leads to the formation of radiotoxins.

II. Classification of radiodiagnosis methods.

Physical phenomena that are the basis of radiodiagnostic methods

The components of radiation diagnostics are: X-ray diagnostics, radionuclide diagnostics, ultrasound diagnostics, magnetic resonance diagnostics, medical thermography. In addition, it includes the so-called interventional radiology, the task of which includes performing medical interventions under the control of radiation techniques.

Integration in the use of radiodiagnostic methods, their professional and adequate purpose are extremely relevant.

Radiological diagnostics are based on the following physical phenomena:

- absorption of x-ray radiation in tissues (x-ray diagnostics);
- radiation of gamma quanta by radionuclides concentrated in certain organs and tissues (radionuclide diagnostics);
- the occurrence of radio frequency radiation due to the excitation of unpaired nuclei of atoms in a magnetic field – magnetic resonance imaging (MRI);
- reflection towards the detector of high-frequency ultrasonic waves directed at the object - ultrasonic diagnostics (ultrasound);
- spontaneous emission of infrared rays by tissues (thermography).

All these means, with the exception of ultrasonic, are based on electromagnetic radiations that have different energy spectra. Their characteristics are given in table. 1.2.

To date, all visualization tools can be grouped by the feature of obtaining an image of the entire volume of tissue or its thin layer. In a conventional X-ray examination, a three-dimensional volume is displayed as a two-dimensional image. A summation two-dimensional image of various organs and tissues is obtained on the film. In tomography, including computed tomography, the rays are directed only to a thin layer of a certain area of study. The main advantage of this method is high differential contrast.

All radiation used in medical radiology is divided into two major types groups:**non-ionizing and ionizing**. As the name suggests, the former differ from the latter in that, upon interaction with the medium, they do not cause ionization of atoms, i.e. splitting into oppositely charged particles - ions.

Non-ionizing radiation includes thermal (infrared) radiation and resonant radiation, which occurs in the body of a person placed in a stable magnetic field under the action of high-frequency electrical pulses. In addition, non-ionizing radiation tentatively includes ultrasonic waves, which are elastic vibrations of the medium.

Radionuclide, ultrasound and magnetic resonance studies were used in medical practice became wide in the 70s and 80s, while X-ray examination methods have been used for more than 100 years.

X-ray is a flow of quanta (photons). Quantums have no electric charge. X-ray radiation occurs when fast electrons are slowed down in the electric field of atoms of the tungsten anode of an X-ray tube (brass radiation) or when the inner shells of atoms are moved (characteristic radiation). The bremsstrahlung has a continuous spectrum, and the characteristic spectrum has a discrete spectrum.

X-ray radiation has the following properties: penetrate through bodies and objects, which are not transparent to light; cause the glow of a number of chemical compounds, this property is the basis of X-ray translucency - a technique of X-ray translucency; it is able to dissociate silver halide compounds, which are part of photoemulsions, this allows obtaining X-ray images; X-ray radiation causes the disintegration of neutral atoms into positively and negatively charged particles (ionization ability). The latter is due to the strong biological effect of X-ray radiation.

The X-ray method is a method of studying the structure and function of various organs and systems, based on the qualitative and/or quantitative analysis of a beam of X-ray radiation that penetrates the human body.

The X-ray radiation generated at the anode of the X-ray tube is directed at the patient, in whose body it is partially absorbed and scattered, and partially passes through. The detector perceives X-rays and converts them into diagnostic information. In X-ray examinations, the detector can be a fluorescent screen, a photo or X-ray film, an electronic-optical converter, a dosimetric counter.

X-ray examination at the modern stage is performed in any medical institution, it is simple and unburdening for the patient. Indications for it are broad, but must be justified in each specific case, since the x-ray examination is associated with unwanted exposure of the patient. A relative contraindication to X-ray examination is an extremely difficult and excited state of the patient, as well as cases that require urgent surgical intervention (open pneumothorax, bleeding). A significant leap in X-ray imaging took place in the 1970s, when X-ray computed tomography (CT) began to be introduced into practical medicine.

X-ray computed tomography (X-ray computed tomography) is a method of obtaining a layer-by-layer X-ray image of organs and tissues by means of computer processing of multiple X-ray images taken at different angles, followed by reconstruction of the image based on the density of different areas of tissue.

Computer tomography -it is the pinnacle of scientific thought and electronic technology of the latter quarter of the 20th century. The history of RKT is instructive and interesting. In 1963, an article by the then little-known physicist Cormac from the South African Republic appeared in the Journal of Applied Physics, in which he proposed a mathematical means of reconstructing the image of the brain using a finely directed beam of X-ray radiation. Only 7 years later, this publication attracted the attention of the specialists of the company for the creation of electronic music, which was managed by the then unknown engineer Hounsfield.

In a short period of time, scientists were able to create a new type of device. The scanning time of the first object (a brain preserved in formalin) with this device was 9 hours. In 1972, the first tomography was performed on a woman with a brain tumor. The advantages of the new device were so obvious that many large electronic companies switched to the production of these devices. Later, they were called computer tomography. The first RCTs were designed only for examining the head, but soon scanners for the whole body appeared. Nowadays, RCT can be used to visualize any part of the body. On modern devices of the fourth and fifth generations, which are equipped with a very powerful processor with a high speed of information processing - up to 10 million operations, which allows you to reduce the scanning time to 40-50 milliseconds. This makes it possible to receive extremely valuable diagnostic information on the video monitor screen, for example, reduction of individual transverse layers of the heart with a thickness of 1-2 millimeters.

Physical principles of RCT

All technologies and methods of visualization using X-rays are based on the fact that different tissues attenuate X-rays differently.

In CT, only thin layers of tissue are exposed to X-rays. There is no layering of other tissues that interfere with obtaining a clear image of certain structures.

A narrowly collimated (limited) X-ray beam scans (examines) the patient's body in a circle. Passing through the tissues, the radiation is weakened according to the density and atomic composition of these tissues. On the other side of the patient and the tube, a circular system of X-ray detectors is installed, each of which (and their number can reach 1000 or more) converts radiation energy into electrical signals. These signals are transformed into a digital code stored in the computer's memory. The recorded signal reflects the degree of attenuation in a certain direction. Rotating around the patient, the X-ray emitter "examines" the body from different angles. At the end of the rotation of the emitter, the signals from all detectors are recorded in the computer memory.

According to standard programs, the computer processes the received information and calculates the internal structure of the object. Calculation data is shown on the display. Modern tomographs allow obtaining images of very thin layers - from 1 to 5 mm thick.

Advantages of RCT over conventional X-ray examination:

1) RCTcharacterized primarily by high sensitivity, which allows differentiation separate organs and tissues differ from each other in density within 1-2%, and on 3-4 generation tomographs - up to 0.5%;

2) RCTdiffers from conventional longitudinal tomography in that it allows obtaining a clear images of organs and pathological foci only in the plane of the examined section, without layering of structures located above and below.

3) RCTmakes it possible to obtain accurate quantitative information about dimensions and density individual organs, tissues and pathological formations, which makes it possible to draw conclusions about the nature of the damage;

4) RCTallows judging not only the state of the examined organ, but also about the relationship of the pathological process with organs and tissues located nearby, for example, invasion of tumors into neighboring organs, the presence of other pathological changes;

5) RCTallows you to obtain topograms, that is, a longitudinal image of the studied area similar to an X-ray image, which allows measuring the size of pathological changes and determining the number of tomographic sections.

Diagnostics using RCT is based on direct X-ray symptoms, i.e. determination of exact localization, shape, size of individual organs and pathological foci, and, what is especially important, on density indicators. Density is measured in conventional units - Hounsfield units. This index (absorption index) is based on the degree of absorption or attenuation of a beam of X-ray radiation when it passes through the human body. Each tissue, depending on the density, atomic weight, absorbs radiation differently. All organs of the human body fit into the density range from -1000 to +1000 Hounsfield units, that is, 2000 units. For example, the cerebral cortex has a density of 19-23, white matter - 13-17, cerebrospinal fluid - 0-7 Hounsfield units. The density of water is taken as 0 units. This list already shows that with the help of RCT, images of such structures are obtained, which the radiologist could not even dream about before.

Modern medicine is impossible without RCT. But its importance is not limited to its use only for the diagnosis of various diseases. Punctures and directed biopsies of various organs and pathological foci are performed under the control of RCT. The role of RCT in monitoring conservative and surgical treatment of patients is extremely important. RCT is a valuable method of accurate localization of tumor neoplasms and centering of the source of ionizing radiation on the focus when planning radiation treatment of malignant neoplasms.

Radionuclide diagnostic method

Common between X-ray and radionuclide research is the use of ionizing radiation. All X-ray studies, including RCT, are based on the fixation of radiation that has passed through the patient's body. At the same time, radionuclide imaging is based on the registration of radiation, a radioactive drug that is inside the patient. Radiopharmaceuticals (RFDs) can be used for both diagnostic and therapeutic purposes. All of them contain radionuclides - unstable atoms that spontaneously decay with the release of energy. During the synthesis of RFP, the radionuclide is combined with a carrier molecule that determines its distribution in the body. An ideal RFP spreads in the body only within the limits intended for visualization of certain organs and structures. Recording changes in radioactivity over time can provide important information about organ function.

The ability to study physiological functions is the main advantage of radionuclide diagnostics in comparison with alternative radiological methods. In order to visualize organs and tissues, preference should be given to radionuclides that emit gamma quanta (high-energy electromagnetic radiation). Alpha particles (helium nuclei) and beta particles (electrons) are not used for imaging because of their short path through tissue. Like X-rays, the penetrating power of gamma rays increases with increasing photon energy. On the other hand, the energy of the gamma quanta should not be excessively large so that the photons do not pass through the collimated detector without absorption. For radionuclide visualization, the energy in the range of 50-200 keV is more favorable, the ideal energy is 150 keV.

Emission computed tomography

Similar to X-ray computed tomography, radionuclide studies also use tomography. Currently, two main tomographic techniques are used:

1) single-photon emission CT - SPECT (SPECT);

2) positron emission tomography - PET (PET).

Single-photon emission CT. SPECT is based on the rotation of the gamma camera detector around the patient's body, which records radioactivity at different scanning angles and reconstructs a sectional image with the help of a computer.

SPECT is used for the same purposes as scintigraphy in the static research mode, i.e. to obtain an anatomical and functional image of the organ, but it differs from the latter in that it detects even minor changes and, accordingly, allows diagnosing pathology in the early pre-structural stages of the disease and with greater benefit. The technique is widely used for examination of cardiology, neurological and oncology patients.

Positron emission tomography. PET is also a layered radionuclide method research. Ultra-short-lived radionuclides emitting positrons are used as radionuclides, the half-life of nuclides is several minutes, for example, $_{11}C$ (20.4 min.), $_{15}O$ (2.03 min.), $_{13}N$ (10 min.), $_{18}F$ (110 minutes). These elements participate in biochemical processes, which makes it possible to study not only structural changes in the body, but also metabolic processes and quantitative assessment of the concentration of radionuclides (RFP) at different stages of the disease. The technique has great potential for diagnosing various pathological processes.

The main disadvantages of radionuclides for PET are the need to use expensive cyclotrons for their production and the short half-life of radionuclides, which requires certain conditions (very close location of the cyclotron to clinical departments), which is the reason for the slow introduction of PET in practical medicine.

Radioimmunological (in vitro) diagnostic methods

Since 1982, clinics began to use (IN VITRO) diagnostic methods, which was a significant progress in radiation diagnostics. The principle of the radioimmunological method is based on the competition for the combination of the desired stable and similar labeled compounds (antigens) with a specific receiving system - with an antibody.

In vitro radionuclide analysis is called **radioimmunological** because it is based on the use of antigen-antibody immunological reactions. If an antibody is used as a labeled substance, the analysis is called **immunoradiometric**, if tissue receptors are taken as a binding system, then they talk about **radioreceptor** analysis.

The principles, indications and contraindications (limitations) for the appointment of radionuclide methods are explained in more detail in previous lectures.

The ultrasound method is a method of remote determination of the position, shape, size, structure and movements of organs and tissues, as well as pathological foci using ultrasound radiation.

The principle of ultrasonography: ultrasound refers to sound waves with a frequency of more than 20 kHz, that is, above the threshold of sensitivity of the human ear. The most frequently used frequencies are in the range of 2-10 MHz. It is known that ultrasound can penetrate through dense substances, including through the human body. At the same time, sound waves easily respond to minimal changes in the structure of the object. An ultrasound wave is reflected from the boundaries of two environments with unequal acoustic resistance (for example, blood and brain, blood and muscle, muscle and fatty tissue, muscle and bone) and returns to the sensor in the form of an echo. If an ultrasound signal is directed at a patient, then, having entered the human body, it will reflect from the boundary of two environments with different wave resistance and return back to the same place from where it was emitted, where the beam is perceived by an electronic device.

Three main ones are used in ultrasonic diagnostic devices **types of sweeps. Type A** – reflected echo signals recorded as a curve. This sweep was used in ultrasonic diagnostic devices of the first generations.

Type B - the display is recorded in two dimensions (in depth and width) and is flat tomographic display of a deep section of organs and tissues. The essence of the method is that with the help of programs, based on a series of ultrasound signals, an image is formed on the monitor screen, which is qualitatively and quantitatively analyzed, determining the dimensions, area, perimeter, contours, volume of the examined organ and other indicators. The image can be captured on polaroid paper or film.

Type M – used to study moving objects that can be defined in different ways moments of motion. This type is based on the Doppler effect, that is, on the registration of frequencies of ultrasonic waves that change due to the movements of the object under study relative to the sensor.

Ultrasound diagnostics - one of the most widespread in radiological diagnostics methods. Ultrasound scanners are, of course, inferior to computer tomographs in terms of their diagnostic capabilities. However, the ultrasound diagnostic procedure itself is short-lived, painless, and can be repeated many times. The ultrasonic installation takes up little space and does not require any protection. Ultrasound equipment is relatively cheap, simpler and cheaper to operate. Ultrasound devices can be used to examine both inpatients and outpatients with various pathologies of the organs of the abdominal and extra-abdominal cavities, pelvis, thyroid and mammary glands and other organs.

The main advantage of ultrasound research is that it does not belong to ionizing methods and does not cause biological effects, that is, it is considered harmless, which allows it to be widely used in pediatrics and obstetrics. The most important value of ultrasound diagnostics reached in midwifery With the help of this method, intrauterine detection of pathological changes in internal organs, malformations, as well as determination of the condition of the fetus, its size and the solution of other diagnostic problems in the process of fetal development are possible.

Magnetic resonance imaging (MRI) is an extremely valuable research method that allows you to obtain images of thin layers of the human body in any projection: in frontal, sagittal, axial and oblique projections, while air and bones are not an obstacle to visualization.

It is possible to reconstruct three-dimensional images of organs, to synchronize the acquisition of tomograms with the waves of an electrocardiogram. The study is not burdensome for the patient and is not accompanied by any sensations or complications.

Physical basis of MRI

MRI is based on the phenomenon of nuclear magnetic resonance. If a body located in a permanent strong magnetic field is irradiated with external electromagnetic pulses, the frequency of which is equal to the transition frequency between the energy levels of atomic nuclei, then the nuclei will begin to transition to higher energy quantum states. In other words, selective (resonant) absorption of electromagnetic field energy is observed. When the influence of the alternating magnetic field is stopped, there is a resonant release of energy in the form of an MR signal. This signal is fed to a detector and then to a computer for analysis. MR - the image is determined by three characteristics: the density of protons (that is, the concentration of hydrogen nuclei), the relaxation time T_1(spin-lattice) and transverse relaxation T_2(spin-spin) and the speed of fluid movement. An MRI image is obtained mainly through relaxation time analysis. MRI research relies on the ability of the nuclei of other atoms to behave as magnetic dipoles. This property is possessed by nuclei containing an odd number of nucleons, which differ in non-zero spin and the corresponding magnetic moment.

Compared to X-ray and radionuclide methods, MRI uses very low energy rays. It is 19 orders of magnitude lower than the energy used in X-ray and radionuclide methods.

MR - tomographs can create an image of an autopsy of any part of the body. At the same time, ionizing radiation is not used. Compared to ultrasonography and X-ray CT, this technique is more expensive, technically more complex and theoretically more difficult to understand. Despite this, MRI has made a significant leap in diagnostic radiology. Since most modern MR tomographs are configured to register radio signals of hydrogen atoms, the MR tomogram is a picture of the spatial distribution of molecules containing hydrogen atoms. The MRI system consists of a magnet that creates a static magnetic field. The magnet is hollow, it has a tunnel in which the patient is located. The table for the patient has an automatic motion control system. For radio wave excitation of hydrogen nuclei, an additional high-frequency coil is installed inside the magnet, which also receives relaxation signals.

Fields with a strength of 0.1 to 2 T are used for clinical MRI (in the experiment, the use of 7 T is allowed). In clinical practice, the radiation safety service prohibits the use of MR tomographs with a field of more than 2.5 T. Above this limit, the fields are considered potentially dangerous and can only be allowed for scientific laboratories. For comparison, Earth's magnetic field strength ranges from 0.7 Gauss at the poles to 0.3 Gauss at the equator. (1 Tl=10000 Gauss).

A significant contrast of soft tissues is one of the main characteristics of MRI, which led to the rapid development of this technique. The contrast is mainly explained by the relaxation phenomena of $T_1$and T_2.

5-10 years ago, contrast agents for MRI were considered completely unnecessary. In many clinical situations this is true, but experience has shown that contrast agents in certain pathological processes increase the amount of diagnostic information. Therefore, in recent years, a large number of contrast agents for MRI have been developed. All of them have magnetic properties and increase the intensity of the image of the tissues in which they are located, reducing relaxation (T_1 and/or T_2) of surrounding protons. Most often, contrast agents contain the paramagnetic ion of the gadolinium metal (Gd_{C+}), which is connected to the carrier molecule. Contrast agents are administered intravenously and distributed throughout the body like water-soluble radiopaque agents.

Contraindications and potential dangers of MRI

To date, the harmful effects of permanent and variable magnetic fields used in MRI have not been proven. However, the presence of any ferromagnetic object in the patient's body is an absolute contraindication to the use of MRI. The most important and dangerous objects there are metal surgical clips and metal fragments in the body, metal foreign bodies in the eyeball area. The greatest potential danger is associated with these objects-it's bleeding. The presence of pacemakers is an absolute contraindication for MRI.

MR-tomograms show soft tissues better than CT scans: muscles, fat layers, cartilage, blood vessels. The advantages of this method are especially noticeable when imaging the brain. MR-tomograms show all anatomical structures of the brain: furrows, nuclei, separate white and gray matter, cerebral ventricles. Moreover, even small brain tissue tumors that cannot be detected by X-ray CT are well visualized on MR tomograms. This is due to the fact that the relaxation time of tumor tissue is different from that of healthy tissue. Thus, MRI can analyze and obtain images of internal organs, based not only on their physical structure, but also on their chemical properties. Due to the small content of water in the bone tissue, the latter does not create a shielding effect, as in X-ray CT, thus does not interfere with imaging, for example, of the spinal cord, intervertebral discs, etc. Therefore, when obtaining MR-tomograms, there is no negative shielding of bones. Air-filled cavities, such as lungs, intestines, stomach, which occur during ultrasound, are not an obstacle for MRI. Another important property of MRI:

since the characteristic of the signal changes when the fluid moves, it is possible to obtain an image of the vessels without injecting a contrast agent into them (MR angiography).

Indications for the use of the method are constantly spreading. If in the early days, the main clinical application of MRI was limited to the clinic of neurological diseases, now studies are conducted on patients with diseases of the musculoskeletal system, heart and large vessels, pelvic organs, mammary glands, ENT organs, abdominal cavity organs. Devices with high magnetic field voltage, starting from 1.5 T, in addition to MRI, perform spectroscopy programs, which allows studying the chemical composition of tissues and metabolic processes in vivo.

Medical thermography is a method of recording the natural thermal radiation of the human body in the invisible infrared region of the electromagnetic spectrum.

During thermography, the characteristic thermal pattern of all areas of the body is determined. In a healthy person, it is relatively constant, but in pathological conditions it changes.

For the first time, the clinical value of thermography was substantiated in detail in 1956. However, the real heyday of the tool dates back to the 70s, when computerized thermographic systems with a high ability to distinguish human body temperature at a distance were created.

The human thermal field is created by infrared radiation. The latter, as is known, is electromagnetic radiation and occupies an intermediate position between visible light and radio waves. Infrared rays are invisible, they can be registered only with the help of special infrared detectors.

Preparation of the patient involves withdrawal of drugs affecting blood circulation and metabolic processes. There should be no ointments or cosmetics on the surface of the body. The patient is forbidden to smoke 4 hours before the examination. This is especially important when studying peripheral blood circulation.

Normally, each part of the body surface has a characteristic thermal relief. Above the large blood vessels, the temperature is higher than in the surrounding areas. A higher temperature is noted in areas of intense vascularization, such as, for example, in the forehead and orbits, near the mouth, in the upper part of the mammary glands. The temperature is higher in the folds of the skin and its depressions, where heat flows cross. A thermal photo contains a lot of information about the state of the body. A temperature drop of more than 10 units within 1 cm with a clear boundary indicates a pathological condition. For inflammatory processes and for malignant tumors, a characteristic zone of hyperthermia corresponds to the area of infiltration with a difference in temperature from the surrounding tissues from 1 to 2.5 degrees. When arterial blood circulation is disturbed (angiospasm, narrowing, complete stenosis of the vessel), the zone of hypothermia is determined, which corresponds to the area of decreased blood circulation. On the contrary, with pathological changes in venous vessels (thrombophlebitis, venous thrombosis), a zone of increased temperature is detected.

Thermography is used in the diagnosis of blood circulation disorders, inflammatory, tumor and some occupational diseases. With the help of a thermogram, disorders of cerebral blood circulation, occlusion of arteries and veins of the extremities are detected. Regarding cancer, thermography turned out to be the most informative when examining the mammary glands.

The method of thermography is objective, simple and absolutely harmless. There are no contraindications to it.

There is a very interesting type of thermography - liquid crystal. It is based on the property of some liquid crystals, for example, cholesterol ether, to change their optical properties depending on the temperature.

When performing liquid crystal thermography, the doctor applies a special film to the surface of the patient's body. Depending on the intensity of thermal radiation, the film-covered surface of the body is painted in all the colors of the rainbow, signaling the localization of the area of abnormal heat production.

III. Interventional radiology

The essence of interventional radiology is the combination in one procedure diagnostic (radiation) and medical manipulation. At the first stage of the study, the nature and extent of damage is determined, at the second stage, as a rule, without interrupting the study, the necessary medical manipulations are performed with the help of special tools.

He received the Nobel Prize for the introduction of X-ray in practical medicine Ch. Dotter endovascular operations.

Currently, there are the following main areas of interventional radiology:

- Endovascular
- Endobiliary
- Endoesophageal
- Endourinary
- Endobronchial
- Aspiration biopsy
- Percutaneous drainage of cysts and abscesses
- Percutaneous operations on various organs and systems

All manipulations are performed more often percutaneously with the help of special tools. As a rule, these interventions are not inferior to conventional surgical interventions in terms of effectiveness. However, they make it possible to eliminate open surgical access and shorten the patient's stay in the hospital. Interventional procedures are performed under the control of the beam method, which provides information in real time. Manipulations can be carried out with the help of x-ray, ultrasound methods, X-ray computer or MR - tomographs. During such procedures, the rules of asepsis and antiseptics are followed. Patient preparation includes premedication and anesthesia. In figure 6.1. a case of diagnosis of cancerous stenosis of the esophagus and its elimination with an endoprosthesis performed under the control of the X-ray method is demonstrated.

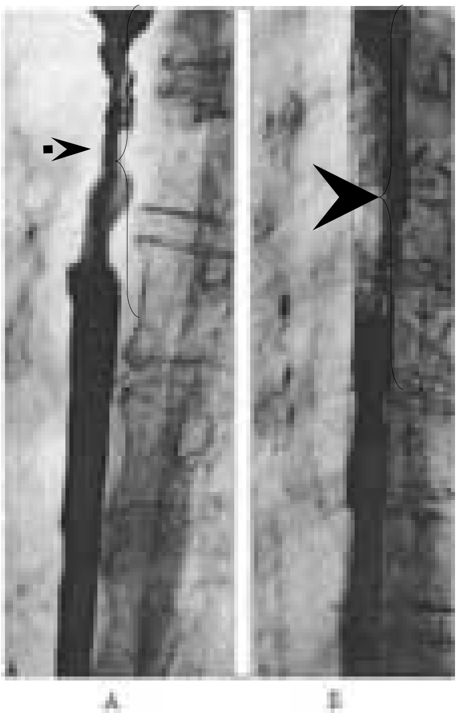


Fig. 6.1. Cancerous stenosis of the esophagus (A) and the condition after endoprosthesis insertion (B)

Materials on the activation of higher education seekers during conducting a lecture: questions, situational problems, etc(if necessary)**:**

General material and mass-methodological support

lectures:

- lecture halls according to the plan of the educational department of ONMedU
- projector, screen
- slide presentation, video film
- PC

Questions for self-control:

1. Concept of biological action of ionizing rays.
2. Sources of ionizing radiation.
3. Properties of ionizing radiation.
4. Dependence of the biological effect of ionizing radiation on its type, energy and dose.
5. Characteristics of ionization and excitation processes.
6. Mechanisms of action of ionizing radiation on living objects.
7. Metabolic changes in the body at all levels of its organization as a result of ionizing radiation.
8. Mutagenic properties of radiation.
9. Individual and species varieties of radiosensitivity.
10. Dependence of radiosensitivity on environmental conditions.
11. Methods of X-ray research: X-ray, X-ray,

planar tomography, fluorography. Advantages and disadvantages of each of the methods.

12. CT as a method of obtaining a spatial X-ray image.

Hounsfield scale.

13. Multimodality of PET/CT. Indication.
14. Ultrasound research. Indications, benefits. Modes of research. Advantages and disadvantages.
15. MRI, RND.

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Main.

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2. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 1. Kyiv, Book plus. 2015. -104 p.

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2. Non-ionizing and ionizing radiation in production conditions (hygienic and clinical aspects) / S.I. Tkach, O.Yu. Lukyanenko, V.G. Shestakov, V.V. Bagmouth. Kharkiv: Khmapo, 2014.
3. Military toxicology, radiology, medical protection: textbook / edited by O. E. Levchenko. Kyiv: SPD Chalchynska N.V., 2017. 788 p.

Lecture No. 2

Topic. Radiological research methods and radiological anatomy of chest cavity organs. Basics of radiation semiotics of the pathology of the chest cavity.

Actuality of theme: inflammatory disease bodies breath is widespread in any age and can lead to disability of a person, as well as his death. Diagnosis of lung diseases requires knowledge of x-ray anatomy and x-ray semiotics. Malignant and benign lung tumors are also distinguished. Cancer, sometimes sarcoma, is more common among malignant tumors. Lung cancer ranks first in the structure of human malignant tumors in Ukraine. In different regions of Ukraine the incidence of this pathology is different and varies widely. This disease is most common in Kirovohrad (62.8), Zaporizhzhia (52.9) and Poltava regions. It is most rarely observed in the Volyn (29.5), Rivne (29.1) and Zakarpattia (39.3) regions, so the topic is extremely relevant.

Goal:

Educational: the student must learn the principle of the method of examination of patients, the effectiveness of using the applied method, the main radiological signs of tumor diseases of the lungs, must conveniently explain that the indicated methods of examining the state of organs are performed with the help of radiological methods, but do not harm the patient; take responsibility for the patient's condition during the examination; guarantee the safety of the radiation load. Be able to find out indications and contraindications for performing basic research methods, use knowledge and skills in the evaluation of research results, carry out diagnosis and differential diagnosis of lung diseases.

Basic concepts: X-ray semiotics of the lungs in normal and disease conditions, x-ray diagnostics of inflammatory diseases, benign lung tumors, lung cancer, sarcoma,

Content of the lecture material

X-ray diagnostics of lung diseases is based on the study of the state of the chest skeleton, the volume and shape of the lung fields, their transparency, changes in the pattern of the lungs, topography of the lungs, the position and mobility of the diaphragm and mediastinal organs.

Changes lung transparency. Numerousand pathological processes in lungs cause a change in their transparency. In cases of lung tissue infiltration, tumor growth, fluid accumulation, lack of air in parts of the lungs, X-ray examination reveals the symptom of blackout. Depending on the spread of the pathological process, its nature, the shadow in the lungs can be total or subtotal, or limited.

Atelectasis of the lungs, pneumonia of the entire lung, total exudative pleurisy, and cirrhosis of the lungs give a widespread shadow.

Limited shadowing in the lungs reflects damage to the lobe of the lung, one or more segments, exudative or ossifying pleurisy, diaphragmatic hernia, mediastinal tumor. Limited shadows include focal shadows - small rounded or irregularly shaped shadows with a diameter of 0.2–1.5 cm. At the base of the focus in the lung lies the lesion of the acinus (small foci - miliary and submiliary) or lobules (large foci). Shadows of foci are often multiple (acute pneumonia, focal, hematogenous disseminated tuberculosis, pneumoconiosis, metastases of malignant tumors).

The localization of shadows, their number and shape are important for diagnosis. Despite the fact that pathological changes in the lungs are more often characterized by a shadow of an uncertain shape, there are also geometrically regular shadows (round, ring-shaped, triangular, linear).

Spherical formations of the lungs when examined in direct and lateral projections are characterized by a round shadow. Among the diseases that give round shadow in the lung, it is necessary to isolate peripheral cancer, tuberculous infiltrate, tuberculoma, metastases of malignant tumors, Echinococcus, tumor mediastinum, displacing the mediastinal pleura, benign tumors and others. The ring-shaped shadow in the lung reflects the cavity in the lung, which contains air. A closed circle is defined on radiographs in direct and lateral projections. This form of shadow can be caused by a tuberculous cavern, a peripheral cancerous tumor that is disintegrating, and an emptied abscess, an air cyst, and cystic bronchiectasis. Segmental atelectasis, pneumonia, mediastinal pleurisy, lung infarction are characterized by triangular shadows. Linear shadows in the lungs can appear in chronic inflammatory diseases as a result of the growth of connective tissue, as a result of tissue compaction in some types of lung congestion.

In the differential diagnosis of lung diseases, as characterized by the shadowing symptom, the structure of the shadow, its intensity, and the condition of the contours are important.

According to the structure, there are structureless (homogeneous), uniform and non-uniform shadows. Atelectasis, exudative pleurisy, echinococcal cyst, lobar pneumonia in the cauterization stage give a homogeneous shadow. Lung tumors, bronchopneumonia, abscess pneumonia, chronic pneumonia are characterized by non-uniform shadows.

The intensity of the shadow depends on the size of the pathological process in the lung, on the pathomorphological substrate. The shadow belongs to the intense one, if not only the lung pattern is differentiated on the background, but also the shadows of the ribs. Shadows of low intensity are characterized by the presence of a lung pattern on their background. The shadow of medium intensity does not have a lung pattern, but the shadows of the ribs are differentiated against its background.

The contours of the shadow in the lung are most often rough, blurred, gradually turning into normal lung tissue. This is observed in acute inflammatory processes. An air-filled echinococcal cyst has a clear, smooth contour

a cyst that suppurated, an inflammatory process of one lobe, the shadow of which is clearly limited by the interlobular gap. A tuberculoma, a peripheral lung cancer, gives a clear, bumpy contour.

Increased transparency of the lungs - hyperpneumatosis occurs in a number of diseases and can be diffuse, bilateral, unilateral or local. The increase in the transparency of both lung fields is due to the increase in the volume of lung tissue in patients with emphysema, bronchial asthma, and chronic widespread bronchitis. An increase in the transparency of one lung is due to a violation of their ventilation (valvular blockage of the bronchus).

A local symptom of increased transparency is given by an air cyst. The so-called giant air cysts sometimes occupy almost the entire lung and cause an increase in its transparency. Cavities in the lungs that contain air (tuberculous cavern, disintegrating peripheral cancer, abscess that has emptied, cystic bronchiectasis, pneumothorax) determine the presence of a local increase in transparency.

Changes in the lung pattern. The majority diseases lungs are accompanied by a change in the pulmonary pattern - strengthening, impoverishment and deformation.

The strengthening of the pulmonary pattern is most often due to a violation of the pulmonary blood flow and is characterized by an increase in the number of elements of the pulmonary pattern, a denser network of small vessels reaching the outer sections of the lung fields. Strengthening of the pulmonary pattern is found in acquired and congenital heart defects, with an increase in pulmonary blood flow in acute inflammatory processes.

Impoverishment of the lung pattern (decrease him elements) observed in valvular emphysema, giant air cysts, congenital heart defects with reduced pulmonary blood flow (tetrad of Fallot, pulmonary artery stenosis, etc.).

Strengthening and deformation of the lung pattern is caused by the growth of connective tissue around the vessels, bronchi, interlobular and interosseous septa and is characterized radiologically not only by a change in the normal course of vascular branches, but often also by the cellular structure of the lung tissue. Such changes in the pulmonary pattern are observed in chronic pneumonia, chronic bronchitis, pneumosclerosis of tuberculous and non-tuberculous etiology, bronchiectasis, pneumoconiosis, etc.

Changes in the roots of the lungs. Many lung diseasesand are accompanied by a change in the roots of the lungs, primarily by their expansion. Root expansion of the lungs can be unilateral, for example, with acute inflammation, and bilateral. Bilateral expansion of the roots of the lungs without a change in their structure and position is observed with increased blood circulation in the small circle of blood circulation with acquired and some congenital defects. The expansion of the roots of the lungs in some cases is accompanied by an increase in the lung pattern and an increase in the configuration of the heart. The expansion of the lung roots is facilitated by the enlargement of the lymph nodes.

In children, the expansion of the root of the lungs with a lack of structure, with a not sharp contour from the side of the lung field is due to tuberculous damage to the lymph nodes. Polycyclicity of extended root contours

lung in an adult indicates a tumor lesion of the lymph nodes.

Violation of lung ventilation occurs as a result of blockage of the bronchus most often by a growing tumor node, a foreign body, etc.

There are three stages of violation of bronchial patency. The first stage is characterized by a narrowing of the lumen of the bronchus and insufficient air inflow in the ventilated segment or segment. This leads to hypoventilation, that is, a decrease transparency and strengthening of the pulmonary pattern as a result of the expansion of blood vessels, the reduction of the size of the lobes of the segment. The second stage - valvular blockage of the bronchus, is accompanied by the development of emphysema, because in the exhalation phase the bronchus narrows, and air accumulates in the lobe or segment. If in the first stage of violation of bronchial patency there is a percussive shift of the mouth to the side of the pathology during forced inhalation (Holtzknecht-Jakobson symptom) and when trying to cough, as well as when exhaling, a shift of the mouth to the healthy side (Prozorov's symptom) is detected, then in the second stage displacement of bronchial patency in the opposite direction.

The first two stages of violation of bronchial patency can lead to the third, i.e. complete obturation of the bronchus and the development of atelectasis. With total atelectasis, an intense shadow of the corresponding half of the chest cell, which merges with the diaphragm, is observed. The cardiovascular shadow is shifted to the side of the pathology.

Change in position and impaired mobility of the diaphragm. Disease of the lungs, which are accompanied by a decrease in the volume of the lung or lobe as a result of the development of cirrhosis, fibrothorax of various origins, atelectasis, as well as the absence of a lobe or the entire lung as a result of surgery, is characterized by a high position of the diaphragm. This is also observed during relaxation, paresis and paralysis of the diaphragm. Sometimes the high position of the diaphragm is due to the growth of tumors of the subdiaphragmatic organs.

A low position of the diaphragm is observed when the volume of the entire lung or its part increases (emphysema, bronchial asthma, compensatory hyperpneumatosis).

Limited mobility of the diaphragm is most often due to the presence of pleurodiaphragmatic adhesions, which is observed in the case of transferred pleurisy, after surgery on the diaphragm. The lack of mobility of one of the domes of the diaphragm can be due to its paralysis or massive pleural adhesions. Displacement of the dome of the diaphragm in the direction of the lesion is characteristic when inhaling - up, when exhaling - down.

Displacement of interoral organs. This symptom plays a big role in differential diagnosis of lung diseases, most often I accompany them. Displacement of the mediastinum to the diseased side is observed in diseases that lead to a decrease in the volume of the entire lung, a lobe or several segments (cirrhosis, fibrothorax, atelectasis, after lung resection). In diseases that lead to an increase in intrathoracic pressure due to the accumulation of fluid or an increase in the volume of the entire lung, or due to the development of emphysema or tumor growth, the mediastinum shifts to the healthy side. See above about interstitial displacement during functional tests (Holtzknecht-Jakobson symptom and Prozorov symptom).

Nonspecific inflammatory diseases.

Bronchitis – inflammatory process in the bronchi with an acute or chronic course. In terms of frequency, it exceeds the frequency of other chronic inflammatory lung diseases.

Pathological anatomical changes, occurring in patients with acute bronchitis, are characterized by the development of inflammatory hyperemia, edema of the mucous membrane of the bronchi, hypersecretion of the mucous glands, In the case of a chronic course disease impressed the whole thicker walls bronchus: muscular and connective tissue layers and lymphatic vessels. Atrophic or hypertrophic histological changes may predominate in the mucous membrane and polyp-like growths may form. Secretion is different: serous, purulent, purulent-hemorrhagic.

X-ray signs. During X-ray examination of patients with acute bronchitis as an independent disease or accompanying pathology in the case of the development of an acute respiratory infection is characterized by an increase in the pulmonary pattern, which is severe in nature, mainly in the basal zones and basal parts of the lungs. On radiographs, paired strips of thickened bronchial walls of the 3rd-5th order, and sometimes smaller, are differentiated. In some places, U-shaped branches of the bronchi are observed. Bronchi filled with secretion resemble dilated vessels in the longitudinal projection, and individual foci in the axial (orthograde) view. The appearance of foci and small disc-like shadows of lobular atelectasis is possible as a result of violation of bronchial drainage (edema of the mucous membrane, obstruction of the bronchi with thick secretions, mucus, desquamated epithelium, as well as spasms).

In the case of valvular violation of ventilation, an increase in the transparency of the limited subpleural zones of the lungs is noted - swelling.

The roots of the lungs are moderately expanded. There is no pleural reaction. These symptoms can be barely noticeable or pronounced. During the dynamic examination of patients, the disappearance of the listed signs is observed after 3-7 days. The pulmonary pattern normalizes.

Chronic bronchitis characterized by more pronounced X-ray morphological and functional changes, especially in the period of exacerbation.

On the radiographs on both sides, strengthening and deformation of the pulmonary pattern are noted. This happens due to thickening of the bronchial walls and peribronchial pneumofibrosis. These changes are especially pronounced in the basal zones and basal parts of the lungs, where multiple bronchi in the longitudinal projection form parallel linear shadows ("rails" symptom). In the axial projection, clearly defined rings with intense walls of the corresponding diameter are noted. The thickened bronchial walls largely cover the vascular pattern. In patients with chronic bronchitis, in addition to heavy and ring-shaped structures, separate fire-like shadows are revealed. Their formation is due to the presence of atelectasis, fibroatelectases of individual lobes and their groups. In addition, limited increases in transparency can be observed - lobular swellings, bullous emphysema, which are noted mainly in the cortical layers of the lungs. The roots of the lungs are expanded due to the branches of the pulmonary artery, in which the pressure increases over time. Chronic bronchitis is characterized by a decrease in the number of medium and small branches of the pulmonary artery. These changes are better visualized during a CT scan. In the exacerbation phase of bronchitis, the expansion and reduction of the structure of the roots may be associated with moderate reactive hyperplasia of the lymph nodes.

Bronchography makes it possible to study anatomical and functional changes in the bronchi. Bronchographic signs are divided into reversible and irreversible (permanent).

The occurrence of reverse symptoms is due to hypersecretion and accumulation of mucus in the bronchi: a decrease in the number of bronchial branches due to non-filling with their x-ray contrast agent, truncation of individual bronchi, fragmentary filling, unevenness of the internal contour.

Irreversible, permanent signs reflect the degree of anatomical changes in the bronchial walls. Persistent unevenness of the contours of the bronchi, thickening of their walls, transverse striation of the relief, jaggedness of the internal contours of the II-Ж order bronchi and unevenness of their width are noted, which is caused by the development of adenoectases, cylindrical or fusiform bronchiectases or deforming (varicose) bronchitis.

During functional bronchography after artificial contrast, slight or complete absence of changes in the transverse size of the bronchi during the phases of maximum inhalation and exhalation is observed.

During remission of chronic bronchitis prevail signs peribronchial pneumosclerosis and emphysema. Over the years, patients develop arterial hypertension, the function of external breathing decreases, and respiratory insufficiency increases.

Bronchial asthma ~~is~~ a chronic relapsing allergic disease, which is characterized by periodic occurrence of shortness of breath caused by bronchial spasm, hypersecretion and swelling of the mucous membrane. More often, the disease begins in childhood, and then gradually progresses.

X-ray acute swelling of the lungs is observed during the attack, limitation of excursions of the low-lying diaphragm, periodic twitching of it instead of excursions, jaggedness of the contour of the diaphragm at the level of the front ribs in the places of attachment of muscle bundles.

Between the attacks, basically the same symptoms are observed, but less pronounced. Over time, patients develop permanent anatomical and functional changes: barrel-shaped deformation of the chest with a more horizontal position of the ribs, emphysema of the lungs, pronounced fibrous deformation of the lung pattern, which occurs due to thickening of the walls of the bronchi, expansion of arterial vessels in the roots and basal zones, low position and flattening diaphragm, the limitation of its excursions. Periodically, volatile infiltrates (eosinophilic or non-eosinophilic) may occur.

During the X-ray examination, the formation of single rounded or confluent foci of darkening without typical localization is observed in the lungs. They have a uniform structure, low or medium intensity, vaguely defined edges. Enlargement of internal lymph nodes and pleural reaction are absent. Volatile infiltrates persist for 1-2 or 3-7 days, and then disappear without a trace, the pulmonary pattern normalizes. Relapses are possible, which are more common during an exacerbation of bronchial asthma. However, there are no changes left.

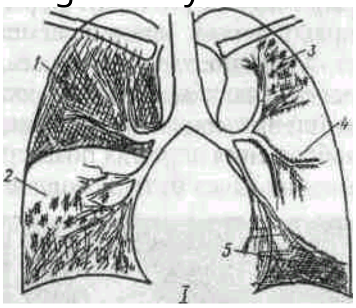
Pneumonia: Pneumonia is one of the most common inflammatory diseases lung diseases. The pathological process is localized in the bronchi, brochioles, alveolar parenchyma, and connective tissue. It often spreads to the vascular system of the lungs.

X-ray observe an increase in the lung pattern due to infiltration of bronchial walls, numerous foci of inflammation of medium intensity, vaguely defined, in some places merge with each other. Pneumonia foci alternate with unaffected or compensatory areas swollen parenchyma. At the level of focal changes, the vascular pattern loses its differentiated image. The roots of the lungs are infiltrated, sometimes moderately enlarged lymph nodes are found. Possible reaction of the pleura according to the type of productive or exudative pleurisy.

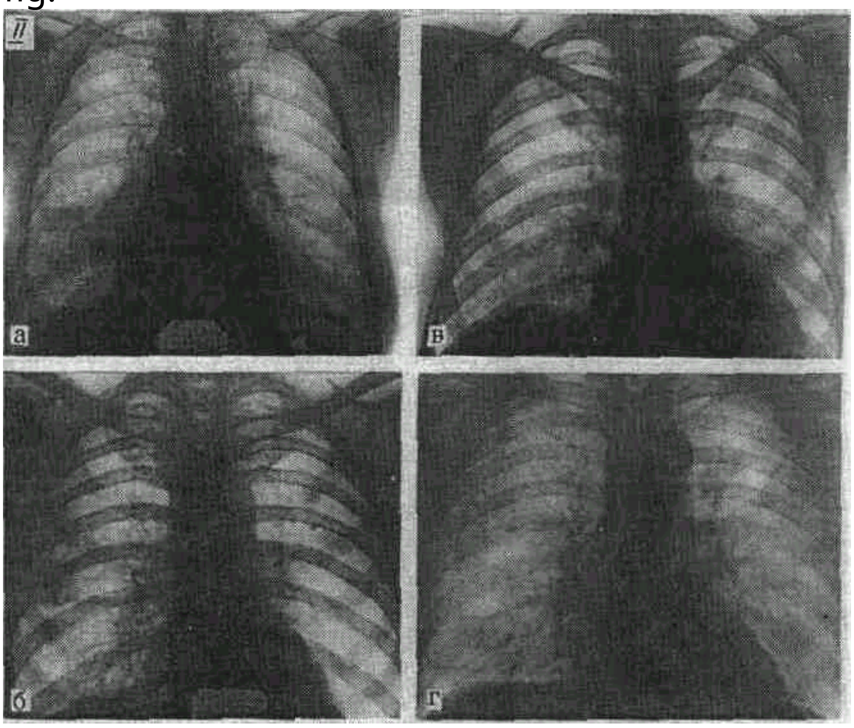
A feature of focal pneumonia is its rapid dynamics. Thus, within 4-6 days, the symptoms increase, and after 10-12 days, pneumonic foci often completely resolve.

The differential diagnosis of focal pneumonia is sometimes carried out with focal tuberculosis in the infiltration phase, pneumonia-like metastases. If tuberculosis is characterized by a lack of dynamics within 10-14 days, with metastases, on the contrary, there is an increase in the size and prevalence of foci, an increase in interstitial changes, and an increase in lymph nodes.

Interstitial pneumonia – an independent nosological form of inflammation, caused by various viruses. The infection spreads hematogenously. The endothelium of capillaries is primarily affected.



The image of X-ray signs of various types of pneumonia is presented in fig.

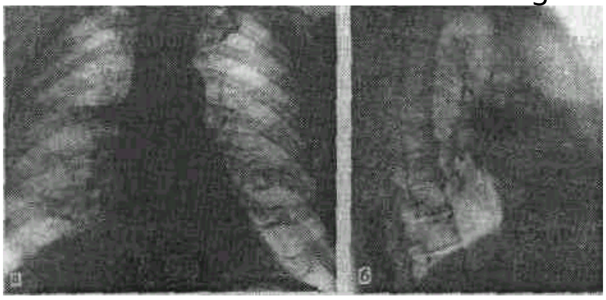


Computed tomography. With the help of CT studies, it is possible to detect changes in lung tissue at an earlier stage of the disease with acute pneumonia, as well as to more accurately determine the localization and spread of the process, especially in areas that are not detected during radiological examination (costal-vertebral and mediastinal areas). In case of prolonged course pneumonia, when there is a risk of the process transitioning into a chronic state, changes in the lung parenchyma can be traced using CT. CT is used when the patient has clinical and radiological signs of pneumonia.

Complications of acute pneumonia: the transition to a chronic inflammatory process lower respiratory tract, carnification, suppuration, pleurisy, pleural empyema, broncho-pleural fistula.

Chronic diseases of the lower respiratory tract is limited by a share or segment, an inflammatory process of infectious origin, which periodically worsens and causes organic and functional changes in the bronchi, blood and lymphatic vessels, parenchyma and interstitial stroma of the lungs.

X-ray signs: taking into account the changes in the bronchi, the following forms of the disease are distinguished: chronic inflammation with bronchiectasis, chronic inflammation without bronchiectasis and cirrhosis. Bronchography can be used to clarify the form of chronic inflammation. The upper and middle lobes of the right lung, the main segments of the lower lobes and the IV segment are most often affected.



Chronic inflammation in the stage of exacerbation is characterized by volume reduction of the affected part of the lung (lobe, segment), which retains its shape, and sometimes changes it to a round, elongated one. Note the displacement of the interlobular pleura, the presence of pneumonic infiltration of a heterogeneous structure due to the image of individual dilated bronchi or areas of swelling. In addition, the heterogeneity of the darkening structure may be caused by the presence of secretions in bronchiectasis, small cavities of destruction with horizontal levels of liquid. The affected segment of the lung merges with a moderately infiltrated root. The latter is shifted in the direction of the maximally reduced segment. Condensed costal, interlobular, diaphragmatic pleura, sinuses are partially or completely obliterated.

Bronchography makes it possible to detect uneven expansion and, in places, narrowing of bronchi that are close to each other, non-filling of the VI-VIII bronchi with contrast material, numerous "filling defects" due to hyperplasia of the mucous membrane and accumulation of secretions. In the presence of bronchiectasis, mixed, cylindrical, bag-like bronchiectasis are observed, in which the contrast medium forms horizontal levels.

Signs of exacerbation of the inflammatory process are observed for 6-8 weeks, and then gradually decrease. In the phase of remission, the volumetric reduction of the lobe or segment is preserved and there is an increase and deformation of the lung pattern. This happens due to the development of pneumosclerosis, chronic bronchitis, bronchiectasis. Infiltration of the root of the lungs disappears.

Periodic exacerbations of the inflammatory process lead to the progression of pneumosclerotic changes, and in some cases to the development of cirrhosis.

Cirrhosis – this is the final phase of the chronic inflammatory process, if present whose pulmonary parenchyma is replaced by fibrous tissue.

During the x-ray examination, a significant decrease in the volume of the affected part of the lung and a significant increase in the intensity of the shadow are revealed. Against the background of darkening, a non-homogeneous heavy structure due to air strips of individual dilated bronchi can be traced, which is better determined during conventional and computer tomography.

Complication hemoptysis, bleeding, suppuration of bronchiectasis, bronchogenic spread of the inflammatory process and the development of bronchitis or bronchopneumonia, as well as pleurisy, pleural empyema as a result of contact spread of the inflammatory process or breakthrough of the focus of destruction in the pleura.

Pneumonia in AIDS. AIDS patients have an inevitable complication pneumonia characterized by a sharp decrease in the body's resistance to exposure to opportunistic microbes. This happens as a result of damage to T-lymphocytes, T-helpers.

Infection of children can occur transplacentally from a mother suffering from AIDS, through breast milk, during manipulation with non-sterile medical instruments, etc.

Infection of adults mainly occurs sexually. Clinical the course of this disease resembles the course of SARS, bronchitis, pneumonia, gastroenterocolitis, candidiasis.

X-ray changes non-specific in the lungs. In the vast majority patients observe bilateral, almost symmetrical changes such as deformation and enrichment of the pulmonary pattern, root infiltration. Along with this, one- or two-sided focal, focal effusion shadows appear in the lungs. Children often develop segmental atelectasis. Massive pneumonic infiltration can be complicated by exudative pleurisy. A distinctive feature of pneumonia that develops in children with AIDS is an active inflammatory reaction in the lymph nodes of the roots of the lungs and the mediastinum. Bronchopulmonary and tracheo-obronchial nodes on both sides are enlarged to 2-3 cm.

Forecast severe. Despite complex anti-inflammatory therapy, the process in the lungs progresses relentlessly, pneumonia in most cases becomes the cause of death of patients.

Lung echinococcosis. The causative agent of lung echicoccosis is tapeworm cystode worm Getting into the lungs by the hematogenous route, the parasite forms cysts.

Under X-ray time studies reveal an echinococcal cyst that has a well-defined rounded or oval shape. The structure of the shadow remains uniform for a long time. As the size of the cyst increases, its shape can change, become irregular, with separate protrusions. Sometimes on the contour of the cyst, separate small crescent-shaped lightenings, due to air streaks, may appear. Their occurrence is caused by bedsores in the wall of a small bronchus and the penetration of air into the space between the chitinous and fibrous membranes. This feature is pathognomonic for echinococcus and is important in the differential diagnosis of rounded shadows. After partial emptying of the cyst, a horizontal level of liquid appears in it; sometimes it is wavy due to the floating chitinous membrane. In the case of complete emptying through the bronchus, an air cyst remains. The surrounding lung tissue and roots are not changed. Sometimes there are multiple echinococcal cysts in both lungs - echinococcosis. After the death of the parasite, an increase in the intensity of the shadow of the cyst and calcification of the fibrous membrane are observed. The structure of the shadow becomes heterogeneous, speckled or characterized by solid shell-like calcification. Calcified echinococcus usually gives a stable picture.

Complications: suppuration of an echinococcal cyst, breakthrough of a cyst into a bronchus or pleural cavity. Compression of the segmental bronchi and violation of bronchial patency with the formation of valve swelling of the segment, the development of hypoventilation, atelectasis, and the addition of pneumonia in the area of hypoventilation are possible.

Alveolar echinococcosis is combined with liver damage and is characterized by multiple lung damage. The size of the cysts is relatively small (1-3 cm).

X-ray distinguish hearth, infiltrative, pneumonia-like, tumor-like, cavitary and mixed forms of echinococcosis, which, in fact, can represent different stages of the disease. In the dynamics, a slow but constant increase in cysts is observed.

Emphysema of the lungs is a stable expansion of the terminal airways, located distally from the bronchioles. The development of emphysema is accompanied by a violation of the function of external breathing.

X-ray signs and the degree of their expressiveness depend on the etiology, duration and prevalence of the disease.

Acute emphysema can be limited (involves a group of lobes, a segment, a lobe) or widespread (affects both lungs).

X-ray semiotics emphysema lungs characterized by X-ray morphological and X-ray functional X-ray morphological signs signs changes in the skeleton of the chest and diaphragm, violation of the structure of the lung pattern, heart damage.

Changes in the chest skeleton are characterized by its barrel-shaped deformation, expansion of the intercostal spaces, horizontal position of the ribs, forward protrusion of the sternum, kyphosis of the thoracic spine. Along with this, the low position of the diaphragm and its straightening or bending downwards (increase in the vertical size of the lungs) are revealed;

deformation of the contour of the diaphragm (jaggedness, waviness); the image of the attachment sites of the dentate muscles against the background of the shadows of the corresponding ribs;

increasing the distance between the arch of the aorta and the clavicle; increase in the angle of the costo-phrenic sinus;

increase in the area of lung fields; expansion of the retrosternal and retrocardial spaces. Patients with emphysema have an increased transparency of the lungs, as a result of which the aorta has a clearer image on the X-ray taken in oblique and lateral projections. In these patients, the undulation of the outer contour of the lungs is also noted. With the help of CT, it is possible to clarify the localization and prevalence of emphysematous changes. The study helps to identify the smallest bullae (0.5 cm in size), which in case of subpleural location form a scalloped contour of the lung. The inner contour was always even. Sometimes, on the left, the inflated pulmonary parenchyma of the basal segments penetrates between the heart and the diaphragm and separates the diaphragmatic surface of the heart from the diaphragm; the vascular pattern in the peripheral parts of the lungs is depleted. In addition, deformation of the pulmonary pattern, avascular zones with a looped rearrangement, thin-walled bullous cavities in the subpleural regions, arcuate deviations of vessels at different levels and pneumosclerosis of varying severity are observed. Segmental, partial, main branches of the pulmonary artery are expanded (secondary arterial hypertension).

Obstruction of blood circulation in the lungs leads to the formation of chronic pulmonary heart disease. In patients with emphysema, it has small dimensions (transverse size does not exceed 11-11.5 cm). On the radiograph, made in the right oblique and left lateral projections, hypertrophy of the right ventricle of various degrees with bulging of the pulmonary trunk and arterial cone is noted.

X-ray functional signs of emphysema: a noticeable difference in the transparency of the lungs during inhalation and exhalation (Sokolov's symptom) is not detected; observe a decrease in the excursion of the diaphragm and the mobility of the ribs during breathing, as well as a decrease in the coefficient of expansion of the chest. An increased amplitude of contractions of the right ventricle, increased pulsation of the vessels of the roots of the lungs are observed on the X-ray. In the case of performing angiopulmonography and lung scanning, slowing of capillary blood flow and arteriovenous anastomoses are observed.

Lung dystrophy(progressive) is the extreme degree of emphysema, which characterized by the absence of lung parenchyma, including small vessels and bronchi. The affected part of the lungs does not participate in gas exchange processes. The disease occurs more often in older men. Its development is based on a chronic inflammatory process, more often - tuberculous.

X-ray changes. The lesion is localized on one or both sides of the within the boundaries of a subsegment, a segment, sometimes a lobe, as a rule, the upper one. In the affected area, the lungs show an extremely high transparency, complete absence of the pulmonary pattern at this level. Only separate thin linear strands can be observed. They cross the zone of high transparency and are directed perpendicularly to the thickened pleura. The outer contours of the foci, characterized by high transparency, merge with the thickened pleura and chest wall, the inner ones are clearly separated from the surrounding lung parenchyma. Bullous swellings can be observed around, due to which areas of dystrophic changes are increasing. In the adjacent parts of the lungs, signs of a transferred chronic inflammatory process (tuberculosis, bronchitis), convergence and deformation of the lung pattern, compacted and calcified foci are revealed. The roots are also fibrously compacted, deformed. The mediastinum, in contrast to what happens in the presence of a pneumothorax, is not displaced.

Lung cancer. A cancerous tumor develops from the epithelium of the mucous membrane bronchi and mucous glands.

Radiological symptoms Lung cancer is numerous and diverse. Their character depends on tumor localization (central, peripheral cancer), predominant direction of its growth (endo- or exobronchial), growth phase (expansive, infiltrative), complications (pneumonia, decay, presence of regional or distant metastases).

Central cancer. Based on the macromorphological changes, the following are distinguished X-ray variants of central lung cancer: endobronchial, exobronchial, peribronchial-infiltrative, one of its variants is branched. They have their own characteristics.

In the presence **endobronchial** cancer the tumor grows in the form of a polyp or a limited node in the lumen of the bronchus and early causes a violation of ventilation. Depending on the degree of narrowing of the bronchus, hypoventilation (segments, lobes) first occurs, followed by obturational emphysema (swelling) and incomplete and complete atelectasis.

Hypoventilation is accompanied by a slight decrease in volume and a decrease in the transparency of the affected segment or part of the lung, an increase in the pulmonary pattern due to the convergence of blood vessels.

Obstructive emphysema is characterized by the opposite signs: some increase in the volume of a segment or lobe of the lung, increase in their transparency, impoverishment of the vascular pattern due to the distance of the vessels in the enlarged lobe.

Atelectasis occurs when a bronchus is obstructed by a tumor, as well as accumulation of mucus in its narrowed lumen and concomitant swelling of the mucous membrane. The lobe or segment is reduced in volume and intensely darkened. Against the background of homogeneous darkening, vessels and bronchi are not differentiated. A segmental or partial bronchus is amputated, abruptly cut off, or conically narrowed. Depending on the spread of atelectasis (lobe, segment), mediastinal organs are shifted to some extent in the direction of atelectasis.

Exobronchial (nodular) cancer characterized by damage to the wall bronchus and early spread of its node around the bronchus. If the size of such a node in the root does not exceed 1 cm on ordinary radiographs, it remains invisible because it is covered by the vessels of the root. Later, a round or oval shadow of the tumor appears along the narrowed partial bronchus, which has clear, sometimes wavy contours and an intensive homogeneous structure. Over time, expansive growth is joined by infiltrative growth: heavy, radiant shadows appear, there is an intensification of the lung pattern, caused by tumor growth in the lung and disruption of blood and lymph flow. Enlarged lymph nodes may appear in the root or mediastinum. In the presence of an exobronchial tumor, atelectasis occurs late. In case of atelectasis contours of the tumor and metastatic lymph nodes in the root of the lung cease to differentiate.

In patients with peribronchial-infiltrative cancer, uneven narrowing of one or several adjacent bronchi, tumoral peribronchial infiltration without complete obturation of the bronchi, patients have only a moderate violation of ventilation, which develops according to the type of hypoventilation or emphysema. Sometimes bronchitis and chronic pneumonia develop, bronchial dilation and the formation of retrostenotic bronchiectasis can be observed. For these reasons, sometimes cancer patients are mistakenly diagnosed with a chronic inflammatory process in the lungs. During tomography, narrowing of a segmental or partial bronchus, thickening of its wall are revealed. The root loses its normal structure. It is expanded, enlarged bronchopulmonary lymph nodes are often noted. Sometimes patients develop cancerous lymphangitis: increased radial roughness and an uneven looped structure of the lung pattern, which spreads from the root to the periphery (branched cancer). Infiltrative growth of the tumor along the large vessels of the mediastinum (aorta, superior vena cava), growth of the tumor into adjacent organs and tissues is possible. Then pleurisy joins.

It should be noted that the progression of central lung cancer, as a rule, occurs in the direction from segmental to partial bronchus. In the advanced stage of the disease, damage to the main bronchus is observed up to the bifurcation of the trachea.

Computed tomography has some advantages compared to the usual one longitudinal tomography. It makes it possible to determine the initial stages of the development of bronchostenosis earlier than the last: convergence, moderate expansion of blood vessels and vagueness of their contours. With the help of densitometry, it is possible to recognize the smallest degree of reduction of lung pneumatization and endobronchial tumor growth, as well as the uneven structure of the lung parenchyma in the presence of a peribronchial tumor. CT scan always shows hyperpneumatization of the lung next to areas of hypoventilation. CT makes it possible to detect the smallest atelectasis of any localization. It happens that in the area where atelectasis is located, small abscess cavities are revealed on the CT scan, which cannot be determined with the help of conventional longitudinal tomography. CT makes it possible to determine the presence of even a small amount of fluid in the pleural cavity. This technique is optimal for assessing the spread of lung cancer in the lung itself, root, pleura, mediastinal organs, chest wall.

CT is important for determining the scope of surgical treatment, topometric preparation of patients for radiation treatment and for evaluating its results, etc.

Peripheral cancer characterized by the formation of a tumor outside the root lungs. The tumor affects the subsegmental bronchi or their branches up to the cortical layer of the lungs. It grows as a single node. Small tumors (1-2 cm) have an irregular rounded or slightly elongated or polygonal shape. Their structure is homogeneous, the contours are clear, sometimes noticeably hilly. Surrounding parenchyma, unchanged. An increase in the size of the tumor to 3-5 cm leads to the formation of a more rounded node. Its structure becomes heterogeneous due to the formation of many nodes (multicentric growth).

The contours of the tumor lose clarity, short strands are formed, spicules are tendrils of different thickness, directed towards the parenchyma. Over time, signs of lymphangitis develop. The pathological process spreads towards the root or pleura in the form of a so-called track. At this level, the costal pleura is thickened. Having reached the chest wall, the tumor spreads to the ribs, where destruction centers appear.

Decay in a peripheral tumor can be single or multi- and small-focal. Often, a single cavity located eccentrically at first has an irregular sickle-shaped or slit-like shape. Over time, if the tumor decay processes progress, the size of the cavity increases. It acquires a more rounded shape, its internal contours become wavy, polycyclic. The walls of the cavity form a shadow of considerable intensity and have an uneven width. During obturation of the draining bronchus, the cavity is filled with liquid, the amount of which increases with the development of complications (suppuration). Simultaneously with the disintegration, there are signs of infiltrative growth of the tumor towards the root or pleura, as well as metastases in the broncho-pulmonary nodes.

One of the variants of peripheral lung cancer is cortico-pleural cancer. It also originates from the mucous membrane of the small bronchi of the cortical layer of the lungs and is characterized by the infiltrative growth of the tumor into the lung pleura, as a result of which it grows early into the chest wall. A tumor that is localized at the apex of the lung is called a Penkost tumor. The course of this form of cancer is accompanied by a significant pain syndrome, which develops according to the type of intercostal neuralgia, plexitis, thoracic radiculitis. In the case when the tumor is localized in the apex of the lung, Horner's syndrome develops (lowering of the eyelid, narrowing of the eye slit and pupil).

Radiologically corticopleural cancer is characterized by intense parietal darkening of a homogeneous structure, which merges with the image of the chest wall. The inner contour is relatively clearly defined. In the adjacent parts, the rib pleura is thickened. On an overexposed X-ray at the level of the location of the tumor, over time, the destruction of one or two ribs, a transverse process or a vertebral body is observed.

With the help of computer tomography, it is possible to diagnose peripheral cancer, the diameter of which is less than 1.5 cm. Note the irregularity of its shape and bumpiness of the contours, which often have a homogeneous structure. Sometimes disintegration or microcalcification of the tumor nodule is visualized. The main sign of malignancy is lymphangitis, which is characterized by the presence of a radiant crown and a path up to 5 mm wide, which are directed to the root of the lung. The same track is traced from the outer contour of the tumor to the visceral pleura. The use of CT makes it possible to detect the smallest amount of fluid in the pleural cavity. A pleural reaction of the interlobular fissure may also be observed. Disc-like atelectasis is sometimes visualized in the area where these changes are observed. CT makes it easier to determine the transition of a peripheral tumor to the chest wall and helps to detect metastases in the lymph nodes and pleura.

In addition to central and peripheral lung cancer, there are other forms of it: mediastinal and partial cancer, as well as cancer pneumonia. They have their own clinical and radiological features, which, in fact, are various manifestations of the development of advanced cancer.

Mediastinal cancer – variety of central cancer. Tumor growth, as as a rule, it begins from the medial wall of the main or partial bronchus, sometimes at the level of the bifurcation of the trachea. Most often, the tumor spreads towards the mediastinum and grows into neighboring organs. Moreover, relatively early but widespread metastasis to the tracheobronchial group of lymph nodes is observed. The tumor together with the metastases developing in the nodes of the mediastinum forms a conglomerate that grows into large vessels and the esophagus and compresses them. Clinically, the superior vena cava syndrome is detected (swelling and puffiness of the face, wide pulsating vessels on the neck, etc.).

Radiologically, mediastinal lung cancer is characterized by expansion and deformation of the mediastinum, an increase in tracheo-bronchial nodes with clear contours. Contrasted esophagus, as a rule, is shifted to the opposite side and unevenly narrowed. In the case of tumor growth of the wall of the esophagus, its contours lose clarity and become uneven. A tomogram or bronchogram reveals narrowing of the main or partial bronchus, an exobronchial component within the lung root and mediastinum, enlarged mediastinal nodes with clear, polycyclic contours.

Cancer of the lobe (partial cancer) arises as a result of the spread of the central or a peripheral node of the tumor for the whole part. Its volume increases, which is evidenced by the protrusion of the pleura of the interlobular fissure. The contours of the lobe remain clear for a long time, although they can become convex, wavy, repeating the topography of the tumor. The structure of the shadow of an intensely darkened lobe is uniform. Vessels and bronchi cannot be traced in it. Enlarged regional lymph nodes are also not shown. During the disintegration of the tumor, the structure of the shadow becomes heterogeneous. The organs of the mediastinum are sometimes shifted to the healthy side, pleurisy joins over time.

Cancer pneumonia meets rarely. It arises because of bronchogenic spread of the tumor from the primary endobronchial node, which is more often located in the peripheral parts of the lung.

X-rays reveal pneumonia-like foci within a lobe or lung, which sometimes resemble focal pneumonia or tubercular dissemination observed in both lungs. The foci of medium intensity are vaguely outlined and merge in places. The number of foci increases over a short period of time (1-2 months). Multifocal decay and metastases to the bronchopulmonary nodes can be observed.

Complications of lung cancer: pneumonia, decay in the area of atelectasis or tumor, suppuration, pleurisy, metastases in distant organs and tissues (skeleton, liver, brain), tumor growth in adjacent mediastinal organs (aorta, superior vena cava, esophagus, pericardium, etc.).

Lung adenomatosis (bronchioloalveolar cancer) — highly differentiated carcinoma. It occurs rarely at any age, regardless of gender. X-ray changes in lungs are similar to pneumonia-like peripheral cancer, partial cancer or pneumonia-like metastasis. Most often, adenomatosis begins with the formation of separate foci of 0.5-3 cm in size, located in the peripheral parts of the lungs. The contours of the foci are uneven, clear.

The foci tend to merge and form darkening in the form of large conglomerates, which over time spread over the entire lobe. The structure of massive eclipses is heterogeneous in connection with multicentric growth and the image of lumens of small bronchi. There are no signs of bronchial patency disorders. Destruction in the tumor is rare, only in the presence of advanced partial lesions. Along with changes in the lungs, fluid may appear in the pleural cavity.

Computed tomography as well as the usual longitudinal tomography, does not give specific signs. The development of lung adenomatosis is characterized by the formation of individual nodular structures; multiple small nodular formations with a diameter of 5-20 mm (the shape of the nodes is round), effusion into the pleural cavity may be observed; the progressive interstitial spread of the process is rarely determined. Uneven infiltration of the parenchyma is revealed. The patency of the small bronchi is not disturbed. There is no metastatic lesion of the intrathoracic lymph nodes. Metastasis occurs by hematogenous route. Verification of the diagnosis is carried out on the basis of catheterization or transthoracic puncture and biopsy data. Forecast unfavorable.

Sarcoma— a malignant tumor that develops from the connective tissue of the lungs. It is rare. Pathological anatomy. The tumor occurs in the thickness of the lung or in the peripheral parts, rarely in the large bronchi. It has the appearance of dense limited nodes of different histological structure: differentiated tumors (fibro-, lipo-, chondrosarcoma), undifferentiated (round-, spindle-, polymorphocellular). Metastasis occurs rarely and late, when tumors reach large sizes.

X-ray: there are no pathognomonic signs of sarcoma. Endobronchial the form of sarcoma is characterized by signs of bronchostenosis, similar to those observed in the case of the development of central lung cancer. Intrapulmonary sarcoma is characterized by the formation of a well-defined tumor of spherical or oval shape, the size of which is 10-15 cm. Sometimes the tumor occupies the entire lobe of the lung, and the interlobular boundary shifts, but the contours remain clear. The structure of the shadow is homogeneous. The lung tissue surrounding the tumor and the root are unchanged. Accompanying pneumonia, as a rule, does not develop. Bronchoscopy and biopsy data help preoperative diagnosis.

Metastases in the lungs. The spread of tumor cells from the site of any of its primary ones localization can be carried out by hematogenous (most often), lymphogenic, bronchogenic and contact routes. There is no direct relationship between the size of the primary tumor, its localization, histological structure and lung metastasis. Usually, metastases in the lungs have the same histological structure as the primary tumor.

X-ray signs vary depending on the path of spread of metastases and phases of development. The following forms of metastatic lesions of the lungs are distinguished: round, nodular, interstitial, pneumonia-like, mixed (fig.). According to localization, metastases can be unilateral or bilateral (limited and widespread), according to number - single (1), single (2-3), multiple (more than 3).

Roundness metastases (single or multiple) are characterized monotonous signs. They are round, intense, clearly defined, have a uniform structure, shadows
Interstitial metastasis. Massive bilateral infiltration of interstitial tissue reach different sizes (1-5 cm) and are located against the background of an unchanged pulmonary pattern. Increasing especially in the lower lobes, they form a conglomerate of nodes that unite with each other. In individual metastases, destruction or impregnation of calcium salts may appear. Partial calcification is observed in the case of thyroid and prostate cancer metastases, as well as skeletal tumors. Single and multiple round metastases can form together with metastases in the lymph nodes of the roots of the lungs and mediastinum.
Nodular metastasis (miliary carcinomatosis) is characterized by the formation of multiple, small, homogeneous, medium-intensity, uniformly distributed foci in the lungs, the development of which resembles disseminated tuberculosis. The rate of growth of foci depends on the histological structure of the tumor. Metastases grow faster in the lower lobes. Unchanged pulmonary parenchyma remains between individual metastases. Over time, bullous swellings appear in it.
Pneumonia-like metastases, usually multiple, are sometimes characterized by unilateral localization. They occur in the case of bronchogenic spread of the metastatic process. They are more common in patients with primary lung cancer, chorionepithelium. The shape of the foci is irregular, the delineation is unclear, in some places the metastases merge with each other and form foci of darkening. Interstitial metastasis (cancerous lymphangitis) reflects the retrograde spread of tumor cells along the lymphatic vessels of the deep lymphatic channels after damage to the mediastinal lymph nodes and lung roots. X-ray on one side, more often on both sides, in the basal zones there is an increase in the pulmonary pattern. Linear strands depart from the roots of the lungs, which gradually turn into mesh-loop structures towards the periphery. Individual foci-like shadows of metastases, arising from heavy formations depicted in the axial projection, can also be observed. The roots of the lungs are expanded, infiltrated. During conventional and computer tomography, the shadows of enlarged metastatic lymph nodes in the roots and mediastinum are better reproduced. Over time, fluid accumulates in the pleural cavity.

CT is used to search for hidden metastases in the parenchyma and lymph nodes of the mediastinum. With its help, it is possible to clearly identify small nodular metastases in the costal and mediastinal pleura as the initial stage of metastasis.

Mixed metastases have signs of hematogenous, lymphogenous or bronchogenic spread (spherical, pneumonia-like, intestinal), which are often combined with lymph node metastases. Course severe, progressive respiratory failure.

Benign lung tumors arise from any lung tissue (epithelial, connective, muscular, cartilaginous), as well as embryonic (in case of a violation of its development).

Intrabronchial tumors — adenoma, cylindroma, carcinoid, hamartoma, papilloma. More often, tumors are localized in large bronchi (main, partial). Their development is accompanied by the formation of a round or oval polyp-like node. The node continues to grow endobronchially, intra-ramurally or mainly exobronchially. In case of predominance of exobronchial growth according to the iceberg type, a small endobronchial component of the tumor does not cause obturation of the bronchus for a long time. Benign tumors can turn into malignant ones.

X-ray disturbances are observed distal to the tumor level bronchial patency of varying degrees, in particular hypoventilation, valvular swelling, atelectasis (complete or incomplete) of a lobe of the lung, pneumonic infiltration are noted. On overexposed radiographs, tomograms, bronchograms, narrowing or amputation of the bronchus and an additional shadow of the tumor, round or oval in shape, are observed. It is clearly outlined, with a wide base it merges with the wall of the bronchus. Sometimes the leg of the tumor is noted. The structure of the tumor is clarified with the help of bronchoscopy and cytological examination.

Intrapulmonary benign tumors (adenoma, papilloma, hamartoma etc.), have no clinical signs for a long time. They are mostly detected during preventive X-ray examinations. Reaching large sizes, they eventually displace and compress nearby organs and tissues (large bronchi, blood vessels, heart), causing a variety of non-pathognomonic symptoms: cough, pain, hemoptysis, shortness of breath.

X-ray benign intrapulmonary tumors, as a rule, have the appearance of individual formations that are localized in different places and form a clearly defined, intense rounded shadow. There are no signs of infiltrative growth or decay. Pulmonary pattern and roots are not changed. Hamartoma is the most common benign tumor.

Hamartoma — is a structure consisting of cartilage, muscle, fat, glandular and other tissues. Depending on which tissue predominates, the following hamartomas are distinguished: hamartochondromas, hamartolipomas, hamartomyomas, etc.

Radiological Hamartomas are round or oval in shape. They can be localized in any part of the lungs, more often in the lower lobe on the right. They are usually 3-5 cm in size, but can be larger. The external contours are clearly defined, sometimes wavy. A characteristic symptom of a hamartoma is the presence of inclusions of calcium salts located in the thickness of the tumor in the form of individual inclusions or a continuous conglomerate. The surrounding pulmonary pattern, roots, pleura are not changed.

Tumors of the pleura. The source of pleural tumor growth is pulmonary and parietal pleura. According to the morphological structure, benign and malignant tumors are distinguished. The latter can be primary and secondary (metastatic).

Benign tumors — fibroma, lipoma, neurinoma, osteofibroma, angioma — grow slowly, for years.

Malignant tumors pleura are united under the general name of mesothelioma. They have a diverse histological structure.

In the case of limited growth, the X-ray semiotics of pleural tumors (benign and malignant) are of the same type. The tumor has the appearance of an oval or round formation of a homogeneous structure with a convex, clearly defined medial contour. In the area of 1-2 intercostal spaces, the broad base of the shadow merges with the chest wall. At the point of transition of the contour of the tumor into the contour of the chest wall, a smooth obtuse angle is formed, rarely straight. A strip of thickened parietal pleura can sometimes be traced up and down from the tumor. The height of the shadow prevails over its transverse dimension. During breathing, the shadow moves along with the chest wall, and its shape and size do not change.

Secondary metastatic tumors pleura can develop in the presence of cancer lungs, mammary and pancreatic glands, etc. Often, metastases occur simultaneously in the skeleton or lymph nodes. Ways of spreading tumors: hematogenous, lymphogenic, mixed.

Pathological variants of metastatic pleural lesions include cancerous lymphangitis, miliary carcinomatosis, large-focal and infiltrative-nodular types of growth. The course of the disease is often accompanied by pleurisy.

X-ray cancerous lymphangitis of the pleura, as a rule, is not recognized. In the presence of miliary carcinomatosis of the pleura, widespread small uniform foci of medium intensity are found, which overlap the lung pattern. Usually, these changes are combined with bilateral progressive pleurisy.

The development of large-focal metastases in the pleura is characterized by the simultaneous or sequential appearance of multiple foci of medium intensity up to 2-3 cm in size. Their fusion and the formation of large wall conglomerates are possible. The pleura in the adjacent departments is thickened. Over time, fluid appears in the pleural cavity.

Infiltrative-nodal type metastasis meets rarely and characterized by diffuse thickening of the pleura and absence of fluid in the pleural cavity. The inner contour of the tumor is convex, nodular, clear. The X-ray picture of this tumor is similar to that of pleural mesothelioma. Sometimes damage to the 1st—3rd ribs is noted. A soft-tissue component can be traced outside the bony skeleton of the chest.

Lesions of the pleura, especially small foci, are best and earliest determined by CT.

Tumors of the pleura should be differentiated from peripheral lung cancer, chest wall tumors, limited pleurisy, thoracoabdominal lipomas. The results of a puncture biopsy are often important in clarifying the diagnosis.

Materials on the activation of higher education seekers during conducting a lecture: questions, situational problems, etc(if necessary)**:**

General material and mass-methodological support

lectures:

- lecture halls according to the plan of the educational department of ONMedU

- projector, screen

- presentation

- PC

Questions for self-control:

1. A 40-year-old man's temperature suddenly rose to 30 degrees Celsius. Chills, headache, pain in the side that worsens with shortness of breath, with a deep breath, cough. SOE-40mm/r, P-100 ud. in min. On R-grams in 2 projections in the first days of the disease in the lower lobes of the lungs (right and left). Obscuration without clear contours, indistinctness of the contours of the lung pattern, the roots are expanded. 10 days after antibacterial and anti-inflammatory therapy, positive dynamics are observed radiologically. Which of the listed diagnoses is the most likely?
A-exudative pleurisy. B-asthma.
C-bronchitis
D-acute pneumonia.
E-bronchoectatic disease.

2. A 30-year-old woman complains of a dry cough, shortness of breath, palpitations, and an increase in temperature up to 35 degrees.
Objectively: Cyanosis. P-10-20 units in min. Percussionally, in the lower part, the right light dulling of the percussion sound, vocal movement and breathing noises are sharply weakened, and in the lower parts it is not determined at all. X-ray: In the lower parts of the right lung, a massive darkening with an obliquely located border, a shift of the interstitium to the healthy side is determined. Which of the named diagnoses is most likely?

A-exudative pleurisy. B-asthma
C-bronchitis.
D-acute pneumonia.
E-embolism of the pulmonary artery.

3. A 42-year-old man complains of chest pain, chills, and a temperature rise of up to 38 degrees. S., slight cough, with discharge of sputum of a purulent nature with an unpleasant smell. Objectively: dulling of the percussion sound on the right, breath weakened, dry wheezing. ESR-35 mm/m.
X-ray: massive homogeneous darkening against the background of which a rounded cavity with a horizontal level is defined.

Name the supposed diagnosis?

A-lung cancer.
B-pneumonia.

C-echinococcus of the lung.

D-abscess of the lung

E-bronchoectatic disease.

4. A 26-year-old woman complains of pain in the chest when taking a deep breath, a dry cough, and an increase in temperature up to 38 degrees. S. in the evenings, weakness, shortness of breath, forced position on the affected side, percussive, dullness in the lower parts on the right, P-120 ud. in min.

Which of the listed research methods is the most suitable in this case?

A-bronchography.
B-R-graph of the chest. S-
CT .
D-angiography
E-cholecystography.

5. A 45-year-old man complains of frequent colds and pneumonia up to 3-4 times a year, cough with phlegm, with an unpleasant smell, more in the morning, shortness of breath when walking.

Objectively: retardation of the mobility of the right lung, cyanosis, thickening of the end phalanges of the fingers in the "drum stick" type with deformation of the nails in the "hourglass" type. Wet wheezing, bronchial breath are heard auscultatively. Wheezing decreases after coughing.

What is the X-ray method? research will be most informative?

ACT.

B-radioisotope scanning of the lungs. C-
bronchography.
D-lymphography.
E-angiography.

6. A 60-year-old man complains of shortness of breath, weakness, cyanosis, and weight loss. Considers himself sick for 3 months.

Objectively: Limitation of respiratory excursions on the right, blunting of the percussion sound in the same place, and sharply weakened breath. P-76 unit in min., A/T-140 mm. mercury Art., the temperature is normal.

X-ray: intense darkening of the entire lung field on the right, displacement of the interstitial organs to the side of the atelectazed lung.

Which of the x-rays. methods will confirm this diagnosis?

A-lymphography.
B-tomography and bronchoscopy. C-radioisotope
scanning of the lymphatic system. D-fluorography.

E-angiography.

7. During a preventive examination of a 35-year-old woman, a fluorogram showed a darkening of the right lung in the lower part without clear contours, the roots were expanded, and the pulmonary pattern increased.
What is the most likely cause of the above?

A-exudation, which is manifested by sweating in the alveoli of blood plasma with an increase in the number of neutrophilic leukocytes.

B-obstruction of the bronchus.
C-mitral insufficiency.
D-melting of lung tissue with breakthrough of pus into the draining bronchus. E-mechanical and toxic action of parasites.

8. During an X-ray examination of the chest organs in a 46-year-old man, a massive homogeneous darkening was found in the region of the apex of the right lung, against the background of which a rounded cavity with a horizontal level is defined.
What is the most likely cause?

A-chronic obstructive disease of the bronchi with a violation of their drainage and cleaning function.

B-toxic effect of nicotine.
C-post-traumatic limitation of mobility of the lung. D-hypertensive disease with frequent crises. E-destruction of the walls of blood and lymphatic vessels.

9. In the patient, after an acute respiratory infection, X-ray of the lungs revealed a massive darkening in the lower parts of the right lung with an obliquely located upper border.
What is the cause of the above?

A-destruction of the walls of blood and lymphatic vessels. B-aspiration obturation of the bronchus.
C-penetration of pathogens into the pleura by the lymphogenic route from subpleural located cells in lung tissue. D-increase in the level of catecholamine in the blood. E-coarctation of the aorta.

10.A man was brought to the emergency hospital after a traffic accident with complaints of chest pain. After the inspection P-scopy of the chest cavity, a rounded single shadow on the right, a fracture of the 4th and 5th ribs with displacement of the fragments and darkening in the outer and lower part with an oblique upper border were revealed.
What caused the above? A-destruction of the walls of lymphatic vessels.
B- violation of the integrity of the pleura, which is accompanied by hemorrhage.

C-post-traumatic limitation of mobility of the lung. D-
aspiration obturation of the bronchus.
E-penetration of pathogens into the pleura by the lymphogenic pathway.

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2. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 2. Kyiv, Book plus. 2015. -168 p.

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Lecture No. 3

Topic:radiological research methods and radiological anatomy of abdominal organs cavities Basics of radiation semiotics of the pathology of abdominal organs.

Actuality of theme:diseases of the gastrointestinal tract occur quite often in people of any age. Due to the polyetiological nature of these diseases, their frequency is significant.

Goal:

Educational: despite the fact that doctors of a number of specialties do not conduct transillumination and imaging of the specified organs, they must be able to determine indications for x-ray examination, choose the right method research, to make a referral to the appropriate radiological department, to research, be able to correctly diagnose leading radiological departments syndromes of damage to the gastrointestinal tract, to be able to analyze a typical X-ray picture.

Basic concepts: relief of the mucous membrane, double contrast, X-ray, CT, MRI, PH examination of the gastrointestinal tract.

Content of the lecture material

The digestive system is a set of interdependent organs that ensure the promotion and processing of food. Combined into a single anatomical and functional complex, these organs will form a digestive canal, the length of which varies from 8 to 12 m. It begins with the mouth opening, behind which the oral cavity, pharynx, esophagus, stomach, colon and rectum emerge. The channel ends with an anteroposterior opening.

The structure and functions of all departments of the alimentary canal can be studied by radiation methods. But due to their long length and unequal activity, it is impractical to study all digestive organs at the same time. It is accepted to examine the salivary glands, pharynx, esophagus, stomach and duodenum, colon and rectum, liver and bile ducts, pancreas separately. For this organ, all optimal methods of radiation diagnostics have been developed.

X-ray methods are leading among radiological methods of examining the alimentary canal. But, despite their diversity, some general methodological provisions can be formulated. The first of them is that the X-ray examination begins before taking the contrast material to assess the presence and distribution of gas accumulations in the alimentary canal and to rule out deposits of calculi, calculi, and foreign bodies in the adjacent organs. But the outlines of the esophagus, stomach, and intestines on ordinary radiographs stand out or are weakly indistinguishable at all, because the walls of the digestive organs absorb X-ray radiation approximately the same as their surrounding tissues. Therefore, the second and almost always mandatory stage is artificial contrast of the cavity of the alimentary canal with an aqueous suspension of sulfate or barium with air (or both contrast media at the same time).

X-ray examination of the esophagus.

The main methods of studying the esophagus are x-ray, endoscopy, monometry. The radionuclide technique - scintigraphy - is of additional importance. The x-ray method provides an opportunity with adjacent tissues and organs. Scintigraphy facilitates the detection of functional disorders of the esophagus, in particular, gastroesophageal reflux.

DISEASE OF THE ESOPHAGUS.

Indications for an X-ray examination of the esophagus are dysphagia and any unpleasant sensations in the esophagus. For the study, the patient must appear on an empty stomach.

DIVERTICULA: A diverticulum is a pouch-like protrusion of the mucosa and submucosa through the slits of the muscular layer of the esophageal wall. Most diverticula are located in the pharyngeal-digestive junction, at the level of the aortic arch and bifurcation of the trachea, and in the supraphrenic segment

Under the pressure of the contrast mass, the diverticulum increases and gives an image in the form of a rounded formation with smooth contours. It can have a wide entrance or communicate with the esophageal cavity through a narrow channel (neck). The folds of the mucous membrane are not changed and enter the diverticulum through the neck. As the contents of the diverticulum are emptied, they decrease. As a rule, diverticula are an incidental finding that has no clinical purpose. But in rare cases, they develop an inflammatory process (diverticulitis). Cases of breakthrough of the esophageal diverticulum into the interstitium are described.

ESOPHAGAL DYSKENESIA. Esophageal dyskinesia manifests itself in hypertension, hypotonia, hyperkinesia or hypokinesia, or spasms of sphincter insufficiency. All these disorders are recognized during X-ray examination in the form of acceleration or deceleration of the advancement of the contrast mass, the appearance of spastic constrictions, etc. The most frequent functional disorder is insufficiency of the lower esophageal sphincter with gastroesophageal reflux, i.e. throwing the contents of the stomach into the esophagus. As a result, inflammatory phenomena develop in the esophagus, superficial and then deep esophagitis occurs. Wrinkling of the esophageal wall contributes to the formation of a hernia of the esophageal opening of the diaphragm.

The best way to detect gastroesophageal reflux is scintigraphy. The patient drinks 150 ml of water with labeled colloid while standing. After 10-15 minutes, he understands the horizontal position. Light pressure on the front abdominal wall provokes the manifestation of reflux. The passage of even a small amount of liquid from the stomach into the esophagus is documented on a series of scintigrams.

The functional disorder of interest is a violation of secondary and tertiary contractions of the esophageal wall. The strengthening of secondary contractions is expressed in spasm of the retrocardial segment of the esophagus. Sometimes the esophagus resembles a clear or corkscrew.

HERNIA OF THE ESOPHAGEAL OPENING OF THE DIAPHRAGM. There are two main types of esophageal hernias: axial and paraesophageal.

With an axial hernia, the subdiaphragmatic segments of the esophagus and part of the stomach are displaced into the chest cavity: the cardia is located above the diaphragm. With a paraesophageal hernia, the subdiaphragmatic segment of the esophagus and the cardia are located in the abdominal cavity, and part of the stomach exits through the esophageal opening of the diaphragm into the chest cavity next to the esophagus.

Large fixed hernias are easily recognized during X-ray examination, because barium fills the part of the stomach located in the posterior interstitium, above the diaphragm. Small sliding hernias are detected mainly when the patient is in a horizontal position on his stomach.

ESOPHAGITIS AND ESOPHAGAL ULCERS. Acute esophagitis is observed after a burn of the esophagus. In the first days, swelling of the mucous membrane of the esophagus and pronounced violations of its tone and motility are noted. The mucosal folds are swollen or not visible at all. Then you can find the unevenness of the contours of the esophagus and the "spotty" nature of its inner surface due to erosions and flat ulcers. During 1-2 months. cicatricial narrowings develop, c areas where there is no peristalsis. The patency of the esophagus depends on the degree of stenosis.

Chronic esophagitis is most often associated with gastroesophageal reflux. The esophagus is moderately dilated, its tone is reduced, peristalsis is weakened, the contours of the esophagus are slightly uneven. Its secondary and tertiary reductions are often strengthened. Sections of the esophagus, in which the folds of the mucous membrane are tortuous and thickened, alternate with zones of the absence of folds - it is replaced by a peculiar granularity and flaky clusters of contrasting mass. Similar changes are observed in viral and fungal lesions of the esophagus.

Contrast material accumulates in the area of the ulcer. In this place, a rounded or triangular protrusion - a "niche" - appears on the contour of the esophagus. If the ulcer cannot be contoured, it gives an image in the form of a rounded contrast cluster. It does not disappear after taking one or two sips of water and reappears with each new portion of barium.

ACHALASIA OF THE ESOPHAGUS. Achalasia - the absence of normal opening of the cardia - is a relatively frequent pathological condition. In the 1st stage of the disease, the radiologist notes the conical narrowing of the subdiaphragmatic segment of the esophagus and the retention of the contrast mass in it for several minutes. Then the cardia suddenly opens, and the barium rushes into the stomach. Unlike cancer of the cardia, the contours of the subdiaphragmatic segment and the upper part of the stomach are equal; clear longitudinal folds of the mucous membrane are traced in these departments.

In the II stage of the disease, the thoracic part of the esophagus is expanded, fluid accumulates in it. Peristalsis is weakened, and the folds of the mucous membrane are thickened. The subdiaphragmatic segment of the esophagus in front of the cardia is narrowed, often bent in the form of a beak. But with a deep breath and straining, it changes its shape, which does not happen with cancer. Barium does not enter the stomach for a long time - for 2-3 hours or more. The gas bubble in the stomach is sharply reduced or absent.

In the III stage - the stage of decompensation - the esophagus is sharply expanded, contains liquid and sometimes the remains of food. This leads to the expansion of the interstitial shadow, in which esophagus can be distinguished even before taking a contrast mass. Barium, as it were, sinks in the liquid contents of the esophagus. The latter will form curves. There is usually no air in the stomach. Esophageal emptying is delayed for many hours, and sometimes several days.

TUMORS OF THE ESOPHAGUS. Benign epithelial tumors (papillomas and adenomas) grow in the cavity of the esophagus in the form of a polyp. They determine the effect of filling in the shadow of the contrast agent. The contours of the defect are sharp, sometimes wavy, the folds of the mucous membrane are not destroyed, the tumor surrounds them. Benign non-epithelial tumors (leiomyomas, fibroids, etc.) grow submucosally, and therefore the folds of the mucous membrane are preserved or flattened. The tumor gives a marginal filling defect with even contours.

Exophytic cancer grows in the lumen of the organ and causes a filling defect in the shadow of the contrast agent in the form of a rounded, oblong or mushroom-shaped lumen (polypoid or mushroom-shaped cancer). If decay occurs in the center of the tumor, the so-called cup-shaped cancer will form. It has the appearance of a rounded niche with uneven and raised edges like a roller. Endophytic cancer infiltrates the wall of the esophagus, causing a flat filling defect and gradual narrowing of the lumen of the esophagus.

Both exophytic and endophytic cancer destroy the folds of the mucous membrane and turn the wall of the esophagus into a dense peristaltic mass. As the esophagus narrows, the movement of barium along it is disrupted. The contours of the stenotic area are uneven, suprastenic expansion of the esophagus is defined above it.

X-ray examination of the esophagus and duodenum.

Among radiation research methods, X-ray is of primary importance.

In conditions of urgent diagnosis, i.e. in case of acute conditions, the patient is subjected to x-rays of the organs of the chest cavity and abdomen in a vertical and horizontal position. Artificial contrast of the alimentary canal is used only in special cases.

The patient must appear in the X-ray room on an empty stomach. 20-30 minutes before the examination, 2-3 Aeron tablets are given under the tongue to relax the stomach. A highly concentrated suspension of barium sulfate with the addition of a defoamer is used as a contrast agent, and a granular gas-forming drug is given to distend the stomach. Fluorography is done in several standard projections in a vertical and horizontal position. If pathological changes are detected on the images, the patient is usually referred for fibrogastroscopy. Check-up mass X-ray studies are justified in those geographical areas where the incidence of stomach cancer is high.

DISEASES OF THE STOMACH AND DUDEON. Chronic gastritis.

X-ray diagnostics is based on a set of radiological signs and their comparison with a complex of clinical and laboratory data. Compulsory joint assessment of the thin and folded topography and function of the stomach.

Determining the condition of the areola is of leading importance. Normally, a fine mesh (granular) type of fine relief is observed. The areolas have a regular, mostly oval shape, clearly outlined, limited by shallow narrow grooves, their diameter varies from 1 to 3 mm. Nodular and especially gross nodular types of fine relief are typical for chronic gastritis. With the nodular type, areolas of an irregular rounded shape, 3-5 mm in size, are limited by narrow but deep grooves. The coarsely nodular type is characterized by large (more than 5 mm) areoles of an irregular polygonal shape. The furrows between them are widened and not always sharply differentiated.

In the period of exacerbation, the empty stomach contains liquid, its tone is increased, peristalsis is deepened, spasm of the antral region may be observed. During the period of remission, the tone of the stomach is reduced, peristalsis is weakened.

Ulcer disease of the stomach and duodenum.

Radiology has an important role in the recognition of ulcers and their complications. The radiologist faces three main tasks. The first of them is it is an assessment of the morphological state of the defect and the study of its position, shape, size, contours, and the condition of the surrounding mucous membrane. The second task is to study the function of the stomach and duodenum. This allows you to find indirect signs of peptic ulcer disease and judge the stage of the disease (aggravation, remission) and the effectiveness of conservative therapy. And, finally, the third task comes down to recognizing the complications of peptic ulcer disease.

Morphological changes in peptic ulcer disease are due to both the ulcer itself and accompanying gastroduodenitis. A niche is considered a direct symptom of an ulcer. This term refers to the shadow of the contrast mass that filled the ulcer crater. The silhouette of the ulcer can be seen in profile (such a niche is called a contour niche) or face-on against the background of the folds of the mucous membrane (in these cases, they speak of a "relief niche" or a relief niche). The contour niche is a semicircular or sharp protrusion on the contour of the shadow or stomach of the bulb. The size of the niche, in general, reflects the size of the ulcer. Small niches are indistinguishable by X-ray. Targeted X-rays of the stomach and bulb are necessary for their detection.

With double contrast of the stomach, it is possible to recognize very small surface ulcers - erosions. They are more often localized in the antral and prepyloric parts of the stomach and have the appearance of rounded or oval openings with a central dot cluster of contrast mass.

As a result of scarring of the ulcer at the level of the niche, there is a straightening and some shortening of the contour of the stomach or bulb. Sometimes the scarring process reaches a large degree, and then gross deformations of the corresponding part of the stomach or bulb are determined. Due to the violation of the evacuation of the contents of the stomach, it stretches. Liquid contents and even food remains are found in it on an empty stomach. The passage of the contrast agent through the portal canal or stenotic bulb is sharply slowed down, sometimes for several hours.

There are a number of indirect X-ray symptoms of peptic ulcer disease. A sign of a violation of gastric secretion is the presence of fluid in it on an empty stomach, this symptom is most indicative of an ulcer of the bulb. An important indirect symptom is regional spasm. It usually occurs in the stomach and bulb equal ulcers, but on the opposite side. There will be a drawing of a contour with even contours. In the stomach, it resembles the end of a finger in shape, hence the name of this sign "index finger symptom". As a rule, spasm of the gatekeeper is observed in the case of an ulcer of the bulb in the period of exacerbation. Finally, with ulcers, a symptom of local hyperkinesia is noted, which is expressed in the accelerated advancement of the contrast agent in the ulcer zone. The following indirect sign-symptom of point pain and local tension of the abdominal wall during palpation, corresponding to the ulcer, is connected with it.

In the stage of exacerbation of peptic ulcer disease, there is an increase in the niche and an expansion of the inflammatory shaft surrounding it. During the period of remission, the niche decreases until it disappears. (after 2-6 weeks). The function of the stomach and duodenum is normalized.

Duodenogastric reflux is often observed in peptic ulcer disease and chronic gastritis. An ulcer niche can remotely resemble a gastric diverticulum. Unlike an ulcer, a diverticulum has a regular rounded shape, smooth arcuate contours, and often a well-formed neck. The folds of the mucous membrane around it are not changed, some of them enter the diverticulum through the neck.

Radiological methods play an important role in the diagnosis of complications of peptic ulcer disease. First of all, this refers to the rupture of the duodenal tongue or stomach. The main sign of a breakthrough is the presence of free gas in the abdominal cavity. On radiographs, the gas causes a clearly visible illumination. When the position of the body changes, it moves in the abdominal cavity, which is why it is called free.

Penetration of the ulcer into the surrounding tissues and organs is indicated by two signs: the large size of the niche and its fixation. Penetrating ulcers have a three-layered content: gas, liquid, and contrast material.

As a result of scarring of the gatekeeper's ulcer, stenosis of the gastric outlet may develop. Its degree (compensated, subcompensated or decompensated) is determined based on radiographic data.

STOMACH CANCER. Initially, the tumor is an island of cancerous tissue in the mucous membrane. But in the future, different ways of tumor growth are possible, which determine the radiological signs of small cancer. If necrosis and ulceration of the tumor predominate, then its central part sinks in comparison with the surrounding mucous membrane - this is the so-called buried cancer. With double contrast, an irregularly shaped niche with uneven contours, around which areolas are absent, is determined. The folds of the mucous membrane converge to the ulcer, expanding slightly in front of the niche and losing their outlines here.

With another type of growth, the tumor spreads mainly to the sides from the mucous membrane and in the submucous layer - it is a superficial or flat-infiltrating cancer that grows endophytically. It determines the area of the changed relief, in which there are no halos. But unlike deep-seated cancer, there is no ulcer, and there is no convergence of the folds of the mucous membrane to the center of the tumor. Instead, randomly located thickenings with lumps of contrast material scattered unevenly over them are observed. The contour of the stomach becomes uneven, straightened. There is no peristalsis in the area of the infiltrate.

In most cases, the tumor grows in the form or node of the plaque, gradually pressing more and more into the stomach cavity - this is "elevated cancer" (exophytic cancer). Initially, its X-ray picture differs little from the X-ray picture of an endophytic tumor. But then there is a noticeable uneven deepening of the contour of the shadow of the stomach, which does not participate in peristalsis. Next, a marginal or central filling defect is observed, corresponding in shape to a tumor protruding into the lumen of the organ. With plaque cancer, it remains flat, with polyposis (fungal cancer) it has an irregular rounded shape with wavy outlines.

It should be emphasized that in most cases, with the help of radiological methods, it is impossible to distinguish early cancer from peptic ulcer and polyp, and endoscopic examination is required. But X-ray examination is very important as a method of selection for endoscopy.

Infiltrative-ulcerative cancer appears in the other face. Not with him there is as much a pronounced filling defect as destruction and infiltration of the mucous membrane. Instead of normal folds, the so-called malignant relief is determined: shapeless accumulations of barium between pillow-shaped and structureless areas. Of course, the contours of the stomach shadow in the affected area are uneven, and there is no peristalsis.

A fairly typical X-ray picture of saucer-shaped or cup-shaped cancer, that is, a tumor with raised edges and a disintegrating central part. X-rays show a rounded or oval filling defect, in the center of which there is a large niche - an accumulation of barium in the form of a spot with uneven outlines. A feature of saucer-shaped cancer is a relatively clear limitation of the edges of the tumor from the surrounding mucous membrane.

Diffuse fibroplastic cancer leads to narrowing of the lumen of the stomach. In the affected area, it turns into a narrow rigid tube with uneven contours. When the stomach is inflated with air, the deformed part does not straighten. At the border of the narrowed part with unaffected sections, you can notice small ledges on the contours of the stomach shadow. The folds of the mucous membrane in the tumor area thicken, become immobile, and then disappear.

BENIGN TUMORS OF THE STOMACH.

The radiograph depends on the type of tumor, the stage of its development and the nature of growth. Benign tumors of an epithelial nature (papillomas, adenomas, villous polyps) emerge from the mucous membrane and enter the lumen of the stomach. First, among the halos, there is a round structureless area that can be seen only with double contrast of the stomach. Then the local expansion of one of the folds is determined. It gradually increases, taking the form of a rounded or slightly oblong defect. The folds of the mucous membrane bypass this defect and are not infiltrated. The contours of the defect are even, sometimes wavy. The contrast mass is retained in small depressions on the surface of the tumor, creating a delicate cellular pattern. Peristalsis is not disturbed, if there is no malignant transformation of the polyp.

Non-epithelial benign tumors (leiomyomas, fibroids, neurinomas, etc.) look completely different. They develop mainly in the submucous or muscle layers and rarely enter the stomach cavity. The mucous membrane above the tumor is stretched, due to which the folds are flattened or spread apart. Peristalsis is usually preserved. A tumor can also cause a rounded or oval defect with even contours.

POSTOPERATIVE DISEASES OF THE STOMACH. X-ray examination is necessary for timely detection of early postoperative complications - pneumonia, pleurisy, atelectasis, abscesses of the abdominal cavity, including subphrenic abscesses. Gas-containing abscesses are relatively easy to recognize: it is possible to find a cavity containing gas and liquid on images and during translucency.

In the diagnosis of subdiaphragmatic abscesses, sonography and CT are successfully used, because the accumulation of pus is clearly visible during these studies.

Among the late postoperative complications, two syndromes should be mentioned: the adduction loop syndrome and the dumping syndrome. The first of them is radiologically revealed by the entry of a contrast mass from the stump of the stomach through the anastomosis into the loop that leads to. The last expanded mucous membrane in it is swollen, its palpation is painful. The long delay of barium in the leading loop is especially revealing. For dumping syndrome, a sharp acceleration of the emptying of the stomach stump and a rapid spread of barium along the loops of the small intestine are essential.

1-2 years after surgery, a peptic ulcer of the anastomosis may appear on the stomach. It causes the X-ray symptom of a niche, and the ulcer is usually large and surrounded by an inflammatory shaft. Its palpation is painful. Due to the accompanying spasm, there is a disorder of the anastomotic function with retention of contents in the stump of the stomach.

DISEASES OF THE INTESTINES. Acute mechanical intestinal obstruction.

X-ray examination is of great importance. The patient is in a vertical position

X-rays of the abdomen are taken in the position. Obstruction is indicated by the swelling of the intestinal loops located above the site or blockage of intestinal compression. In these loops, gas accumulations and horizontal liquid levels (so-called Kloiber cups or levels) are determined. All loops of intestines distal to the site of obstruction are in a collapsed state and do not contain gas or liquid. It is this sign - the collapse of the post-stenotic segment of the intestine - that allows us to distinguish mechanical intestinal obstruction from dynamic (in particular, from paresis of intestinal loops).

Of course, it is important to distinguish between obstruction of the small and large intestines. In the first case, the loops of the small intestine are swollen, and the large intestine is in a collapsed state.

In the case of colon obstruction, huge swollen loops with high gas bubbles in them are observed. Accumulation of fluid in the intestines is usually small. On the contours of the intestine, haustral retractions are outlined, and coarse arcuate semilunar folds are also visible. By introducing a contrast suspension through the rectum, it is possible to specify the place and nature of the obstruction (for example, to find a cancerous tumor that leads to a narrowing of the intestine).

Acute intestinal obstruction associated with thrombosis or embolism of mesenteric vessels is peculiar. When the upper mesenteric artery is blocked, gas and fluid accumulate in the small intestine and in the right half of the colon, but the patency of the colon is not disturbed.

APPENDICITIS.

With acute phlegmous or destructive appendicitis, small accumulations of gas and fluid are observed in the distal loops of the ileum and in the cecum. The wall of the cecum is thickened due to edema. When the position of the body changes, the intestine does not move. If an abscess forms around the appendix, it causes an indentation on the intestinal wall. With chronic appendicitis, the radiologist can establish fixation of the appendix, its deformation, fragmentation of its shadow, coincidence of the painful point with the shadow of the appendix, and in some cases - the presence of stones in the appendix.

MALABSORPTION.

With malabsorption, there is a violation of the absorption of various components of food. Regardless of the nature and type of malabsorption, the radiological picture is more or less the same:

REGIONAL ENTERITIS AND GRANULEMATOSIS COLITIS (CROWN'S DISEASE).

The disease can affect any part of the digestive tract - from the esophagus to the rectum. But the typical and most frequent forms are lesions of the distal part of the small intestine and the proximal part of the ileum (jejunoilitis), the terminal parts of the ileum (terminal ileitis), and the proximal parts of the large intestine.

The course of the disease is divided into two stages. In the first stage, there is thickening, straightening and even disappearance of the folds of the mucous membrane. The contours of the intestine become uneven, jagged. Then, instead of the usual pattern of folds, multiple rounded lightenings are revealed, caused by islands of inflammation of the mucous membrane. Among them, barium barium, deposited in transverse cracks, can stand out. In the affected area, the intestinal loops are straightened and narrowed. In the second stage, there is a significant narrowing of the intestinal loops with the formation of scar strictures from 1-2 to 20-25 cm. A stenosed area may look like a narrow, uneven channel on images ("cord" symptom). In contrast to the syndrome of impaired absorption, there is no diffuse expansion of intestinal loops, hypersecretion and fragmentation of contrast material and a clearly expressed granular nature of the relief of the inner surface of the intestines.

TUBERCULOSIS OF THE INTESTINES.

The ileocecal angle is most often affected. But already during the examination of the small intestine, thickening of the folds of the mucous membrane, small accumulations of gas and liquid, and slow progress of the contrast mass are noted. In the area of the lesion, the contours of the intestine are uneven, the folds of the mucous membrane are replaced by areas of infiltration, sometimes with ulcers, and haustration is absent. In the future, processes of wrinkling of the intestinal loop occur with a decrease in its lumen and limitation of displacement due to adhesions.

NON-SPECIFIC ULCERATIVE COLITIS.

In mild forms, there is thickening of the folds of the mucous membrane, punctate accumulations of barium and small jaggedness of the bowel contours as a result of erosions and small ulcers. Severe forms are characterized by narrowing and rigidity of the affected sections of the large intestine. The distal half of the colon is mainly affected, as well as the rectum, which is sharply narrowed in this disease.

BOWEL CANCER.

Cancer occurs in the form of a slight thickening of the mucous membrane, the appearance of a plaque and a polypoid flat formation on it. On radiographs, a marginal or central filling defect is determined in the shadow of the contrast mass. The folds of the mucous membrane in the area of the defect are infiltrated or absent. Peristalsis is interrupted. As a result of tumor tissue necrosis, an irregularly shaped barium depot may appear in the defect - a reflection of ulcerated cancer. As the tumor grows further, there are mainly two variants of the X-ray picture. In the first case, a lumpy formation is found, which will enter the lumen of the intestine. The filling defect has an irregular shape with uneven contours. The folds of the mucous membrane are destroyed. In the second case, the tumor infiltrates the intestinal wall, leading to its gradual narrowing. The affected part turns into a rigid tube with uneven outlines (endophytic type of growth).

BENIGN TUMORS.

95% of benign intestinal neoplasms are epithelial tumors - polyps. They are single and multiple. The most frequent adenomatous polyps. They are small, usually no more than 1-2 cm, growths of glandular tissue. They often have a leg (stem). In X-ray examination, filling defects in the shadow of the intestine are caused, and with double contrast - additional rounded shadows with even and smooth edges.

Villous polyps appear during X-ray examination a little different. A defect or filling with an additional shadow with double contrast has uneven outlines, the surface of the tumor is unevenly covered with barium: it flows between the convolutions, into the grooves. But the intestinal wall remains elastic. Villous tumors, in contrast to adenomatous polyps, often become malignant. Malignant transformation is indicated by such signs as the presence of a stable depot of barium suspension in the ulcer, rigidity and indentation of the intestinal wall in the location of the polyp, and its rapid growth.

POSTOPERATIVE STATE.

X-ray examination is widely used to study the morphological and functional changes of the intestines after surgery, including to detect postoperative complications; anastomoses, scar structures, tumor recurrences, etc. Usually limited to retrograde and oral contrast of the alimentary canal.

LIVER AND BILE TRACTS. PANCREAS. X-ray picture of lesions of the liver and bile ducts. Recognition of diseases of the liver and bile ducts is currently the result of the collective efforts of a therapist, surgeon, radiation diagnostician, laboratory doctor, etc. specialists. Radiation methods occupy an important place in this complex of diagnostic measures.

DIFFUSED LIVER INJURY.

Radiation methods usually play a supporting role. The exception is fatty hepatosis.

In case of hepatitis, uniform enlargement of the liver is determined on X-ray, sono-, and scintigrams. RFP accumulates in the liver and gall bladder more slowly than normal. Both on sonograms and on scintigrams, a slight inhomogeneity of the image can be noted. Moderately enlarged spleen. During cholecystography, the shadow of the gallbladder is weak and slowly decreases after eating. The chronic course of hepatitis leads to the narrowing and straightening of small arterial and venous vessels in the liver and to the slowing of blood circulation in it.

Radiological symptoms of liver cirrhosis are much more indicative. Liver enlarged, its edge becomes uneven. In the future, a reduction and deformation of the right lobe of the liver may be observed. The spleen is always noticeably enlarged. Scintigraphy with colloidal solutions shows a sharp increase in the radioactivity of the spleen, while the concentration of RFP in the liver is reduced. There are foci of reduced RFP accumulation in areas of connective tissue growth and, conversely, increased RFP accumulation in areas of connective tissue growth and, conversely, increased accumulation in regeneration nodes. During cholecystography, i.e. during scintigraphy with IDA derivatives, a violation of the function of hepatocytes is revealed. The radioactivity curve of the liver reaches its maximum at the average weight of the lesion after 20-25 minutes. The extension of the plateau zone on the curve indicates intrahepatic cholestasis. The bile ducts are contrasted late.

FOCAL LESIONS OF THE LIVER.

Cysts, abscesses and tumors are classified as focal (volumetric) formations of the liver. Cysts filled with liquid are most definitely recognized.

On the CT scan, the cyst is reflected as a rounded formation with smooth arc-shaped contours containing fluid. If you use the technique of "enhancement" during tomography, you can find very small cysts. With radionuclide scintigraphy, the cyst also causes a rounded defect in the image of the liver, but only if the cyst is of sufficient size (more than 2 cm). In addition, the scintigram cannot establish that the contents of the formation are liquid.

Abscess of the liver, like a cyst, on sonograms, scintigrams and CT causes a limited defect in the image. In addition to clinical data, additional signs help distinguish these two lesions. First, there is usually a zone of altered tissue around the abscess. Secondly, the internal contours of an abscess are less uniform than those of a cyst, and in terms of densitometric density (20-30N) it surpasses a cyst (0-10N). Small pyogenic abscesses are usually located in groups; they often have visible seals - along or at the edges in the center of the cavity.

Most benign liver tumors are hemangiomas. On CT, hemangiomas are caused by a limited area of reduced density (30-50N).

The boundaries of the tumor are both smooth and indistinct. When a contrast substance is injected into the blood, the density of the hemangioma increases.

HEPATOCELLULAR CANCER (HEPATOMA).

On CT scans and scintigrams, the hepatoma causes a defect of an irregular shape and with uneven outlines. The density of the tumor is the same or lower than the density of normal liver tissue. But in the thickness of the tumor there may be denser areas (scar tissue) and very transparent fatty inclusions.

The radiographic pattern of metastases of malignant tumors in the liver (this, unfortunately, is a frequent lesion) depends on the number and size of tumor nodes. Roundness and multiplicity of defects, of course, facilitate recognition. On a CT scan, metastases appear as areas of reduced density - of the order of 30-50 N. With intravenous administration of a contrast agent, their shadow becomes more intense. The advantage of sonography and CT is the possibility to perform a puncture of the focus under their control, to obtain material for biopsy, to start transcatheter therapy for an abscess or chemotherapy for a single or some tumor nodes. Metastases will form "cold foci" on scintigrams.

In difficult cases of differential diagnosis of non-tumor and tumor lesions, radiologists turn to angiography. Benign formations only squeeze and squeeze vessels. A malignant tumor significantly changes the vascular pattern: the feeding tumor vessel is often expanded, and in the tumor itself, the vessels are dilated, destroyed, replaced by unusual blood channels, in which blood sometimes stagnates, creating "lakes" and "puddles". In addition, the time of the transition of the contrast agent from the arteries to the veins is shortened due to the absence of a normal capillary network in the tumor - arteriovenous shunting occurs. In many cases, the shadow of malignant tumors in the prorenchymatous phase of celiacography is enhanced because they receive nutrition from the hepatic artery, while normal liver tissue receives 75% of blood from the portal vein.

BILE TRACT DISEASE. Recently, the frequency of gallstone disease has increased dramatically. According to the composition, cholesterol, pigment, mixed (cholesterol - pigment - calcareous) and calcareous stones are distinguished.

Gallstones can only be recognized on plain X-rays if they contain lime deposits. Other stones are detected during cholecystography, if the vesical flow is passed and the contrasted bile penetrates into the bladder. Stones give defects in the shadow of the gallbladder. The number, size and shape of defects depend on the number, size and shape of stones. Stones in the gall bladder are quite clearly detected during CT.

If the patient does not have pronounced jaundice, the shadow of the bile ducts appears on radiographs and tomograms. Stones cause filling defects in this shade. But, of course, stones in the bile ducts are most clearly outlined during cholangiography.

X-ray surgical occlusive lesions of the biliary tract intervention at develop rapidly.

X-ray methods are a valuable aid to the clinician in the diagnosis of cholecystitis. First, they allow you to immediately distinguish calculous and stoneless cholecystitis. Secondly, with their help, a group of patients with inflammatory stenosis of the terminal part of the common bile duct is identified. Thirdly, they make it possible to establish the patency of the vesical duct and the degree of impaired concentration and motor function of the gallbladder, which is very important when planning treatment and especially when deciding on surgical intervention.

In the recognition of CHRONIC COLECYSTITIS, in addition to sonography, cholecystography and cholegraphy play a certain role. The most important thing is to exclude calculi and find out the patency of the vesicular duct. The absence of a shadow of the gallbladder in the presence of a shadow of the ducts definitely indicates a disconnection ("blockade") of the gallbladder. An indirect indicator of cholecystitis is the expansion of the extrahepatic bile ducts, in particular, an increase in the caliber of the common bile duct by more than 0.7-0.8 cm. looking closely at the shadow of the gallbladder, you can notice the unevenness of its contours in the case of pericholecystitis, as well as various deformations of the bladder. But there is a known danger here: the fact is that 8% of healthy people have congenital variants of the shape of the gallbladder, sometimes quite bizarre. Ago the radiologist must be careful to distinguish between an abnormality of the bladder and its deformation as a result of wrinkling and adhesions. With adhesions, the shape of the bladder changes little during contraction, and emptying is slowed down. Violations of the concentration function of the gallbladder and its motility are also among the indirect symptoms of cholecystitis.

RADIATION SEMIOTICS OF PANCREATIC GLAND LESION. Acute pancreatitis is characterized by a high position of the diaphragm and weakening of its mobility. CT shows enlargement of the gland. With the edematous form of pancreatitis, the density of the gland decreases, with hemorrhagic - it increases. The formation of an abscess leads to the appearance of an irregularly shaped area of heterogeneous structure and reduced density. Accumulations of fluid in the small omentum, in the spleen, and in the kidneys can be seen. Celiacography makes it possible to find increased vascularization of the gland and heterogeneity of its shadow in the parenchymal phase.

X-ray diagnosis of chronic pancreatitis is quite difficult, so it is necessary to summarize the data of various X-ray methods. On ordinary X-rays, lime deposits and calculi in the gland can be detected, especially in cases of alcoholic pancreatitis. When examining the stomach and duodenum with barium sulfate, indirect signs of an enlarged pancreas are revealed. They are expressed in the displacement of the antral part of the stomach forward and up, in the displacement of the sections of the duodenum ("dilation of the duodenal loop"), in the flattening of the inner contour of the descending part of the intestine.

If pancreatic cancer is suspected, the investigation should begin with sonography. The tumor causes an increase in some part of the gland, most often its head. The contours of this department become uneven. The tumor node itself is visible as a homogeneous formation with uneven contours. If a cancerous tumor grows or squeezes the common bile and pancreatic ducts, then they expand in places. At the same time, stagnant enlargement of the gallbladder, as well as compression of the splenic or portal vein, is revealed. Metastases may be detected in the lymph nodes of the abdominal cavity and in the liver.

Many similar signs are determined on a CT scan: an increase in the affected or part of the entire pancreas in the area of the tumor. It is possible to establish tumor growth in blood vessels, neighboring tissues and metastases in lymph nodes, liver, kidneys, etc. When injecting intravenous contrast material, it is possible to distinguish the image of the tumor more clearly.

Materials on the activation of higher education seekers during conducting a lecture: questions, situational problems, etc(if necessary)**:**

General material and mass-methodological support

lectures:

- lecture halls according to the plan of the educational department of ONMedU
- projector, screen
- presentation
- PC

Questions for self-control:

Situational problem #1.

Make a conclusion.

After two sips of aqueous suspension of barium sulfate in the upper part of the stomach, the interweaving of folds in different directions is determined. In the body of the stomach, 5 longitudinal winding folds are defined. Near a low steepness, the folds are parallel in the longitudinal direction. The contour of high steepness is jagged. In the antral part of the stomach, there are 4 longitudinal folds that converge to the outlet channel. On the border of the bulb and the nasal part of the duodenum, Kerkring folds are found.

The answer is a normal X-ray picture of the stomach.

Situational problem #2.

The patient complains of the development of pain in the epigastric region of moderate intensity soon after eating. He considers himself sick for 2 years. During the period of exacerbation of pain, the patient experiences rapid fatigue, irritability, and poor sleep.

Previous diagnosis?

Make an examination plan.

Answer: chronic gastritis.

- physical examination
- fractional study of gastric juice
- fibrogastroduodioscopy.
- radiography
- biopsy.
- clinical and biochemical blood tests, stool tests.

TESTS

1. X-ray examination of the esophagus revealed a filling defect in the form of a rounded lumen. The contours of the defect are different. In the center of the illumination there is a round niche with uneven raised edges.

   Make an X-ray conclusion.

   A - Exophytic cancer of the esophagus in the stage of decay B -
   Achalasia of the cardia
   B - Chronic esophagitis D -
   Reflux esophagitis D -
   Esophageal diverticulum

   The answer is A

2. An X-ray examination of the esophagus with 1-2 barium swallows revealed flattening of the folds of the mucous membrane and its expansion. The furrows are narrowed, their depth is reduced. There is an area of "baldness" of the mucous membrane. A small elevation of the mucous membrane was found in a limited area.

   Make an X-ray conclusion.

   A – Normal stomach
   B – Age-related changes in the gastric
   mucosa B – Gastric ulcer
   G – diverticulum of the stomach

   The answer is D

3. A man, 55 years old, a driver, complains of difficulty swallowing dense food, pain when passing a food ball. After taking a sip of liquid, he notes esophageal vomiting.

   An X-ray examination with a liquid barium suspension reveals an asymmetric narrowing with a zone where there is no palsy. Establish a diagnosis.

A – Tumors of the mediastinum
B – Hysterical spasm
B – Bronchogenic cancer D
– Esophageal cancer
D - Esophageal diverticulum

The answer is G

4. Name the most effective x-ray method for diagnosing colon cancer:

A – Colonoscopy
B - Irrigoscopy
B – Oral administration of barium sulfate D
– Parietography
D - Angiography

The answer is A

5. After how many hours after taking the contrast agent, you can start examining the colon

A - in 10 minutes B
- in 3-4 hours C - in
a day
D - in two days D -
in three days

The answer is B

6. A 35-year-old man complains of hungry, nocturnal, sharp whites, which usually calm down after taking a meal and a drink. During X-ray examination, a barium depot was detected in the first oblique position on the lesser curvature of the bulb, outlined by illumination. In the second oblique position, a conical protrusion is observed on the contour of the bulb. X-ray conclusion - duodenal ulcer.

7. Woman, 54 years old. During X-ray examination of the stomach, uneven expansion and flattening of the folds is determined. The furrows are narrowed and have a linear appearance with small crater-like depressions along their course. The parallelism of the folds has disappeared. X-ray conclusion: submucosal cancer of the stomach.

8. Woman, 71 years old. On the radiograph of the mucous membrane of the antral part of the stomach, low, several expanded and thickened folds of the antral part of the stomach are visible, the furrows between them are small, with even edges. The relief of the mucous membrane resembles a "ploughed field". The contours of this part of the stomach are unevenly twisted. X-ray conclusion: submucosal cancer of the stomach.

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Additional.

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2. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 2. Kyiv, Book plus. 2015. -168 p.

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Lecture No. 4

Topic. Radiation signs of diseases of the musculoskeletal system.

Actuality of theme:X-ray method significantly enriched anatomy and physiology of the musculoskeletal system. It made it possible to study the structure and function of bones and joints during life. X-ray studies made it possible to look at the traditional manifestations of skeletal diseases in a new way, to revise the classifications of its lesions that existed before, and to describe many new pathological processes in bones.
The X-ray method is traditional and basic for studying the radiological morphology of the bones of the skeleton. But recently they are increasingly used

computed tomography, magnetic resonance imaging, radionuclide scintigraphy and sonography.

Goal:

Educational: the success of diagnostics depends primarily on professional training doctors, from their erudition and breadth of outlook. The integration of radiological semiotics with clinical semiotics creates a complex approach in diagnostics. Therefore, four important stages should be distinguished in the thinking of the diagnostician: sciological, semiotic, syndromic and nosological - they are all interconnected, they must be formed starting from knowledge of the norm. The doctor must be able to apply and know the methods of research of the musculoskeletal system; to be able to analyze bone system changes; to be able to issue a referral for a patient to study the locomotor system.

Basic concepts: the laws of sciology, X-ray semiotics of bones and joints are normal and in diseases, age-related features of the development of bones and joints, CT-, MRI-, ultrasound examination of bones and joints, injuries, inflammatory diseases of bones, bone tumors.

Content of the lecture material.

Diseases of the joints and the entire musculoskeletal system can be caused by many reasons. it:

- injuries of various origins,
- infectious diseases,
- degenerative changes in bones and joints caused by previously experienced colds.

Many diseases of bones and joints have practically the same symptoms. A timely and correct diagnosis will enable the doctor to choose the most suitable method and prescribe an effective course of treatment for the patient. Therefore, to determine the diagnosis, doctors often use several methods of diagnosing joint diseases in their practice.

Currently, medical diagnostics has much more opportunities than a couple of centuries ago. X-rays, ultrasound, magnetic resonance and computer tomography have been added to the visual examination by a doctor and laboratory tests, which help the specialist establish a new or confirm a previously established diagnosis.

1. Radiography - a long-known and most common method of researching injuries and diseases of the musculoskeletal system. The location of the injury, its shape and size, the presence of degenerative changes in the bones and joints and their severity are clearly visible on the X-ray image. X-rays are prescribed as in the primary case

examinations to establish a diagnosis, as well as at the next stages of treatment in order to determine the quality of repositioning, monitoring the process of bone fusion and evaluating the effectiveness of the measures taken.

2. Ultrasound makes it possible to detect the presence of pathologies in the human body. It is successfully used to study soft tissues, but it does not provide an opportunity to determine the state of bone tissue, ligaments and menisci. If studying the joints, ultrasound is most suitable for examining the shoulder and knee joints. If for an adult, ultrasound of the hip joint at certain sizes is a rather controversial procedure, then ultrasound of the hip joint of an infant is quite an informative procedure. Research using ultrasound waves does not cause any harm to the human body and does not require special preparation.
3. The most progressive method of studying bones and joints is computer tomography. It is based on the ability of different internal organs to absorb different amounts of X-ray radiation. During the degenerative process in the joint, when necrosis occurs, the surface of the bone under the cartilage changes. Only computed tomography can determine this. Thanks to the CT scan, it is possible to detect swelling, a cyst and compaction of the patient's soft tissues.

4. Magnetic resonance imaging is the most informative method of soft tissue research. With its help, it is possible to detect the presence of pathological processes in tissues at earlier stages of development, which makes it possible to start treatment earlier, thereby preventing or significantly slowing down degenerative processes in the body. Magnetic resonance examination is a non-contact method of diagnosis, painless and safe.

Diseases of the joints and spine are one of the most frequent reasons for limiting work capacity and mobility to the point of crippling a person. Most pathologies in the initial stages of development are practically asymptomatic and do not cause concern for the patient. As the pathological process progresses, tissue changes intensify and become irreversible. High-quality diagnosis, accurate determination of the causes of joint disease and comprehensive treatment make it possible to eliminate the pathological process or, at least,

slow it down

The most common causes of joint diseases:

heavy physical exertion or insufficient motor activity;

excess body weight;
injuries;
improper nutrition;
· infectious diseases;
insufficient production of structural components of cartilage tissue;
· endocrine disorders;
· engaging in some sports;
accompanying chronic diseases (diabetes, gout);
· specific labor activity;
· old age - joint diseases can also develop as a result of natural aging processes.
Some causes of joint diseases are common to spine diseases, for example, heavy physical exertion, injuries, excess body weight, sedentary lifestyle, metabolic disorders. Specific favorable factors are also identified for this group of pathologies, which include:
incorrect posture during work or study;
· different leg lengths in children;
birth trauma;
· muscle dystrophy;
· children's cerebral palsy, etc.
Identifying the causes that led to diseases of the joints or spine plays an important role in the treatment of this pathology. Therefore, at the consultation stage, the doctor tries to collect as detailed an anamnesis as possible and learn about all the circumstances of the disease.

Diseases of the joints and spine are classified into:

· Degenerative-dystrophic (arthrosis). They develop as a result of the destruction of cartilage, bone tissue and other joint structures.
· Inflammatory (arthritis). In this case, the cause is inflammatory changes that can be localized both directly in the joint and around its capsule.
· Traumatic. Diseases of the joints and spine are the result of trauma.
· Congenital. They develop in utero and are accompanied by anatomical anomalies of bones and joints.
Tumorous. It is a consequence of benign and malignant neoplasms.

Joint diseases can be divided by localization.

Diseases of the joints of the upper limbs include:

1. Epicondylitis (tennis elbow) - inflammation of the tendons and other tissues surrounding the elbow joint.
· Symptoms: spontaneous pain of an intense nature in the area of the elbow joint; increased pain during physical exertion on the elbow or when shaking hands; decrease in muscle strength in the hand; swelling in the area of the elbow joint.

2. Deforming osteoarthritis of the elbow joint is a degenerative-dystrophic disease in which the cartilage tissue that forms the cavity of the elbow joint is destroyed.

· Symptoms: an asymptomatic course is usually characteristic; all signs of the inflammatory process are possible (hyperemia, swelling, limitation of movements in the elbow joint and pain syndrome).

3. Rheumatoid arthritis of the hand joints is an inflammatory autoimmune disease that affects the small joints of the hand. In rheumatological diagnosis, a review RG of symmetrical joints is always used, even if the symptoms concern one joint. It is very useful, especially for the assessment of the width of the joint space (currently there are no developed standards, so the assessment is always subjective), local bone demineralization, as well as the location of changes.

- Symptoms: pain and morning stiffness in the affected joints; swelling, sensitivity of the joint during stress; impaired mobility and subsequent deformation of the joints.

Diseases of the shoulder joint

1. Scapular periarthritis. Inflammatory changes in the soft tissues surrounding the shoulder joint (muscles, ligaments, capsule) are noted.

· Symptoms: low fever; hyperemia of the skin over the joint; swelling, restriction of movement (difficulty raising the arm); forced position (desire to keep the arm bent, pressing it to the chest); shoulder pain (night time).

2. Arthrosis. With arthrosis, cartilage is destroyed, but bone growths are formed in its place.

· Symptoms: impaired mobility; stiffness of movements; signs of deformation of the shoulder joint (crepitus, unnatural position of the limb, swelling of soft tissues, stiffness of movements).

Diseases of hip joints

Among the diseases of the hip joint can be noted:

1. Coxarthrosis is a chronic disease of the hip joint in which the cartilage is slowly destroyed.

· Symptoms: pain during movement; restriction of movement; lameness; synovitis

2. Aseptic necrosis of the femoral head. It develops as a result of impaired blood circulation in the joint, which leads to the destruction of bone marrow, and then bone tissue.

· Symptoms: dull, pulling pain in the groin during walking and exercise.

3. Arthritis. They can develop as a result of infections or rheumatological diseases. For example, acute rheumatic fever is a post-infectious complication of a streptococcal infection that affects large joints and has a volatile nature.

Diseases of knee joints

1. Dislocation of the patella.
· Symptoms: pronounced pain in the knee; leg shortening; swelling and bluishness of the injured area; change in the anatomical shape of the joint; lack of leg support function.

2. Inflammation of ligaments, tendons and joint bag.

3. Hoff's disease. It is characterized by the transformation of fatty tissue into fibrous tissue, due to which the joint loses its mobility.
· Symptoms: pain and discomfort; swelling in the area of pterygoid ligaments and folds; restriction of mobility; changes in the appearance of the joint; local hyperemia; the appearance of compactions or soft formations.

Diseases of small joints of the lower limbs

1. Gout is caused by metabolic disorders and excessive levels of uric acid in the blood. This leads to the formation of uric acid crystals in the joints, causing an acute attack of pain and inflammation. Gout can be related to genetic predisposition, diet and lifestyle.
· Symptoms: sharp joint pain (big toe); edema and hyperemia; attack more often at night or in the morning; the presence of gouty tophi.

Types of spine diseases

They also differ in localization (cervical, thoracic, lumbar, sacral) and nature of occurrence. This group includes:

1. Osteochondrosis. The destruction of the cartilage and bone tissue of the vertebrae is noted.
· Symptoms: pain that can occur in the neck, shoulders, lower back and even in the ribs; feeling of stiffness in the back and lower back; numbness of the limbs; muscle spasms; fatigue; dizziness and headache caused by pinching of nerve endings.

2. Scoliosis. A deforming disease that is accompanied by curvature of the spine in different planes. Scoliosis can have several degrees, depending on the severity of the curvature.
· Symptoms: asymmetry of shoulders, nipples, shoulder blades, waist triangles; stoop; deformation of the chest; sinking of the ribs; front ribs are strongly protruding

(especially lying down); pain in the chest, back or neck; different length of the upper limbs when stretching; pronounced pelvic deformation.

3. Hernias of intervertebral discs. In this disease, the capsule of the intervertebral disc is damaged, as a result of which the nucleus pulposus (base of the disc) goes beyond its limits.
· Symptoms: pain during exercise; shots that hit the thigh, buttocks, feet, sternum; impaired sensitivity of the limbs; stiffness of the spine; frequent headaches; muscle weakness, numbness of limbs; dysfunction of the intestine, genitourinary system.

4. Spondyloarthrosis. Another degenerative-dystrophic disease in which the small joints of the spine are affected.
· Symptoms of spondyloarthrosis of the cervical region: problems with hearing and vision; dizziness; increased blood pressure; tingling in the fingers, numbness; crunching, clicking, pain when moving the head; inability to fully turn or tilt the head; pain in the neck, shoulders, arms, sometimes in the chest, which can resemble a heart attack.

5. Sciatica. In this disease, the spinal roots are compressed. Usually, sciatica is a consequence of other diseases of the spine (osteochondrosis, scoliosis, herniated disc).
· Symptoms: pain in the affected part of the spine, the nature of the pain is shooting or aching, intensifies during movement; stiffness of the spinal muscles, which are painful when palpated; restriction of movements; numbness of the legs and feeling of crawling ants; fatigue.
7. Analysis of synovial fluid with a description of its physical and chemical properties and the characteristics of cellular elements, which is carried out for the diagnosis of various inflammatory joint diseases and dystrophic processes.

Instrumental research methods

1. X-ray of joints. Pain in the joint area, limited mobility, swelling and discoloration of the skin in the joint area may be an indication for its implementation. X-ray allows you to see the deformation of the joints and their pathology.
2. CT - a type of X-ray that allows you to get a clearer and better image. It is mostly used for differential diagnosis.
3. Roentgenoscopy is an observation of the work of the skeleton with the help of X-rays, when the image is displayed on the monitor online. The method allows the doctor to assess the amplitude of displacement of bones and joints, the localization of pathological changes, the extensibility of ligaments and tendons.
4. MRI is a method of joint examination that will allow determining their condition using electromagnetic waves. MRI determines the condition of soft tissues - nerves, muscles, ligaments. The device clearly sees intervertebral discs, cartilage, structures of the spinal cord, spine and joints.
5. Ultrasound of the joints helps to assess the turbidity (inflammation) of the joint fluid, to determine its volume. He finds tumors, tears, lacerations, muscle spasms,

tendons, menisci. The study allows you to determine the density of bone tissue (ultrasound densitometry), detect osteoporosis at an early stage.

The main indication is the presence of subjective or objective symptoms from the side of the joints and peri-articular tissues, as well as the suspicion of a disease accompanied by bone and joint changes. RG is performed with the aim of: 1) establishing a diagnosis (sometimes preliminary)
2) assessment of the degree of disease progression.

Characteristics of changes

Edema of peri-articular soft tissues- caused by synovitis and inflammatory process in the surrounding soft tissues; especially noticeable in inflammatory diseases in the area of the joints of the hands and feet - RA, PsA and gout.

Osteoporosis of epiphyseal parts of bones- occurs as a result of local bone hyperemia caused by the inflammatory process, as well as increased bone resorption by osteoclasts under the influence of proinflammatory cytokines. It is characteristic of RA and other inflammatory changes, especially tuberculosis, in PsA it may be less pronounced, but in other seronegative spondyloarthropathies, osteoarthritis and gout, bone density usually remains normal.

Narrowing of the joint space– caused by destruction of articular cartilage; the width of the gap is inversely proportional to the degree of cartilage damage. With RA and others, the narrowing of the joint space is uniform and symmetrical; on the other hand, with osteoarthritis, joint gaps can be symmetrical or uneven (they are especially well visualized in the supporting joints - knee and hip). With RA in the femoro-tibialis joint, the lateral part is most often narrowed, and with primary osteoarthritis – the medial part.

Subchondral cysts(geodes) –**inflammatory**geodes (e.g. with RA) are formed due to the growth of inflammatory granulation tissue (in the form of a layer - pannus, pannus) in the trabecular bone located under the articular cartilage; radiographs do not have sharp contours. In osteoarthritis, they are formed due to the penetration of synovial fluid into the subchondral bone through cracks and defects of the articular cartilage and may have a sclerotic capsule.

Subchondral osteosclerosis(thickening of the subchondral bone) - occurs due to fractures of bone trabeculae located under the articular cartilage. It is a typical X-ray symptom of osteoarthritis.

Osteophytes(bone growths) - is a consequence of adaptation of the bone to the changes biochemical conditions caused by degeneration of articular cartilage (peripheral and intervertebral joints) of intervertebral discs (vertebral bodies). They belong to the main radiological symptoms of osteoarthritis. In peripheral joints osteophytes are formed on the edges of the articular surfaces, and in the spine on the edges of the vertebral bodies. Large pseudo-osteophytes (hypertrophy of bones in the places of attachment of tendons and ligaments, resembling a "parrot's beak", begins slightly above the edge, and this distinguishes them from true osteophytes in spinal osteoarthrosis), compression of adjacent vertebrae occurs in generalized idiopathic skeletal hyperostosis, that is, the disease Forestier.

Erosions (patterns) is most often the result of damage to the articular cartilage and bones with granulomatous inflammation (pannus), so their detection indicates an inflammatory process - RA, PsA, tuberculosis. Patterns are initially formed in the area of the joint capsule on the surface of the bone, which is not covered by articular cartilage, the pannus that grows primarily destroys the areas "unprotected" by cartilage, thus forming the so-called **marginal** patterns In the future, the patterns increase in size and destroy the bone forming the epiphysis. In gout, patterns are caused by the destruction of bone trabeculae by deposits of sodium urate. If the surrounding bone tissue is affected by osteoporosis, then the edges of the erosion are "blurry" (as in RA), if there is no osteoporosis - "sharp" (delimited as in gout). In addition to the joints, patterns can also form in the body of the calcaneus (in RA, PsA and reactive arthritis) and the teeth of the axial vertebra (RA). In osteoarthritis, patterns are not found, with the exception of the erosive form of osteoarthritis of the hands (osteoarthrosis of the manus erosiva), in which they are formed as a result of the secondary inflammatory process **central** patterns in the central part of the articular surface.

Osteolysis – most often affects the fingers and toes; occurs in PsA, RA and scleroderma. In systemic scleroderma and diabetes, as well as in PsA, the distal phalanges are affected. In RA and PsA, the humeral end of the clavicle, the distal end of the ulna, the radius, and the spinous processes of the cervical vertebrae ("pointed" processes) can also undergo osteolysis.

Bone proliferation – is a typical symptom for PsA and others seronegative spondyloarthropathies. Available in several variants:

1) in the distal interphalangeal joints in PsA, where accompanied by bone destruction, it is visualized in the form of a characteristic picture **simultaneous osteolysis with osteogenesis**; RA patterns are never accompanied by bone proliferation

2) **layering of the periosteum** along the diaphyses of the metacarpal and metatarsal bones, the diaphyses of the phalanges of the fingers (a symptom specific to PsA, also found in juvenile idiopathic arthritis). Layering of the periosteum also occurs with nonspecific bacterial inflammatory changes and primary malignant bone tumors.

3) **ossifying inflammatory reactions** (enthesopathy, enthesopathy, enthesitis) is one of the most characteristic symptoms of seronegative spondyloarthropathies. Ligaments and tendons arise in places of attachment to bones. Infiltration

inflammatory cells appears in bone parts fastening, perivascular tissue, ligaments, tendons and loose connective tissue surrounding the attachment site. Inflammatory and destructive changes create the conditions for the release of the connection of tendon fibers with the surrounding cartilage and bone fibers from under the bone-articular surface - in this way, ossifying tissue is formed at the attachment site, which is visualized in the form of cloud-like or striped shadows. These changes are most often located on the edges of the ischium, ilium, iliac trochanters and calcaneus tubercle - on the lower surface in the place of attachment of the plantar aponeurosis and on the back surface in the place of attachment of the Achilles tendon.

Bone ankylosis(ankylosis, ankylosis) of the joints - atrophy of the joint space with simultaneous limitation of movements in the joint - occurs in the sacroiliac joints (in ankylosing spondylitis [AS]), in the intervertebral joints (in AS and other seronegative spondyloarthropathies), as well as in the joints of the fingers and wrists (etc. in RA, PsA, Still's disease in adults).

Deformations of joints, such as:

1) ulnar deviation of the fingers in the metacarpal joints and lateral deviation in the metacarpal-phalangeal joints are typical for RA and SLE

2) subluxations - e.g. in the joints of the hands (most often in RA and PsA), in the middle atlanto-axial joint.

3) articular contracture is a consequence of inflammatory or degenerative changes (secondary changes of the capsule and ligamentous apparatus and muscle attachment sites)

4) valgus and varus deformation of the knee joint (femoral and tibial) - a late complication resulting from the destruction of articular cartilage. Its lateral part (valgus deformity) and medial part (varus deformity).

Soft tissue calcification(skin, subcutaneous tissue, muscles, connective tissue) - occurs in dermatomyositis, systemic scleroderma and SLE. In chondrocalcinosis, calcifications occur in hyaline (vitreous) and fibrous (connective tissue) cartilage, e.g. in the menisci. In seronegative spondyloarthropathies, especially in AS, they are formed**syndesmophytes**, arc-shaped calcifications that connect the bodies of adjacent vertebrae, are located above the lower edge and below the upper edge of the bodies of adjacent vertebrae. The outer part of the fibrous ring of the intervertebral disc, the short fibers located between the anterior longitudinal ligament and the paravertebral connective tissue and the surrounding connective tissue, are also calcified. Syndesmophytes have a vertical location and are calcified soft tissues, in contrast to osteophytes, which are characterized by a horizontal location and a structure similar to bone tissue. Calcifications can also be visualized in synovial bursae, tendons and ligaments (e.g. after injuries, repeated microtraumas and overloads that lead to a secondary inflammatory process).

Degenerative changes of intervertebral discs- lead to their reduction height and secondary degenerative-productive changes (osteophytes) along the edges of the vertebral bodies. Sometimes a "vacuum phenomenon" is visualized (vacuum disc sign), that is, an oval space inside the disc that is filled with gas that accumulates due to degeneration of the intervertebral disc.

Interpretation

On the basis of the characteristic X-ray changes of the affected joints and peri-articular tissues, the number of affected joints, the location of the changes (in the peripheral joints, spine, soft tissues), symmetry or asymmetry of the changes - it is possible to establish a diagnosis, sometimes a primary one.

1. Number of affected joints

1) damage to 1 joint (monoarthritis) indicates a local pathological process, most often it is a primary or secondary (e.g. after an injury) degenerative disease, a disease caused by the deposition of crystals (gout); less often, aseptic necrosis, bacterial (including tuberculosis) arthritis

2) damage to 2–4 peripheral joints (oligoarthritis) most often occurs in seronegative spondyloarthropathies and gout

3) damage to a large number of joints, namely ≥ 5 (polyarthritis), is most typical for RA, PsA, SLE and gout (polyarticular form); less common in polymyositis and dermatomyositis, systemic scleroderma, chondrocalcinosis, osteoarthritis and sarcoidosis

2. Location of changes

1) changes located mainly in the small joints of the feet and hands occur in the early stages of RA, PsA and gout

2) changes in the spine and large joints are typical of AS and reactive arthritis

3) changes in the joints of the hands, feet and large joints usually occur in the late stages of RA, PsA, polyosteoarthrosis

4) in RA, the distal interphalangeal joints are most often not affected (in PsA they may be affected); with primary osteoarthritis of the hands, the distal and proximal interphalangeal joints may be affected, but not the metacarpals. The metacarpal joints are affected in RA and PsA. In gout, the changes are usually localized in the metatarsophalangeal and interphalangeal joints.

5) RA almost always affects only the cervical spine - inflammatory changes occur in the atlanto-occipital joints, atlanto-axial joint, transverse ligament of the atlas, spinous processes and vertebral bodies. In AS, in addition to the sacroiliac joints, changes are also most often localized in the lower thoracic and upper lumbar vertebrae (the so-called sterno-lumbar transition), and in the later stages, the thoracic, lumbar, and then the cervical spine is completely affected. In osteoarthritis, the changes are most often localized in the lumbar and cervical regions, less often in the thoracic region (with the exception of Forestier's disease, in which the thoracic region is also affected).

6) in the case of atypical location of degenerative changes (e.g. in the elbow joints, metacarpal joints, hand joints, shoulder joints, ankle joints) other causes should be sought, e.g. trauma, chondrocalcinosis, juvenile hemochromatosis, ochronosis

3. Symmetry of joint changes

1) symmetric changes (most often in RA) - concern small joints (hands and feet) and large joints (hip, knee, ankle, shoulder, elbow)

2) asymmetrical changes – in PsA and gout

3) single- or multi-joint changes - in osteoarthritis

4) damage to the sacroiliac joints is bilateral in AS and arthritis in non-specific inflammatory bowel diseases, and can be unilateral in PsA and reactive arthritis.

X-ray methods. X-ray examination of joints and internal organs is important in the diagnosis of many RBs. The early stage of osteoarthritis — a degenerative disease of the joints — is characterized by the phenomena of subcartilaginous osteosclerosis with the formation of pronounced osteophytosis (for example, sharpening of the edge of the acetabulum in coxarthrosis or the poles of the patella in gonarthrosis), initial narrowing of joint spaces, flattening of articular surfaces. In the late stages of osteoarthritis, unevenness of the width of the joint space, deformation of the joint ends, pronounced osteophytosis, and restructuring of the internal structure of the bone tissue are revealed. In osteoarthritis, there is never bone ankylosis. An early X-ray sign of inflammatory joint diseases is osteoporosis, which has different types: diffuse, focal, spotty, peri-articular. Other signs — narrowing of the joint space in the progression of arthritis, usuratsiya, cyst-like rearrangement of the subchondral part of the bone, 27 subluxations, dislocations, ankylosis — are characteristic of late stages of arthritis (more often RA). In the advanced stages of some diseases, X-ray diagnosis is even pathognomonic, for example, the "puncture" symptom in gout, the presence of rounded bone-cartilaginous formations in peri-articular tissues with chondromatosis, etc. In the early stages of the disease, X-ray examination should be carried out in the so-called zones of predominant localization. For X-ray diagnosis of the early stage of RA, images of the joints of the feet and hands should be taken, in Bekhterev's disease, an examination of the iliosacral articulation, in gout - of the first metatarsophalangeal joint. Recently, special methods of joint research using computer tomography, arthroscopy, radioisotope methods, thermal imaging, and the use of liquid crystals have become widespread. Arthroscopy is a method of visual examination of the internal cavity of the joint using an arthroscope, which is an optical system with independent illumination and which works in an optically neutral environment - isotonic sodium chloride solution. Direct examination of the joint cavity allows, without open arthrotomy, to establish traumatic or degenerative lesions of the menisci, ligamentous apparatus, cartilage lesions, assess the state of the synovial membrane, and target areas of pathologically changed tissue for further morphological analysis. Currently, diagnostic arthroscopic criteria for synovitis in CKD with joint syndrome are being developed. Thermal imaging is a method of studying the intensity of infrared radiation in living tissues of the body with the help of an electronic device (thermal imager). The latter has the ability to remotely capture infrared rays from the examined organs, in particular joints, and record on photo paper a thermogram in the form of a contour figure of a joint or a curve, on which the skin temperature is recorded in degrees. A thermogram is an objective method of assessing local temperature and can be used for differential diagnosis of inflammatory and degenerative joint diseases, allows detecting the subclinical phase of synovitis, and evaluating the treatment. To study the intensity of infrared radiation, liquid crystals of the cholesterol base are sometimes used, which, when in contact with the skin of the joint area, give a color scale depending on the local temperature, from orange to greenish shade. To study the condition of the soft tissues of the joints, ultrasound examination is increasingly used, due to the fact that these tissues are X-ray negative.

Neoplasms of the musculoskeletal system are tumors that develop from all its tissues:
directly of bone tissue, periosteum, cartilage and joints.
They are characterized by local destruction with rapid growth and almost exclusively hematogenous metastasis. There are no reliable data on the epidemiology of these tumors. They account for about 1.5% of all tumors. Primary malignant bone tumors occur 2-3 times more often than benign ones. 50-60% of patients
- persons under 30 years of age. Localization can be in all parts of the skeleton, but sarcoma is characterized by damage to long tubular bones - femur, tibia, and humerus. From the flat bones, the iliac bones and ribs are affected.
In adolescence and young adulthood, osteogenic sarcomas and Ewing's tumor are more common.
Osteoblastoclastomas are detected in women aged 21-30 years.

In the age group over 30 years, chondrosarcomas, lymphosarcomas and metastases of other tumors are preferred.

Tumors can be both in the central and in the peripheral part of the cortical layer. An increase in the size of the primary focus leads to compression of the normal part of the bone and resorption by reactive osteoclasts. Even in the early stages, you can see the destruction.

The tumor gradually exfoliates and destroys the periosteum with the surrounding soft tissues. The periosteum thickens, peels off, radiant outgrowths - spicules - appear perpendicular to the bone. Inside the tumor, the processes of osteolysis prevail, so pathological fractures are possible. In osteoblastic forms of sarcoma, the newly formed bone loses its normal structure and radiologically has the appearance of a structureless shadow. When the internal spongy layer of the bone is destroyed, the tumor moves to the bone marrow and, not encountering any resistance, spreads far beyond the radiologically changed part of the bone. Intramedullary invasion is especially pronounced in Ewing's sarcoma.

Malignant bone tumors metastasize hematogenously, because there is no lymphatic drainage of the bone.

Primary tumors of the bone system are benign and malignant neoplasms that develop both from skeletogenic tissues and other tissue elements of the bone.

Processes on the border with tumors (fibrous dystrophy, Paget's osteodystrophy, chondromatosis of bones, etc.) processes of a dysplastic nature, which are close to tumors according to a number of biological, clinical and pathological features. Metastatic forms of various tumors.

Primary tumors:

a) benign (osteoma, osteochondroma, chondroma, osteoid osteoma, chondroblastoma, giant cell tumor, fibroma, hemangioma); b) malignant (osteosarcoma, paraosseous sarcoma, chondrosarcoma, fibrosarcoma, Ewing's sarcoma, reticulosarcoma, hemangioendothelioma, myeloma).

c) uncertain behavior

Secondary tumors:

a) metastases cancer and sarcomatous tumors in bones;

b) tumors growing in the bone from the surrounding soft tissues.

Recognizing bone tumors is one of the most difficult problems, because the choice of treatment method and the future fate of the patient depend on it. In practice, there are serious difficulties in the diagnosis of bone neoplasms, especially in the early stages of the disease. Clinical signs of bone tumors - pain, swelling, dysfunction, dilatation of subcutaneous veins, sometimes a local increase in temperature, pathological fractures - appear in the late stages of the disease.

General principles of KSS diagnosis:

- Main signs: trophic changes in bone tissue - osteoporosis, atrophy, lack of pronounced endosteal reaction, weakness of periosteal reaction;

- Change in the size of the joint gap, intervertebral spaces;

• Focal nature of primary bone destruction

• Contact "kissing" nature of primary bone destruction;

• Change in the degree of density of paraarticular and paravertebral soft tissues near the lesion;

• Early violations of normal anatomical proportions in the affected parts of the skeleton

Materials on the activation of higher education seekers during

conducting a lecture: questions, situational problems, etc(if necessary)**:**

General material and mass-methodological support

lectures:

- lecture halls according to the plan of the educational department of ONMedU

- projector, screen

- presentation

- PC

Examples of test tasks

1. Where are tophi most often localized?

1. Auricles.
2. On the cheeks.
3. On the hips.
4. On the sole surface of the feet.
5. In the area of the distal interphalangeal joints of the hands.

2. Where are Heberden's nodes?

1. Distal interphalangeal joints of the hands.
2. Proximal interphalangeal joints of the hands.
3. Carpal-phalangeal joints.
4. Knee joints.
5. Metatarsal-phalangeal joints of the thumb.

3. Where is the favorite localization of gouty arthritis?

1. Metatarsal-phalangeal joint of the thumb.
2. Hip joints.
3. Immobile joints of the spine.
4. Carpal-phalangeal joints.
5. Shoulder joints.

4. Where are rheumatoid nodules most often located?

1. In the area of the elbow joints.
2. In the area of the proximal interphalangeal joints of the hands.
3. In the area of accessible interphalangeal joints of the hands.
4. In the area of ankle joints.
5. In the sole area.

5. From what lesion does ankylosing spondylitis make its debut?

1. From the iliac-sacral joint.
2. From the lumbosacral spine.
3. From the thoracic spine.
4. From the cervical-thoracic spine.
5. From hip joints.

6. In which disease there is a violation of the posture - "out

that which asks"?

1. Bekhterev's disease.
2. SLE
3. Dermatomyositis.
4. Rheumatoid arthritis.
5. Sjögren's disease.

7. What is the main X-ray sign of rheumatoid arthritis?

1. Usuration.
2. Marginal osteophytes.
3. Symptom of the puncher.
4. Narrowing of the joint space.
5. Destruction of epiphyses of bones.

8. What is the typical X-ray sign of gout?

1. Symptom of the puncher.
2. Patterns.
3. Osteophytes.
4. Heel spurs.
5. Narrowing of the joint space.

9. What is the characteristic X-ray sign of osteoarthritis?

1. Osteophytosis.
2. Usuration.
3. Osteoporosis.
4. Joint dislocations.
5. Symptom of the puncher.

10. Ulnar deviation characterizes what disease?

1. Rheumatoid arthritis.
2. Psoriatic arthropathy
3. Reactive arthritis.
4. Osteoarthritis.

5. Chronic gout.

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Lecture No. 5

Topic. Principles and methods of radiation therapy.

Actuality of theme: In Ukraine it is close50% of patients are in the middle age category, economically active age and thanks to early diagnosis and as a result of quick and high-quality treatment, they could return to a normal life. According to statistics, in Ukraine, about 18-23% of cancer patients die between the ages of 19 and 55, and about 25-32% of patients die between the ages of 56 and 65. According to statistics, 50% of cured oncology patients were treated with surgery, the other 40% of the total number of cured cancer patients were cured thanks to radiation therapy as an independent therapy and in combination with other methods, the other 10% were treated with chemotherapy as itself. and in combination with other methods. In the world, cancer patients need at least one course of radiation therapy for more than 50% of newly discovered oncological pathologies. Some palliative treatments for frequently detected metastatic solid tumors are inferior to radiation therapy. Palliative radiation therapy is a fairly cost-effective method. In the modern world, more and more modern methods of oncology treatment and radiation therapy methods are used for the treatment of malignant diseases. All this is due to the fact that today everyone strives to improve the accuracy of dosing to oncopathologies as much as possible and to minimize the dose load on healthy surrounding organs and tissues as much as possible.

Goal:

Educational: Develop elements of cancer prevention in future doctors.

The first place with malignant neoplasms and a diagnosis established for the first time in their life - oncology among sick women for the period from 2017 is occupied by breast cancer, followed by skin pathologies and neoplasms of gynecological localization. Lung cancer, prostate cancer and skin cancer occupy the first places among sick men. According to international protocols, about 50-60% of cancer patients should undergo radiation therapy. **Basic concepts:**intensity modulated radiation therapy (IMRT), gamma knife, linear accelerator, cyber knife, optimal dose, radio modification.

Content of the lecture material.

Radiation therapyis one of the sections of medical radiology that studies the issue of using ionizing radiation for the treatment of various human diseases. Radiation therapy is based on the strong biological action of ionizing rays, which is caused by the ability to cause ionization and excitation of atoms and molecules of the environment and, thanks to chain reactions, is realized by structural, functional and metabolic changes in the body.

The formation of radiation therapy on a scientific basis was facilitated by the study of the physical, chemical and biological bases of radiation effects. The development of radiation therapy is based on the integration of scientific achievements in the field of nuclear medicine physics, biochemistry, biophysics, mathematics and technology, which contributed to the further development and improvement of the use of ionizing radiation for the purpose of treatment.

In Ukraine, radiation therapy is carried out in radiology departments of regional and city oncology dispensaries and research institutes. In the arsenal of means used for the treatment of malignant neoplasms, radiation therapy occupies one of the leading places and is often the only possible method of treatment. In 80% of patients with oncological diseases, radiation therapy is carried out in combination with surgical or chemotherapeutic methods of treatment, and in 40% of patients it is the method of choice and is used as an independent radical method of treatment. Both the immediate and long-term results of radiation treatment have improved due to persistent regression of the tumor with preservation of the function of the affected organ.

The indications for the use of radiation therapy are expanding and non-neoplastic diseases (treatment of acute and chronic inflammations, dystrophic processes, and in some cases with organ hyperplasia), which is due to the possibility of obtaining a clinical effect in a short time with small doses of radiation.

Indications for radiation therapy in non-neoplastic diseases

AND. Inflammatory processes, including purulent pathological processes of a surgical profile:

- boils of the face, neck, carbuncles, phlegmon, abscesses, hidradenitis, erysipelas, panaritium, osteomyelitis, postpartum mastitis, thrombophlebitis, paraproctitis;
- postoperative complications: anastomosis, inflammatory postoperative infiltrates, fistulas of various localization, weakly granulating wounds;

II. Degenerative and dystrophic diseases of bone and joint device:

deforming arthrosis, spondyloarthrosis, osteochondrosis, bursitis, tendovaginitis, epicondylitis, slaughterhouse spurs and others.

III. Inflammatory and hyperplastic diseases of the nervous system:

neuritis, neuralgia, plexitis, radiculitis, arachnoiditis, syringomyelia.

IY. Chronic dermatoses and skin diseases:

local (non-microbial) eczema, neurodermatitis, pruritic dermatoses, local forms of fungal skin lesions of the scalp and face.

For the treatment of these diseases, small, single, and total focal doses are used. The more acute the process, the smaller the one-time (ROD) and total (SOD) absorbed radiation dose. Choice**optimal dose**in case of non-cancerous diseases, it depends on the course of the process and is:

in acute inflammatory processes - ROD - 0.25 - 0.5 Gy, SOD - 1-1.5 Gy, in

chronic inflammatory processes - ROD - 1 Gy, SOD - 5-6 Gy

For the treatment of malignant tumors, much larger single and total radiation doses are used. They depend on the radiosensitivity of the tissue (histological structure) from which the tumor originates, as well as its size and localization.

The choice of the optimal radiation dose for malignant neoplasms depends on their histological structure**:**for the treatment of tumors originating from the epithelial tissues of the SOD - 40-60 Gy; adenocarcinoma – tumors originating from the tissues of the glandular epithelium SOD – 65-80 Gy; sarcoma – tumors originating from connective, muscular tissue SOD – 80-90 Gy; melanoblastomas, which are insensitive to irradiation and require the introduction of SOD 100-110 Gy.

Since tumors in the body are not autonomous, their radiosensitivity also depends on the reactivity of the body, the patient's age, his general condition, previous treatment, and the condition of the tissues surrounding the tumor. Tumors with infiltrating growth are less radiosensitive than exophytic forms, because they more strongly disrupt blood and lymph circulation in the surrounding tissues. Tumors rich in stroma are more radioresistant due to their low oxygenation.

Mechanism anti-inflammatory actions ionizing radiation at non-cancerous diseases are multifaceted. First of all, ionizing radiation has the property of pain relief. Due to the reduction of edema, the function of the organ improves, blood circulation increases, which has a positive effect on the course of inflammation. Already in the first hours after irradiation, a reaction on the part of blood vessels appears in the form of capillary expansion, increased permeability of the vascular wall, increased exudation, migration of blood elements into tissues, followed by their disintegration and formation of biologically active substances. Lymphocytes (phagocytes) are very sensitive to radiation, they begin to die from a dose of 0.1 Gy. Lymphatic capillaries expand, which contributes to increased outflow from the inflammatory focus, as a result of which intra-tissue pressure decreases and pain decreases. The phagocytic activity of leukocytes increases. The reaction of the tissue environment changes towards the alkaline side, which leads to the equilibrium of the ion balance - acidosis is replaced by alkalosis and helps to reduce the pain syndrome. After a short-term expansion, the lumen of the arteries narrows, as a result of which hyperemia and edema decrease.

The mechanism of action of ionizing radiation on malignant tumors is:

1) dystrophic changes and inhibition of cell division are observed in the tumor during irradiation (cell division is delayed);

2) capillary permeability increases, a significant number of phagocytes reach the tumor and phagocytize tumor cells; after phagocytes, histiocytes, which are precursors of connective tissue, arrive at the pathological focus.

3) histiocytes divide the tumor into separate fragments, collagen begins to be deposited;

4) encapsulation of individual cells that did not die is observed.

As the dose increases, the number of cells that lose the ability to reproduce increases, and the number of pathological mitoses increases initially. However, cells that continue to multiply die after several divisions due to chromosomal aberrations and gene mutations associated with the lesion

DNA. Under the influence of radiation in the tumor tissue in the following

the following changes occur in the sequence:

– tumor reduction due to the death of the most radiation-sensitive elements;

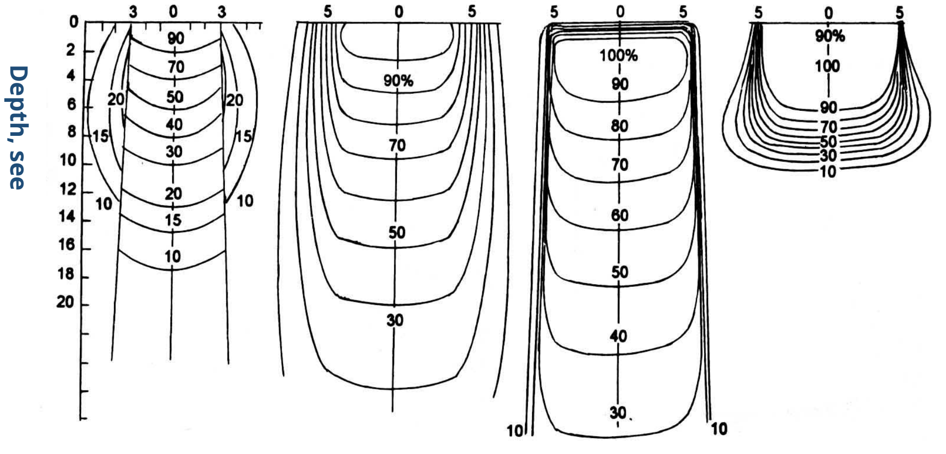
- development of granulation tissue and encapsulation of groups of malignant cells;

- reduction of tumor vascularization;

-**death of all tumor elements and their replacement by connective tissue.**

Different sources (X-ray radiation, gamma, beta and high-energy sources) are currently used for the course of radiation therapy, which allows, depending on the depth of the location of the pathological focus, to use such radiation sources that ensure maximum absorption of energy in the tumor. Using different sources and methods of radiation therapy, we have the opportunity to irradiate tumors with a sufficient therapeutic dose, which are located at different depths, showing isodose curves for different types of external irradiation (Fig. 7.1).

Fig. 7.1. Isodose curves for different radiation sources



X-ray radiationGaanmnaya-p2r3o0mkVni G6a0lSyomivne vypromEil **nude**Epactrnonian6eM **and radiation23 MeV**

100% dose – 0 cm **1.25 MeV** **100% dose – 1.5 cm 100% dose – 3.5 cm**

80% dose - 3 cm100% dose - 0.5 cm 80% dose - 7 cm**80% doses**–10 cm

50% dose - 7 cm80% dose - 5 cm 50% doses - 16 cm50% dose - 22 cm

50% dose - 10 cm

With X-ray radiation, the maximum absorbed dose is on the surface of the human skin, so it is most intensively irradiated. In the depth of the tissues, the dose decreases continuously and steeply and at a depth of 10 cm is 20% at a generation voltage of 200 kV.

With gamma radiation, the maximum absorbed dose is shifted to a depth of 0.5 cm from the surface of the skin, which reduces exposure, and at a depth of 10 cm, about 50% of the surface dose remains, which is relatively higher than with X-ray radiation.

A great advantage over gamma radiation is bremsstrahlung radiation with high photon energy of 25 MeV, when using which the maximum absorbed dose is at a depth of 4-6 cm from the surface of the skin.

Protons with high energy move almost in a straight line until the time of "stopping" in the tissues. They disperse little in the tissues, but constantly reduce the speed of movement, the linear loss of energy increases, reaching a maximum at the end of the run (Bragg peak) (Fig. 7.2).

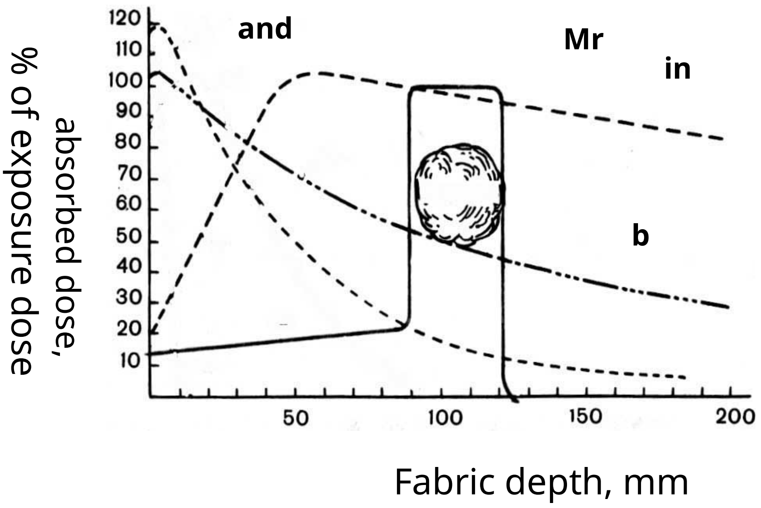


Fig. 7.2. Distribution of absorbed energy by depth from various radiation sources:

a) X-ray radiation (voltage 200 kV, photon energy 100 keV); b) gamma radiation ^{60}Co (photon energy 1.25 MeV); c) bremsstrahlung radiation (photon energy 25 MeV);

d) corpuscular radiation (proton energy 160 MeV)

When prescribing radiation therapy to a patient, the main principles of radiation therapy must be followed for its successful administration:

1. Selection of the optimal necessary dose of irradiation of the pathological process with minimal irradiation of normal tissues (organs) and with minimal disruption of the reactivity of the entire organism.
2. Conducting radiation therapy with the optimal dose and at the optimal time.
3. The course of radiation treatment should be as radical as possible.
4. Application of medical measures to increase the body's defense forces in order to obtain a minimal reaction from organs and systems.

It should be remembered that in addition to indications for radiation treatment, there are also contraindications, which are divided intoabsolute**and**relative

Absolute contraindications are those in which radiation treatment is not performed on the patient.

- Severe general condition of the patient caused by the main process, tumor disintegration, cachexia.
- Severe concomitant diseases of the cardiovascular and respiratory system, liver and kidneys in the stage of decompensation.
- Leukopenia (L - 3.2 x 10^9/l), thrombocytopenia (Tr - 150 x10^9/l), pronounced anemia (Hb - 70 g/l).
- Radiation sickness and radiation damage in the patient's history.

Prescribing radiation treatment to the patient should be followed**main-**

th rules of radiation therapy– the radiation dose should be optimal, the surrounding healthy tissues should be preserved as much as possible and the reactivity of the whole organism should be minimally disturbed. With radiation treatment, there is absolutely no ablastic dose, and the viability of irradiated malignant cells only decreases. The smaller the tumor, the:

- more surrounding healthy tissues;
- more chances for successful treatment;
- less cancerous intoxication of the body;
- its general reactivity is less impaired.

Therefore, early diagnosis is very important, when the tumor is still small, the surrounding tissues and organs have not changed, and there is no cancer intoxication the body with the products of tumor cell decay, the reactivity of the body is preserved, there are no metastases.

In approximately 68% of cases, malignant tumors are untimely diagnosed, it is difficult to treat such patients and obtain a positive effect, so treatment should be started as early as possible, when the tumor is local and the body's reactivity is not impaired.

Radiotherapy of malignant tumors can be used as an independent method of treatment and is used under radical, symptomatic or palliative programs, or as part of combined (combination with an operative method of treatment) or complex (combination with chemotherapy and hormone therapy) treatment. Self-irradiation can be used in the form of remote X-ray and gamma therapy, therapy with high-energy sources, as well as in the form of combined radiation therapy (combination of one of the types of remote and contact therapy) (Fig. 7.3).

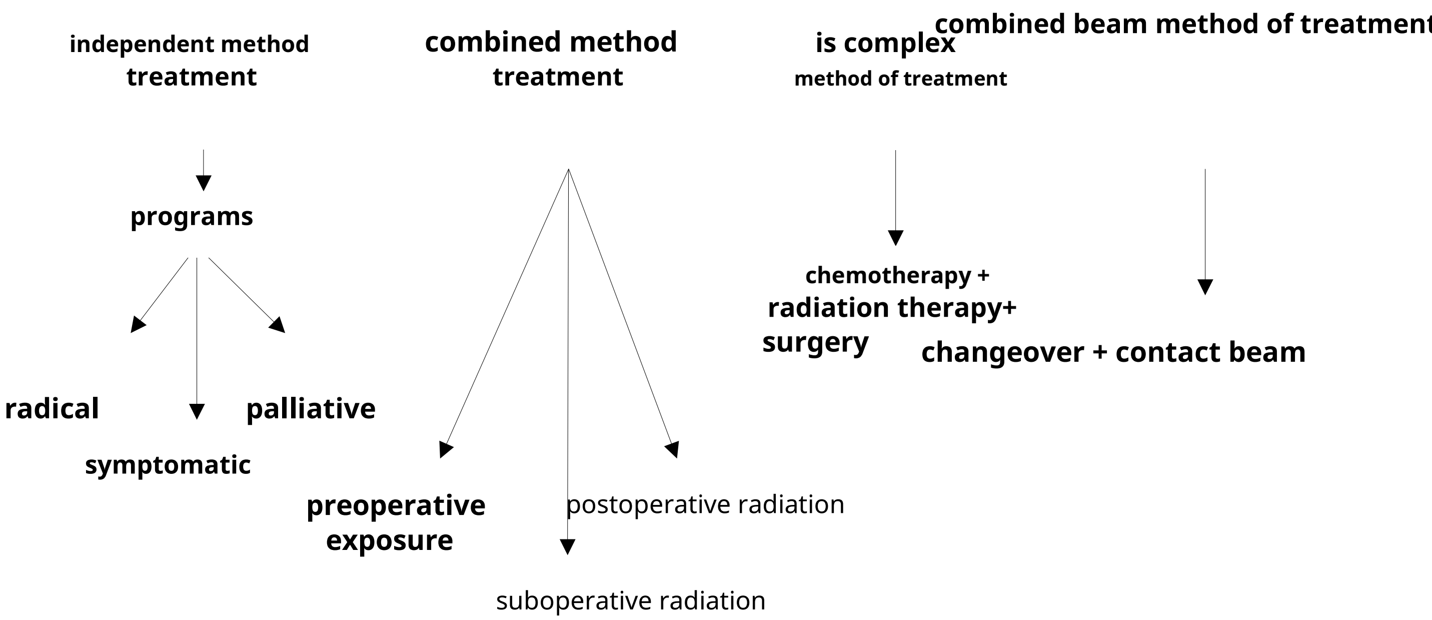


Fig. 7.3. Radiation therapy methods

When using **independent** Radical, palliative or symptomatic treatment programs can be used for the method of irradiation of malignant tumors.

Radical treatment involves the complete destruction of tumor elements in zone of the primary focus and zones of possible metastasis, it is aimed at the complete cure of the patient. It is used in more than 40% of patients (cancer of the skin, lips, cervix of the I-II stage, as well as in the case of an inoperable form of the tumor of the III stage).

Palliative treatment is used in neglected, inoperable cases and aimed at delaying the growth of the tumor and its spread, reducing the pain syndrome, syndromes of compression or tumor growth of adjacent organs, improving the quality and extension of the patient's life.

Symptomatic the course is aimed at removing difficult clinical symptoms caused by the generalization of the process (bleeding, compression mediastinal syndrome, prevention of pathological bone fractures in the presence of metastases).

Each of the treatment programs has its own tasks and indications for the appointment of each of them.

Tasks of radical, palliative and symptomatic treatment programs

I. A radical program of treatment provides for:

- complete destruction of tumor elements in the area of the primary focus and in areas of possible metastasis;
- aimed at the complete cure of the patient.

It is used in more than 40% of patients (cancer of the skin, lips, cervix of the I-II stage, as well as in the case of an inoperable form of the tumor of the III stage, as part of combined or complex methods of treatment).

II. Palliative program treatment is used:

- in advanced, inoperable cases;
- aimed at delaying tumor growth and its spread;
- to reduce pain syndrome, compression syndromes or tumor growth of adjacent organs;
- improving the quality and extension of the patient's life.

III. Symptomatic program is directed:

- to relieve severe clinical symptoms caused by generalization process (bleeding, compression mediastinal syndrome, prevention of pathological bone fractures in the presence of metastases).

Radiation therapy in operable stages of malignant tumors used in various combinations with a surgical method of treatment depending on the patient's condition. This method of treatment is called **combined**.

Combined methodtreatment is used in three variants:

- preoperative (radiation therapy is carried out before surgery);
– suboperative (radiation therapy is carried out during surgery);
- postoperative (radiation therapy is carried out after surgery);

Preoperative courseaimed at:

- prevention of tumor relapses and metastases;
- devitalization of the most radiosensitive tumor cells;
- reduction of perifocal inflammation;
– stimulation of connective tissue development and encapsulation of cancer cell complexes;
- bringing the tumor into an operable state by reducing its volume.

Surgery performed after a course of radiation makes the treatment prognosis more favorable.

Suboperative irradiationis carried out during surgical intervention with the aim of:

- irradiation of the bed of the removed tumor;
- prevention of implantation metastases.

Postoperative radiationis carried out in order to increase effectiveness of the operation with the help of radiation on residual or implanted tumor elements during surgery. It is carried out for the prevention of relapses and the treatment of regional and distant metastases. It is advisable to carry out postoperative irradiation within a period not exceeding 3-4 weeks after the operation.

Complex methodtreatment is the radiation method treatment in combination with chemotherapy, hormone therapy and surgery.

Combined beam method(combined**-**radiation) is a combination of two methods of radiation treatment - remote and one of the contact methods.

In radiation therapy, as a rule, local irradiation of the pathological focus is used. With any method of local radiation action on the focus, tumor destruction, anti-inflammatory, desensitizing or pain-relieving effects are obtained. The effect of irradiation depends on the radiosensitivity of tumors and the amount of the absorbed dose in the focus. At the same time, radiation can adversely affect the normal tissues surrounding the tumor. The degree of local or general changes arising in this case depends on the size of the dose, radiosensitivity of the organism, physical and technical conditions of irradiation. The larger the local dose and the larger volume the more tissues that are irradiated, the greater will be the integral dose, that is, the dose for the whole body, which can cause an undesirable general reaction, a decrease in the body's reactivity. All human organs and tissues have different sensitivity to ionizing radiation. Different tissues and cells of the body react differently to the action of ionizing radiation - this phenomenon is called**relative radiosensitivity**cells, tissues and organs.

Radiosensitivity of tumors also depends on its origin. All tumors are conditionally divided into**radiosensitive**and**radioresistant**.

Radiosensitivity of the tumor is determined by:

- localization, size, spread of the process;
- the shape and growth rate of the
- tumor; histological structure;
- the degree of cell differentiation; a
- feature of their mitotic cycle;
- degree of blood supply.

The presence of the so-called radiotherapeutic interval contributes to success in the treatment of malignant tumors.

Radiotherapy interval -is the radiosensitivity difference between the tumor and healthy tissues within the same histological structure.

The longer the radiotherapeutic interval, the easier it is to achieve the destruction of tumor elements while preserving the vitality of the surrounding tissues, that is, to fulfill the main task of radiation therapy.

Since the irradiation is carried out through the surface of the skin, it should be remembered that the tolerable dose for the skin for the entire course of gamma irradiation is 55-60 Gy, and for X-ray irradiation - 30-35 Gy with fractionation of 2-2.5 Gy,

5 times a week.

To extend the radiotherapeutic interval, changes in irradiation conditions are used (dose options, changes in the rhythm and time of irradiation), the degree of saturation of tissues with oxygen; chemical and physical factors are also used.

Factors selectively weakening the effect of irradiation on normal tissues include**radio protectors**– pharmacochemical and biological agents. Pharmacochemical protectors reduce metabolism, increase hypoxia, protect hematopoiesis. These include cysteine, cystamine, mercamine, drugs containing a sulfhydryl group. Means that are used to increase radiation damage to tumors are called **radiosensitizers**. These include chemicals that increase primary radiation damage by increasing the oxygen content in tumors (heparin), increase primary DNA damage; potentiate the radiation effect (5-fluorouracil, methotrexate). Radioprotectors and radiosensitizers were named**radio modifiers**(Table 7.1.).

Table 7.1. Radio modifiers

Radiosensitizers (increase the radiosensitivity of tumors to irradiation)	**Radio protectors** (reduce the radiosensitivity of normal tissues to irradiation)
1. Saturation tumors oxygen (inhalation O_2or use of an oxygen cocktail, hyperbaric oxygenation) 2. Use of pharmaceuticals (heparin, 5-fluorouracil, methotrexate) 3. Use of physical means (hyperthermia, magnetic therapy)	1. Artificial hypoxia (overlay harnesses, inhalation of mixtures, oxygen depleted) 2. Use of pharmaceuticals (cystamine, cysteine, mercamine, serotonin) 3. Use of physical means (hypothermia)

Therefore, the potentiation of the radiation antitumor effect by various drugs extends the radiotherapeutic interval, which leads to an increase in the effectiveness of radiation therapy of malignant tumors. The doctor can influence this interval by increasing the difference in radiosensitivity by increasing the sensitivity of the tumor or decreasing the sensitivity of the surrounding tissues. For example, the oxygen effect is widely used. Due to the oxygenation of the body before irradiation, the sensitivity of tumor cells to the action of radiation increases. By inhaling oxygen or giving an oxygen cocktail to the patient, or irradiating him under increased atmospheric pressure in a sarcophagus made of organic glass, where the pressure can be raised to three atmospheres and the oxygenation of tissues can be significantly increased. Protection of healthy tissues is carried out due to hypoxia. For this purpose, the patient during irradiation is allowed to inhale a mixture of nitrogen and oxygen, where the oxygen content is reduced from 20% to 12%. This procedure largely protects healthy tissues from damage. Vasoconstrictor drugs, such as serotonin, are also used. It narrows the vessels of healthy tissues and does not affect the vessels of a malignant tumor, which do not have a muscular sheath and therefore cannot be narrowed under the influence of vasoconstrictor drugs.

The radiotherapeutic interval can be extended by changing the rhythm of irradiation: the more extended the irradiation time, the longer this interval will be due to the fact that healthy tissues have the ability to regenerate at a faster rate than tumor cells.

The total focal absorbed dose for a course of radiation therapy is chosen based on clinical and radiobiological factors. The value of the total focal dose consists of the sum of single absorbed doses and determines the duration of exposure in days -**a course of radiation therapy**.

Rhythm of irradiationis the dose distribution over time. There are several ways dose distribution over time:

- one-time,

- fractional,

- continuous.

At**disposable**irradiated, the planned dose is delivered to the tumor at once. This method of irradiation is mainly used in the preoperative course of radiation therapy, and can also be used for suboperative irradiation.

At**factional**method, the tumor is irradiated for several days or weeks, that is, the total dose is divided into separate parts (fractions). They are distinguished: small fractions - 2-2.5 Gy, medium fractions - 3-4 Gy, large fractions 5-13 Gy.

Continuousirradiation (for several hours or days) is carried out with intratissue and intracavitary radiation therapy and therapy with incorporated radioactive pharmacological drugs (RFP) for the treatment of thyroid cancer - radioactive iodine, multiple bone metastases - radioactive phosphorus, etc.

The most common method of irradiation is the fractional method. Irradiation of malignant tumors requires large doses, which in turn can cause damage to healthy tissues. Therefore, in order to deliver the optimal dose to the pathological focus with the least damage to the surrounding healthy tissues, irradiation is carried out by various methods -**static and dynamic**(dose distribution in space - Fig.7.4).

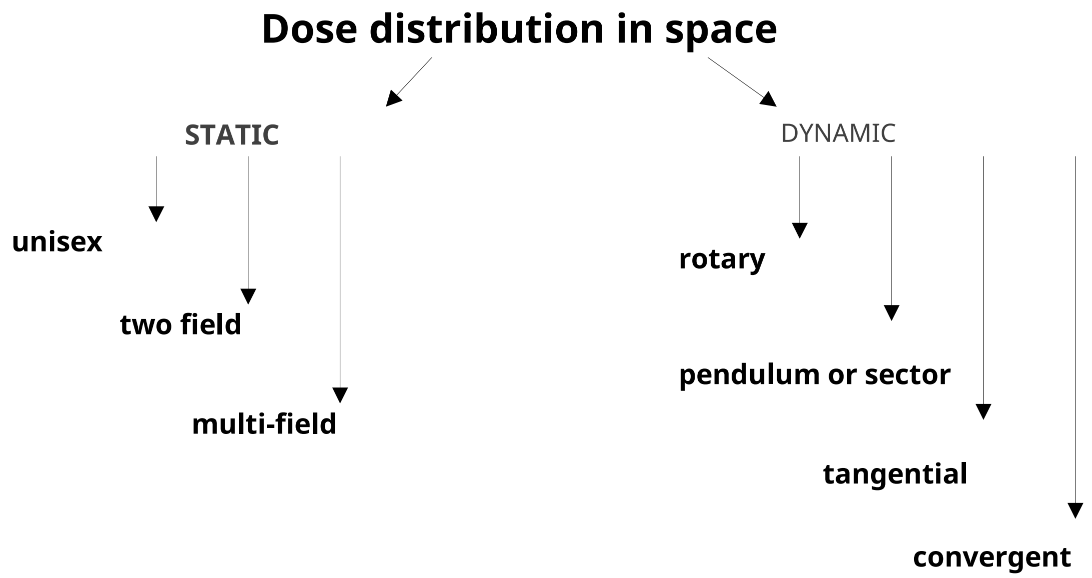


Fig. 7.4. Dose distribution in space

A necessary condition for radiation treatment of cancer patients is an individual approach. For each patient, a treatment plan is drawn up taking into account the size (magnitude) of the pathological focus, localization, spread, morphological structure and assessment of the patient's general condition. Three specialists participate in drawing up a treatment plan: an oncologist, a radiation therapist, and a chemotherapist.

The structure of the radiation therapy course consists of three periods: **preradial, radial and postradial** , in each of which conducted:

PRE-RADIATION PERIOD:

- detailed examination of the patient, establishment of indications and contraindications to radiation treatment
- choosing the type of radiation treatment and additional non-radiation methods treatment
- determination of the topographical and anatomical relationships of the tumor with surrounding healthy organs and tissues
- selection of the optimal radiation dose
- selection of the optimal irradiation mode
- definition of irradiation technology
- preparation of the skin for irradiation
- psychological preparation of the patient

RADIAL PERIOD:

- carrying out irradiation according to the established plan
- use of additional symptomatic treatment methods
- patient care, if necessary - correction of the treatment plan

POST-RADIATION PERIOD:

- observation of patients' condition;
- assessment of treatment results

IN **pre-radiation period** a detailed examination of the patient is carried out: general clinical, laboratory and instrumental studies (ultrasound, x-ray, CT, MRI, etc.).Each patient must,a histological examination of the tumor (puncture biopsy) is mandatory.

According to clinical and morphological data, a clinical and morphological diagnosis is established. A radiation treatment plan is drawn up depending on the localization of the pathological focus, its radiosensitivity. This treatment plan includes: the presence of indications and contraindications for radiation treatment, the choice of the type of radiation treatment, the optimal dose of radiation, the mode and technology of radiation are determined.

Before starting the radiation treatment (at the first stage), topometric preparation of the patient is carried out: the location of the tumor, its boundaries in relation to neighboring tissues and organs are determined, and the outline of the projection of the tumor on the patient's skin is drawn. Determining the topography of the tumor allows you to correctly choose the type of irradiation, its energy, and the method of irradiation (Fig. 7.5, 7.6).

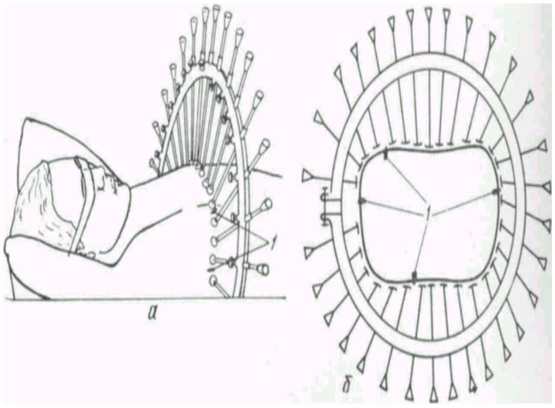
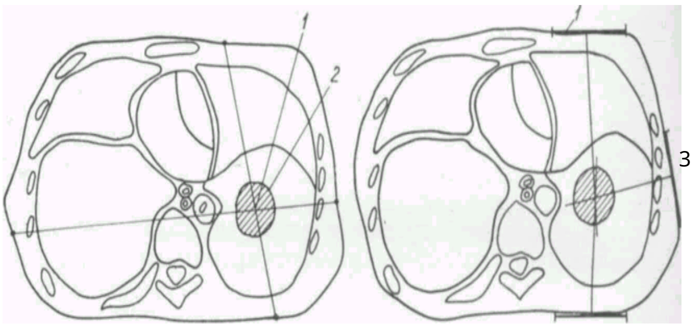


Fig. 7.5. The scheme of making an individual cross-section of the body:

a — removal of the body contour at the level of projection marks (1);

b — transfer of the obtained external contour to paper with determination of the tumor projection of the tumor



3

and

2

b

Fig. 7.6. Definition of radiation fields:

a — sketch of the cross-section of the patient’s chest cavity (1 – the center of the tumor, 2 – tumor contours b — determination of the radiation fields on the sketch of the cross-section of the patient’s chest cavity (1 –

The radiologist must psychologically prepare the patient for radiation therapy. It is also necessary to prepare the skin for external irradiation, so that it does not have damage, there are no skin diseases, otherwise a radiation reaction will quickly occur during irradiation. You should also not allow the action of other chemical and physical factors on the areas to be irradiated.

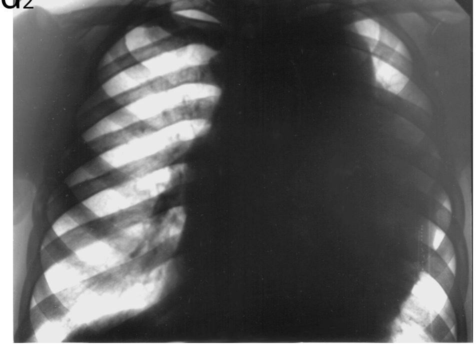
IN **radiation period** the patient is treated according to the schedule plan, in the same period the correction of the treatment plan can be carried out. Against the background of radiation treatment, follow-up therapy is carried out, determined by the general condition of the patient.

Support therapy includes detoxification measures, the use of drugs that increase the body's defenses, vitamin therapy, the use of antioxidants, as well as the prevention of local and general radiation reactions.

IN **post-radiation period** is conducted performance evaluation direct results of treatment, correction of further treatment. During the first 5 years, the dispensary examination of the patient is carried out by an oncologist, a radiologist and a chemotherapist twice a year, and in the next 5 years — once a year. After ten years of observation (if no recurrence of the disease is registered), a person is considered healthy and is excluded from the oncology registry.

and1

and2



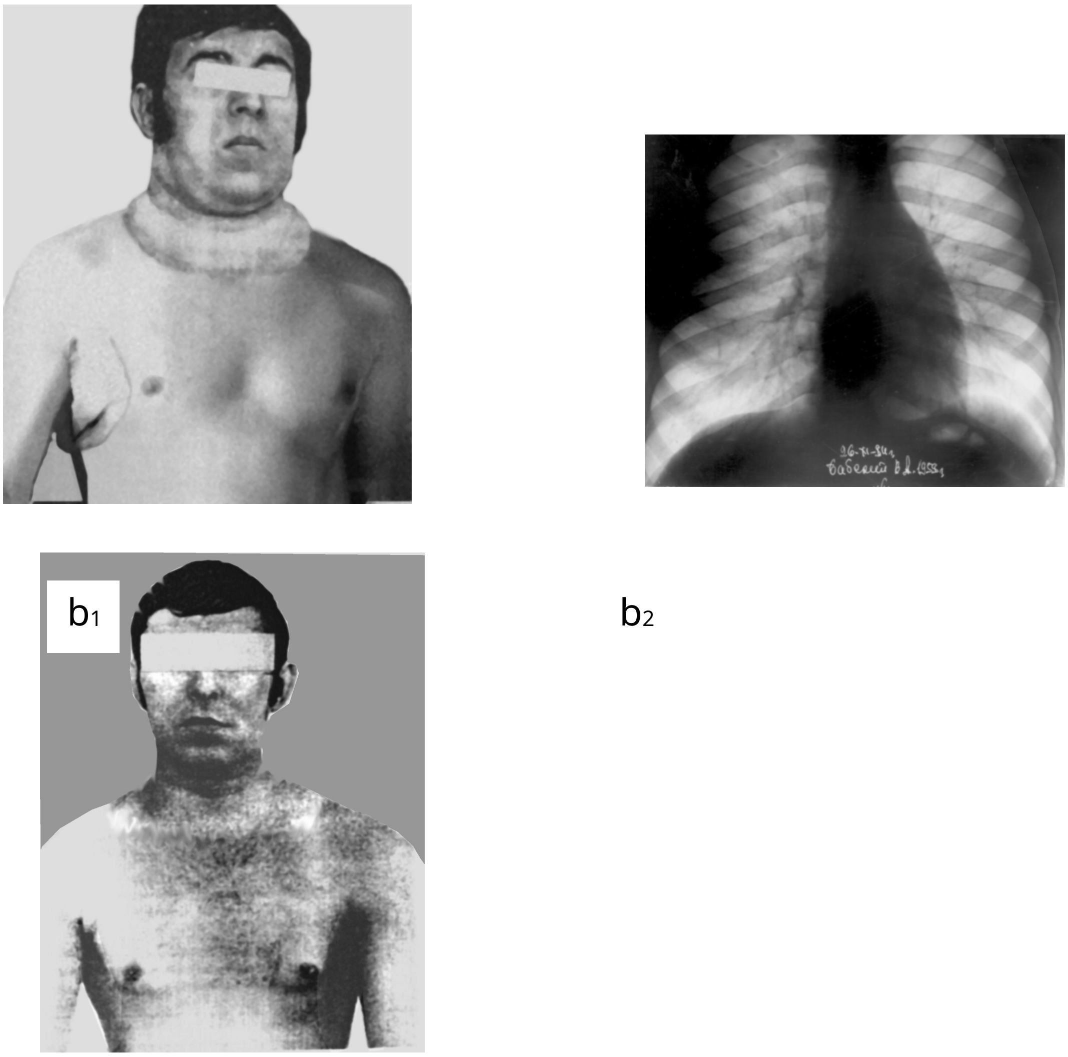


Fig. 7.6. General appearance of a patient with Hodgkin's disease and X-ray organs of the chest cavity

(and1,and2- before treatment; b1,b2– after comprehensive treatment)

1. Classification of radiation therapy methods.
2. Determination of external and internal methods of irradiation.
3. Characteristics of sources of ionizing radiation used for radiation which therapy.
4. Methods of external irradiation: long- and short-range X-ray therapy. Devices for X-ray therapy.
5. X-ray therapy devices and physical and technical conditions of their operation.
6. Long-distance gamma therapy. Devices for long-distance gamma therapy. Characteristics of gamma radiation sources.
7. Static and dynamic methods of irradiation. Indications for their use. Characteristics of each of these methods.
8. Devices, sources, forms of sources used for contact methods of treatment.
9. Contact (application, intratissue, intracavity) methods of radiation therapy. Characteristics of each of these methods, indications for their use.
10. Determination of the gamma constant of a radioactive drug.

Ionizing radiation is used for the treatment of malignant neoplasms, as well as for the treatment of non-cancerous diseases.

Radiotherapy can be effective only when the tumor is irradiated in the required dose and at the optimal time. The treatment will have a positive effect when the basic principles of radiation therapy are fulfilled:

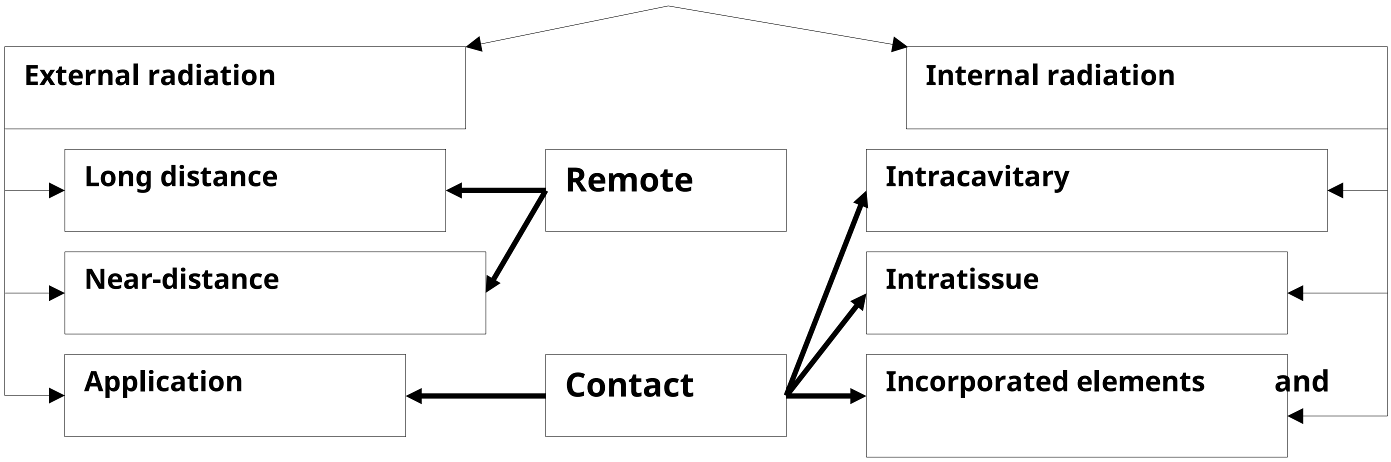
- delivery of the optimal dose to the tumor with minimal damage to the surrounding healthy tissues and preservation of the reactivity of the entire organism (that is, so that the integral dose is as small as possible);
- the timeliness of using radiation therapy in the early stages of the disease;
- simultaneous irradiation of the pathological center and the ways of regional metastasis;
- at the same time as radiation therapy, follow-up therapy is used to increase the body's reactivity.

To fulfill the basic principle of radiation therapy, depending on from the location of the pathological focus, different radiation sources are used and different means of delivering the dose to the tumor focus are used.

Depending on the location of the radiation source in relation to

the patient's body is allocated:**external**and**internal**exposure **(**Table 8.1.) If the radiation source is located outside the body, it is **external exposure**, if the source of radiation is located directly in the body, then this method of radiation is called **internal method**.

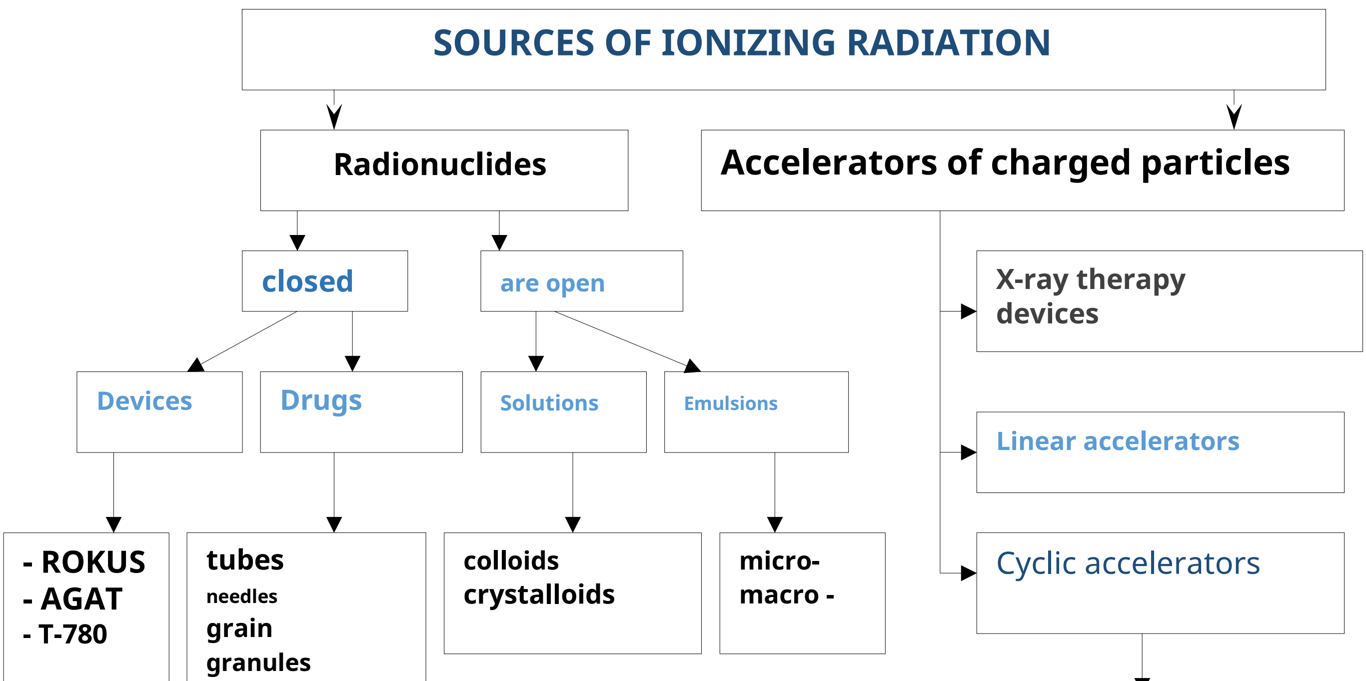
Table 8.1. Radiation therapy methods



Sources of ionizing radiation used for these methods can be both in the form of radioactive pharmacological preparations (open radiation sources) and in the form of closed radiation sources:

radionuclides (i.e. radioactive sources); charged particle accelerators (Table 8.2).

Table 8.2.



betatrons,
cyclotrons, synchrophasate wounds

Gamma emitters:60Co, 137Cs, 192Ir, 182Ta, 282Cf, 125I**Beta production frosters:**131I, 32P, 198Au , 89Sr , 90Y

Open radionuclides(radiation sources) is, in the main most, liquid radioactive preparations with mixed radiation, which are in such a shell, or in such a physical state, in which their distribution into the environment is possible. These can be solutions, which in turn are divided into crystalloids and colloids. Radioactive substances are also used in the form of other open sources - suspensions (micro- and macrosuspensions).

Closed radionuclideshave a protective cover - a filter, or are located in such a physical state that it is impossible to spread them into the environment. They are also used in devices for long-distance radiation therapy, which are divided into:

- static (the source does not move during the irradiation process);

- dynamic (the source can move during the irradiation process).

Sources of radiation can be: ^{60}CO, ^{137}Cs, ^{182}That ^{192}Ir and others. Closed drugs can have the form of metal tubes, cylinders, balls, needles.

Sources ionizing radiation appear also **charged particle accelerators**, which are divided into:

1. X-ray therapy devices: long-distance (static, dynamic strong), close-range;

2. Linear accelerators, where electrons are accelerated, which are directly used for irradiation, or electrons that are decelerated and converted into high-energy bremsstrahlung X-rays;

3. Cyclic accelerators (cyclotrons, cyclophazotrons), in which heavy ions (hydrogen, deuterium, carbon, argon nuclei) are accelerated.

External irradiation is carried out at different distances from the source of ionizing radiation to the surface of the patient's body (distance-source-skin VDSh).

External methods of irradiation include:

1. Long-distance radiation therapy (VDSH from 30 cm to 1.5-2 m).
2. Short-distance radiation therapy (VDSH from 1.5 cm to 30 cm).
3. Application method of radiation therapy (VDSH from 0 to 1.5 cm).

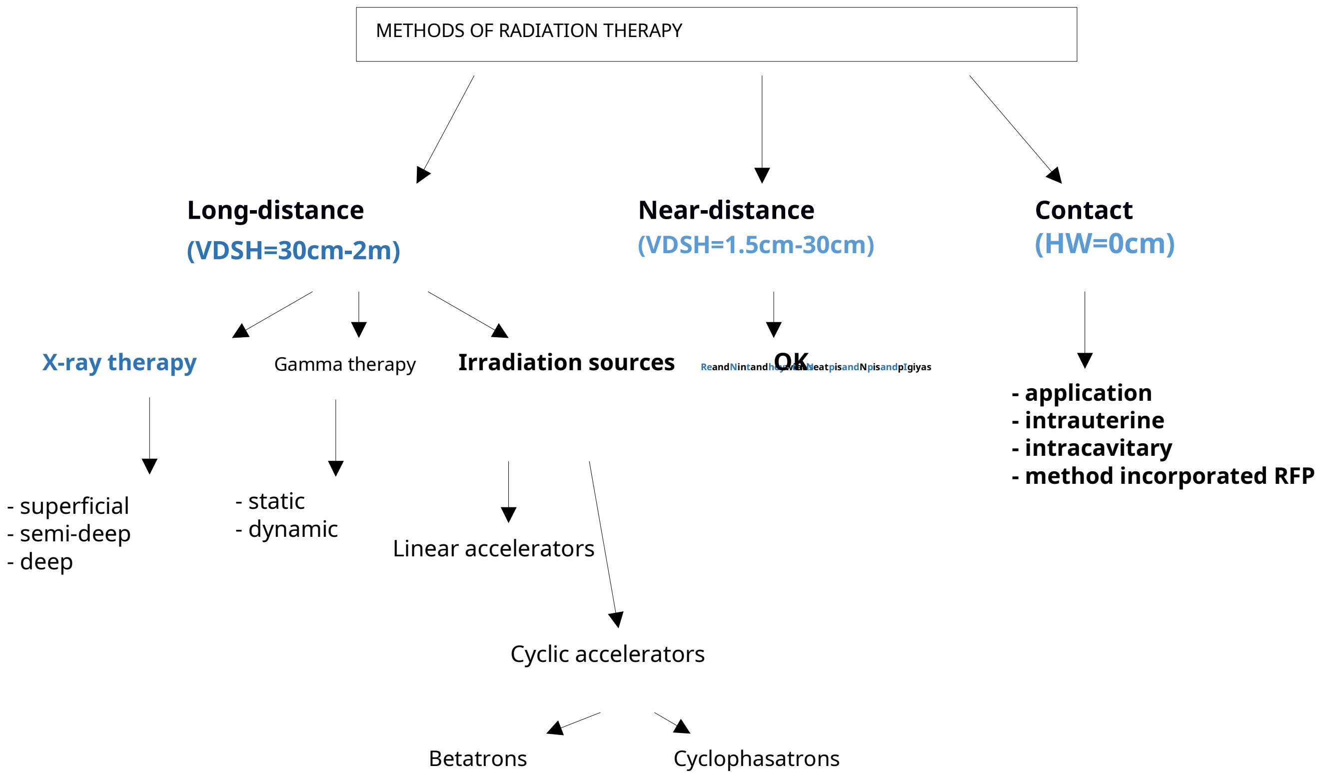
Internal irradiation methods include:

1. Intracavity radiation therapy.
2. Intravenous radiation therapy.
3. Therapy with incorporated radioactive drugs.

All methods of internal irradiation and the application method refer to **contacts**radiation therapy methods.

At**application method**irradiation, the radiation source is located directly on the surface to be irradiated; direct introduction of the radiation source into the tumor is interpreted as **intratissue method**exposure Location of the source
radiation in the natural cavities of the patient's body is called **intracavitary method**radiation therapy (tab.8.3.).

Table 8.3.



CHARACTERISTICS OF RADIATION THERAPY METHODS

All installations for remote radiation therapy are stationary and must be located in special rooms for operation. According to sanitary and hygienic standards, depending on the source of radiation, the office must have: a room containing the radiation apparatus (procedural room), the device control panel (control room). All rooms should be equipped with forced ventilation, and the walls should be made of barite concrete. An observation window made of leaded glass is used in x-ray therapy rooms for visual monitoring of patients, and television sets are used in gamma therapy rooms.

RADIOTHERAPY

One of the methods of radiation therapy is**radiotherapy**. The source of radiation in X-ray therapy devices is an X-ray tube (Fig. 8.1).

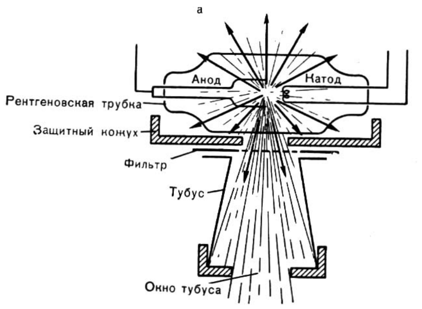


Fig. 8.1 Scheme of the structure of the X-ray emitter X-ray therapy device

The X-ray tube is a hermetic vacuum bulb with soldered electrodes (cathode thread and anode plate), which generates X-ray radiation and can operate at voltages from 15 to 60 kV (for short-range X-ray therapy) and from 100 to 250 kV (for long-range X-ray therapy).

A beam of X-ray radiation contains photons with different energies, which causes their different penetrating ability. Filters are used to create a uniform beam of radiation (reduce the number of low-energy photons) and make the beam more uniform (Fig. 8.2).

Fig. 8.2 Set of filters for X-ray therapy apparatus

Filters– aluminum or copper plates of different thicknesses. For cutting most of the low-energy photons are used by the plates greater thickness and density. In x-ray therapy units, a standard set of aluminum and copper filters is used.

In X-ray therapy devices, the X-ray tube is placed in a protective casing with an outlet opening, on which replaceable tubes of different sizes are placed (Fig. 8.3).

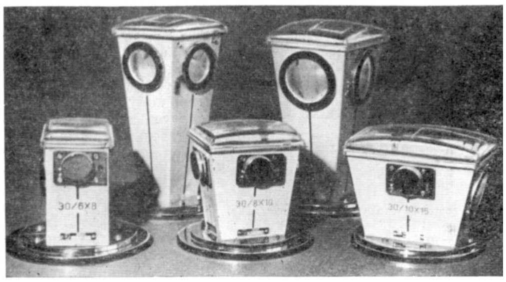


Fig. 8.3 A set of tubes for long-distance X-ray therapy device

Tubusserves to form the irradiation field, allows to fix the required distance from the radiation source to the surface of the body and direct the radiation beam to the focus.

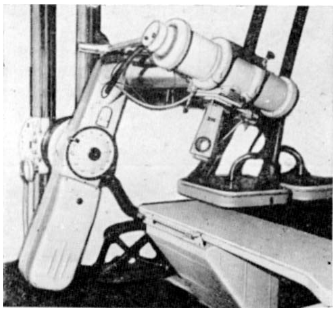


Fig. 8.4 X-ray therapy device RUM-17

For**long distance**x-ray therapy in medical institutions uses x-ray medical equipment: RUM-17 (Fig. 8.4.).

By changing the voltage on the X-ray tube, it is possible to generate radiation of different penetrating power. Depending on the location of the pathological focus, long-distance X-ray therapy is divided into:

- superficial
- semi-deep
- deep

Superficial- is used when locating the pathological foci at a depth of up to 1 cm from the skin surface. Voltage = 100-120 kV, aluminum filter - 3 mm thick.

Semi-deep- is used when locating the pathological foci at a depth of up to 3 cm from the surface of the skin. Voltage = 140-160 kV, filter 0.5 mm copper + 3 mm aluminum.

deep- used when locating a pathological focus on depth up to 5 cm from the surface of the skin. Voltage = 180-230 kV, filter 1 mm copper +

5 mm aluminum.

The dimensions of the tube are chosen depending on the size of the pathological focus with the inclusion of at least 1 cm of healthy tissue in the radiation zone. Tubes have a square, rectangular shape, sizes from 4x4cm to 12x16cm. When performing superficial X-ray therapy, the distance from the radiation source to the skin (VSH) is 30 cm, and with semi-deep and deep X-ray therapy, it is 40-50 cm.

To conduct**short distance**X-ray therapy method RUM-7, RUM-21 devices are used. RUM-7 has (in contrast to the long-distance apparatus) an X-ray tube with a side hole closed by a beryllium disk 1 mm thick. The device works with replaceable aluminum filters with a thickness of 0.1; 0.5; 1; 2.5 mm. Tubes have round, oval, rectangular and square shapes and allow irradiating an area of up to 25 cm^2(Fig. 8.5).

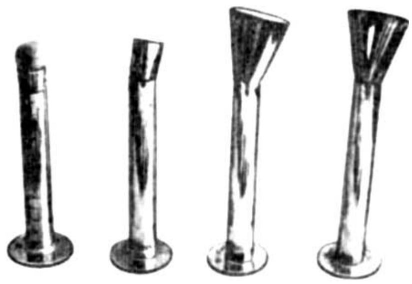


Fig. 8.5 A set of tubes for short-range external irradiation

VPSH in close-range x-ray therapy is from 1.5 to 30 cm when the pathological focus is located at a depth of up to 0.5-0.7 cm from the skin surface. But more often the tubes of the device provide a distance within 10 cm. At least 0.5 cm of surrounding healthy tissue is included in the irradiation zone.

A type of short-distance X-ray therapy is**ultra soft radiotherapy**(Bucky rays), which are generated at a voltage from10 to 20 kV. The penetration ability of Bukki rays in tissues - skin, mucous membranes does not exceed 1.5 mm. These rays are used in the treatment of superficial inflammatory processes, dermatitis, hyperkeratosis, blepharitis, conjunctivitis.

DISTANCE GAMMA THERAPY

At the current stage, gamma therapy devices with a radiation source are used to treat malignant tumors located deep in the body ^{60}Co (average energy of gamma quanta 1.25 MeV, period half-life T1/2=5.3 years) AGAT-S (for static irradiation), (Fig. 8) ROKUS-M (rotational-convergent installation), (Fig. 7) AGAT-R (for rotational irradiation) and linear accelerators electrons (LPE), or betatrons with energy from 6 to 23 MeV.

Gamma therapy devicesconsist of:

- a radiation head (made of lead, an alloy of heavy metals tungsten, uranium), which contains a source of gamma radiation; the radiation source consists of a set of radioactive tablets ${}_{60}$CO, placed in an ampoule made of stainless steel, which absorbs beta radiation; the output hole is placed in the radiation head, through which the radiation beam exits in only one direction, which in turn is closed by a shutter made of tungsten; the formation of the irradiation field is carried out using a diaphragm; (Fig. 8.6).

- tripod on which the radiation head is held;
- a treatment table that can be easily moved in all possible planes; (Fig. 8.7., 8.8.)
- control panel for providing remote control;
- intercom;
- surveillance systems (video camera).

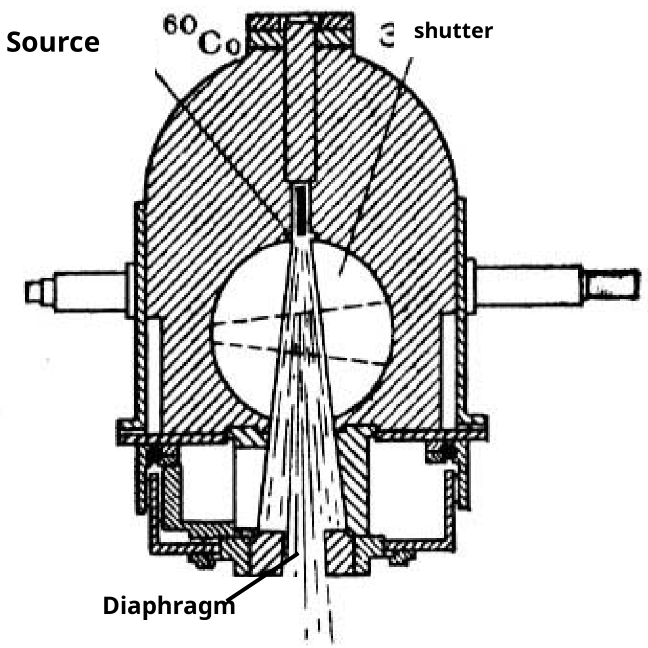


Fig. 8.6. The structure of the gamma therapy facility

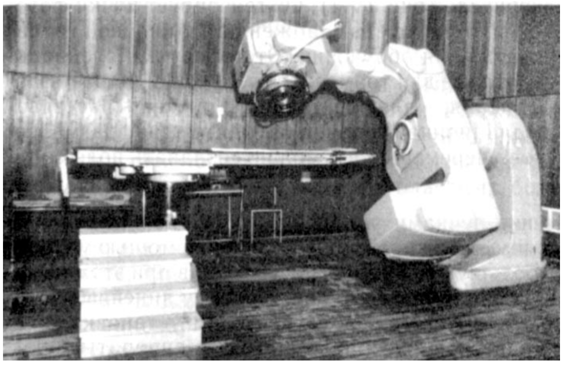


Fig. 8.7. Gamma therapy installation"ROCUS-M"

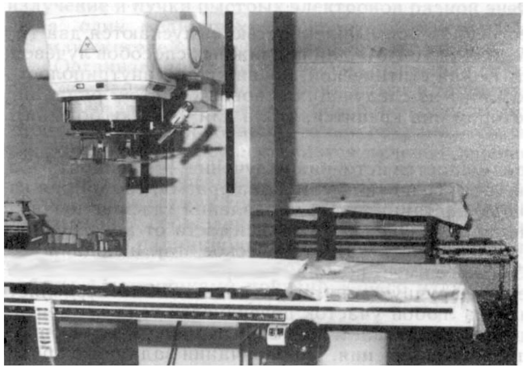


Fig. 8.8. Gamma therapy installation

It is well known that high doses are required to irradiate malignant tumors, which in turn can cause damage to healthy tissues. Therefore, in order to deliver the optimal dose to the pathological focus with the least damage to the surrounding healthy tissues, irradiation is carried out by various methods - static and dynamic (methods of dose distribution in space).

Staticis called exposure in which the source of radiation during the entire treatment session is motionless in relation to the patient's body. The distance from the radiation source to the surface of the patient's body is 75 cm. To increase the radiation field of the VDSH, it can be increased to 1-2 meters. Static irradiation can be carried out in the form of single-field, three-field or with a larger number of irradiation fields (Fig. 8.9).

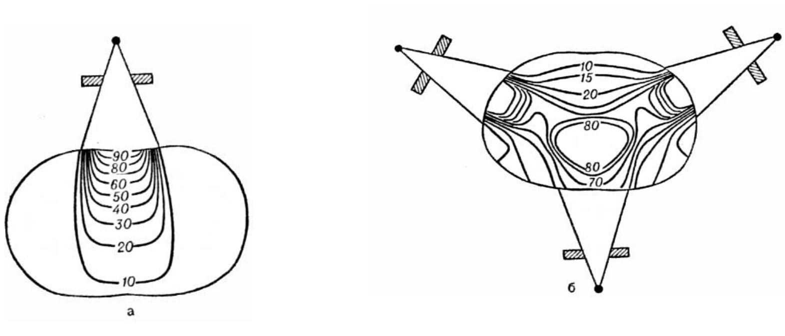


Fig. 8.9 Static single-field (a) and multi-field (b) irradiation

In case of static irradiation of a large area, it is used to reduce the dose to the skin**lattice**filters Irradiation is used to create a shaped field**lead blocks**different forms In areas with anatomical unevenness, tumors are used to create uniform irradiation**wedge-shaped**filters

Dynamicis called exposure in which the source of exposure moves around the human body. The following types of dynamic exposure are distinguished:

- rotary;
- pendulum or sector;
- tangential;
- convergent.

Rotaryis called exposure in which the source of radiation rotates around the patient's body in a 360 degree arc$_0$. This method is used in the treatment of cancer of the middle third of the esophagus, mediastinum, neck and body of the uterus, that is, when the focus is located along the central axis of the human body.

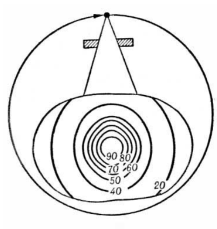


Fig. 8.10. Motion-rotational irradiation (360_0)

At**pendulum (sector)**method, the movement of the radiation source is carried out in a given sector (in an arc less than 360 $_0$). This method is used to treat tumors located eccentrically relative to the axis of the human body (cancer of the lower third of the esophagus, rectum, mediastinum, bladder) (Fig. 8.11).

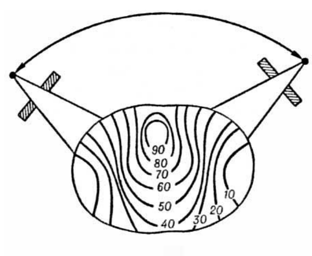


Fig. 8.11. Moving-sector (pendulum) irradiation

Tangentialexposure is characterized by the fact that the bundle radiation is directed tangentially to the surface of the patient's body and it is used for the treatment of breast cancer, tumors of the upper jaw, metastases in the pleura (Fig. 8.12).

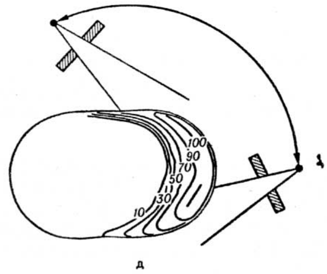


Fig. 8.12. Tangential irradiation (on the tangent)

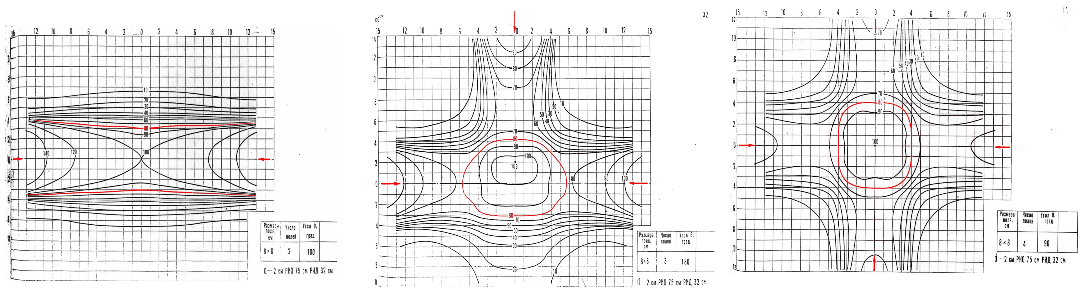
Convergentirradiation is characterized by the fact that the central beam radiation is directed to the longitudinal axis of the patient's body at an angle of $30_0$to 60_0, which changes. It is used to treat tumors that occupy a large area and are located at a depth of 3 to 6 cm from the surface of the skin (cancer metastases in soft tissues).

Characterizing the near and long-distance methods of radiation therapy, we see that with the help of these methods, it is possible to irradiate pathological foci located at different depths. For example, with long-distance X-ray therapy, foci located at a depth of up to 4-5 cm are irradiated, and with gamma therapy - at a depth of up to 10 cm. If the foci are located deeper, beams with higher energy should be used, which are obtained with the help of linear or cyclic accelerators .

When exposed to soft rays (especially with short-range X-ray therapy), a sharp drop in dose is observed. With deep x-ray therapy, the dose decline will be slower and already at a depth of 4 cm, 60% of the dose remains on the surface.

With gamma therapy, 50% of the dose is at a depth of 10 cm, and when using corpuscular irradiation (heavy ions), the dose on the surface will be less than at depth (Fig. 8.13).

During irradiation, much attention is paid to the dose on the skin, which is more sensitive to radiation than subcutaneous fat.



and b in

Fig. 8.13. Dose distribution with static multifield irradiated at a gamma therapy facility:

a) double-field irradiation; b) three-field irradiation; c) four-field irradiation.

By adjusting the energy of positive ions, you can get the necessary dose increase at the depth of the pathological focus. In addition, the dose will increase significantly at depth and may even be 2-3 times higher than on the surface, reaching a maximum in the center of the pathological focus. This increase in dose is called the Bragg peak.

CONTACT METHODS

The group of contact irradiation methods includes methods in which the source of radiation in the form of a radioactive drug is placed directly on the surface of a pathological focus, injected into a cavity or directly into a tumor.

Depending on the location of the irradiated focus, there are three main methods of contact radiation therapy:**application, intracavitary and intratissue.**For all these methods treatment is characterized by the fact that:

- the maximum dose is in the tissues adjacent to the drug, and as the distance from the source decreases sharply;
- special safety measures are necessary to protect the environment from radioactive contamination in connection with the placement of open radioactive drugs on the surface or inside the patient's body;
- for contact methods, radioactive drugs with a low dose rate are used, which allows continuous irradiation for several hours or days.

For contact methods of radiation therapy, gamma rays are used

beta radiation sources. Gamma radiation sources include: $_{60}$So,$_{137}$Cs,$_{182}$That$_{192}$Ir; beta sources include –$_{32}$P,$_{90}$Sr.$_{90}$Y,$_{204}$T$_{198}$Au, to sources of mixed type -$_{131}$J.

According to the form of the radiation source, there are:

- linear (cylinders, needles);
- volumetric (balls, grains, granules);
- suture material (catgut, staples);
- solutions (crystalloids, colloids).

Applicationthe method of irradiation is a medical procedure in which radioactive drugs are placed on the surface of the skin or mucous membranes with the help of applicators. For the treatment of malignant neoplasms, in the case when the thickness of the tumor does not exceed 1-3 mm, and the diameter is 1.5-2 cm, the beta application method is used. Preparations that emit beta particles are placed in plastic or applied to a film, which is modeled exactly according to the shape of the pathological focus. The applicator is fixed to the body. This method is more often used in the treatment of malignant neoplasms of the cornea, conjunctiva, and skin cancer of the eyelids.

Gamma therapy is used to treat malignant neoplasms of the skin and mucous membranes that have spread to a depth of up to 2 cm. Preparations for gamma therapy are placed on a dummy made of plastic (Fig. 8.14). For uniform distribution of the dose, the size of the dummy should exceed the size of the tumor by 1 cm, and the radioactive drugs are placed in one plane in the form of a triangle, square, or polygon. The manufactured dummy together with radioactive drugs is fixed on the irradiated surface with the help of bandages or special fixatives. With the application method, irradiation can be continuous or intermittent (4-10 hours daily until the therapeutic dose is reached). The radiation session is carried out in a special ward equipped with protective screens, since the patient is the source of radiation.

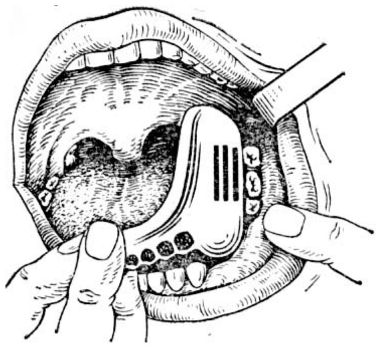


Fig. 8.14. Dummy (applicator) with radioactive drugs for cancer treatment mucous membrane of the cheek

All the following contact methods refer to the internal method of radiation therapy.

Intracavitary method– is used for the purpose of summary radiation sources as close as possible to the tumor localized in the wall of any body cavity or hollow organ. Direct contact of the radioactive drug with the pathological focus allows to obtain a high absorbed dose in the walls of the natural cavity with relatively small doses outside it. Both gamma and beta emitters are used for this method. Indications for using intracavitary gamma therapy are: cancer of the vulva, vagina, cervix and body of the uterus, rectum, bladder, esophagus, oral cavity. In these cases, apply special fixators (endostats) for fixing radioactive drugs in the required position. (Fig. 8.15)

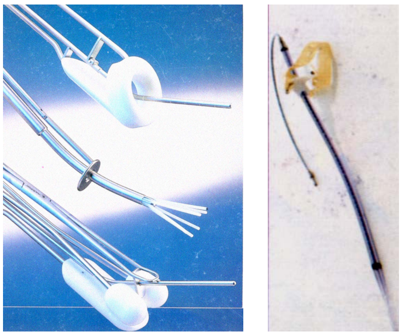


Fig. 8.15. Retainers (endostats) for radioactive placement sources in the irradiated cavity

Correct placement of the endostat in the organ cavity is checked using radiography. After that, in a special procedure room where the radiation session is performed, the endostat is connected to the hoses of the device and radioactive drugs are injected into the endostat using automatic means. The sequential introduction of the endostat into the cavity and radiation sources (two-stage introduction) was named**remote afterloading**. The automatic system of supplying radioactive substances to the endostat, introduced into the hollow organ, is the basis of the operation of hose devices of the type AGAT-B, AGAT-VU (charge$_{60}$So), Selectron (charge$_{137}$Cs) (Fig. 8.16)

Fig. 8.16. Procedural with remote input of radiation sources cavity

They have such devices storage for radioactive drugs, set endostats for tumors of various localizations, a mechanical or pneumatic system for transporting drugs from the storage via a hose to the fixator (endostat).

X-rays (RUM-22) are also used to treat patients with this method, on devices that have a Shaul tube with an extended anode and a tube diameter of 18 mm, which allows irradiating the tonsils, cervix, rectum (inferior ampullary section).

A variant of the intracavitary method is beta therapy, which is carried out by direct injection of a liquid radioactive drug into closed body cavities (abdominal, pleural, subarachnoid space of the brain and spinal cord) in case of multiple metastases in the walls of these cavities. For this purpose, colloidal solutions of radionuclides are used $_{90}$Y, $_{198}$Au, 90% of the volume of which settles on the serous membranes (the energy of beta radiation is absorbed, mainly, at a depth of 1-3 mm), and only 10% is carried along the lymphatic and blood vessels and is captured by the elements of the reticulo-endothelial system.

All manipulations with exposed radioactive drugs are carried out behind protective screens with a special protective tool, and the patient, after administering the drugs, becomes a source of radiation and is isolated in a special ward for a period of 4-5 radioactive half-life periods substances

Intratissue metod - method of radiation therapy in which radioactive drugs are injected directly into the tissue of a malignant tumor.

A distinction is made between intratissue gamma and beta therapy. For gamma therapy, closed radioactive drugs are used in the form of needles, granules, grains, suture material, where the source of radiation is $_{60}$So, $_{137}$Cs, $_{182}$That $_{192}$Ir. (Fig. 8.17)

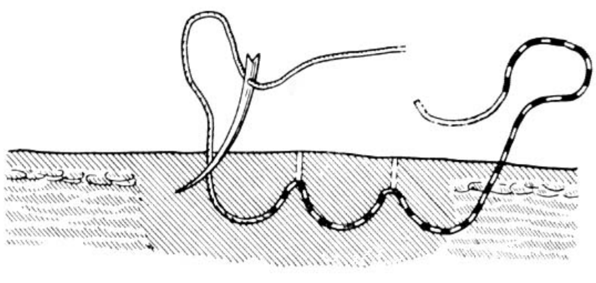


Fig. 8.17. Stitching of the tumor with nylon threads containing granules with $_{60}$Co

It is used for stitching tumors nylon tubes, in in the cavity of which there is a radioactive drug; for suturing the stump of the lungs after extirpation, conductors are used, which are used to make staples; to irradiate the tumor, radioactive needles are also injected into it. The needles are placed in parallel rows at a distance of 1-1.2 cm from each other in the form of a rectangle or other shapes to create a uniform dose field. With this method, only continuous irradiation is carried out up to the required total dose.

For intratissue beta therapy, open forms of radioactive drugs are mainly used. These are colloidal solutions and suspensions of radionuclides $_{198}$Au, silicone$_{90}$Y.

Injection of colloid solutions into the tumor (intratumoral radiation therapy) is carried out through thin injection needles, which are previously injected into the tumor in parallel rows at a distance of 5-10 mm from each other. The amount of radioactive solution for uniform irradiation should be 1/3 of the volume of the tumor.

Patients treated with the intratissue method are in special "active" wards with protective devices until the radiation sources are removed, and in the case of beta therapy - during the 4-5 half-life periods of the radioactive drug.

One of the varieties of intratissue therapy is the method of selective accumulation of the drug in malignant tumors -**therapy incorporated radioactive drugs.**This method is based on the ability of some tissues to tropically (selectively) accumulate radioactive elements. Radioactive substances are most often used in this method $_{131}$J,$_{32}$P,$_{89}$Sr, which are administered orally, intravenously.

Radioactive iodine is used in the treatment of thyroid cancer, thyrotoxicosis, and metastases of thyroid cancer in the lungs.

Radioactive phosphorus is used to treat multiple bone metastases.

In intratissue and intracavitary radiation therapy, the dose for treatment with incorporated drugs is determined by calculation, based on the amount of radioactive drug, the type of radiation, and the residence time of the radioactive drug in relation to the mass of the pathological focus. This value is used to calculate the dose from such radioactive drugs as tubes and sticks**as gamma- constant of the radioactive drug. Gamma is constant**it is a dose of 1 mCi of radium at a distance of 1 cm. It represents the radiation dose from a certain amount of the drug in a certain time. Gamma is constant$_{226}$Ra=8.4 R/h.

If one source is used, the calculations are carried out using a mathematical method, when two or more sources are used, complex mathematical calculations are carried out using computer technology.

For ^{60}Co gamma - constant - 13.5 R/h. Gamma rays ^{60}So have more energy, so they form a larger dose. The following concept is also used to calculate the radiation dose in contact methods:**as a gamma equivalent glad**, that is, the ratio of the dose of the gamma emitter to radium, which is the equivalent of radioactivity. If 13.5 (gamma is constant ^{60}Co) divide by 8.4 (gamma constant ^{226}Ra) is the gamma equivalent ^{60}So will be equal to 1.68. This is the tabular value. When administering a radioactive drug, the dose depends on the activity (in Bq, mKi), radiation energy (the higher the energy, the higher the dose), on time, on the geometric factor (which part is absorbed: beta rays will all be absorbed, and gamma rays only 10%), from the mass in which the rays are distributed.

Materials on the activation of higher education seekers during

conducting a lecture: questions, situational problems, etc(if necessary)**:**

1. The place of radiation therapy in the system of treatment of various diseases. Definition and tasks of radiation therapy.
2. Indications and contraindications for prescribing radiation therapy.
3. Dosimetric characteristics of X-ray, gamma radiation and radiation from high-energy sources. Isodose lines. Determination of surface and deep doses.
4. Selection of the optimal radiation dose for non-cancerous diseases.
5. Selection of the optimal radiation dose for malignant neoplasms.
6. Mechanism of anti-inflammatory effect of ionizing radiation.
7. Mechanism of radiation damage to tumor cells.
8. The basic principle of radiation therapy.
9. Radiotherapy programs and their tasks.
10. Combined, complex, combined radiation methods of radiation therapy, their tasks.
11. Concept of radiosensitivity, radiotherapeutic interval.
12. Radiomodifying agents (factors) increasing the radiotherapeutic interval.
13. Structure of the radiation therapy course.
14. Characteristics and tasks of each period of radiation therapy.

General material and mass-methodological support

lectures:

- lecture halls according to the plan of the educational department of ONMedU
- projector, screen
- presentation
- PC

References.

Main:

1. Kovalskyi O. V. Radiology. Radiation therapy. X-ray diagnostics: assistant. For students higher honey. education closing IV level of accreditation / O. V. Kovalskyi, D. S. Mechev, V. P. Danylevich. - 2nd edition. - Vinnytsia: New Book, 2017. - 512 p.

2. Radiodiagnostic methods Study guide (Department of Medical Research Protocol No. 5 dated 05.25.17) N.V. Tumanska, K.S. Barska. 143 p

3. Radiology. Educational and methodological complex of the study discipline "Radiology" for students of the III year of the I and II medical faculty of the VNMZ of the educational and qualification level "specialist" in the direction 1201 "Medicine" of the specialty 7.12010001 "Medical business", 7.12010002 "Pediatrics" / N.V. Tumanska, S.O. Myagkov, O.G. Nordio., T.M. Kichangina - Zaporizhzhia: ZDMU, 2018. - 153 p.

4. Radiology Kovalsky O.V. Radiology. Radiation therapy. X-ray diagnostics: assistant. for students higher honey. education closing IV level of accreditation / O. V. Kovalskyi, D. S. Mechev, V. P. Danylevich. - 2nd edition. - Vinnytsia: New Book, 2017. - 512 p.

Additional.

1. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 1. Kyiv, Book plus. 2015. -104 p.

2. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 2. Kyiv, Book plus. 2015. -168 p.

3. Radiology (radiodiagnosis and radiation therapy). Test tasks. Part 3. Kyiv, Book plus. 2015. -248 p.