Original Article: Investigating the Difference Between Electron and Photon Radiation in Radiotherapy

Amirhossein Ahmadivand Koshki[1]*, Ghazal Tanzifi[1]
[1]Department of Nuclear Engineering Islamic Azad University, Central Tehran Branch, Tehran, Iran

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ABSTRACT

Radiotherapy may help achieve different treatment goals. For example, it may increase the effectiveness of surgery, help prevent cancer from spreading, or reduce symptoms of advanced cancer. Most radiation therapy devices use photon beams. Photons are also used in X-rays, but at lower doses. Photon beams can reach tumors deep in the body. When photon beams pass through the body, they scatter some radiation along the way. These rays do not stop once they reach the tumor, but also go to the normal tissue. Radiation therapy is one of the types of cancer treatment methods that uses high-energy particles or waves such as X-rays, gamma rays, electron beams or by using a certain type of energy to stop the growth and division of cancer cells. As a result, the cell will gradually shrink and die. The goal of radiation therapy is to destroy cancer cells with minimal damage to healthy cells, but sometimes this treatment also damages healthy cells adjacent to the cancer tissue, or stops them from growing and dividing by destroying their DNA. Also, radiotherapy can be part of the treatment and prevent tumor recurrence after surgery to remove the malignant tumor. Radiation therapy increases the effect of chemotherapy and is used in sensitive tumors before, after and simultaneously with chemotherapy.

Introduction

Patients Radiotherapy or radiation oncology is the medical use of ionizing radiation as part of cancer treatment to control or kill malignant cells. Radiotherapy can treat some cancers that are limited to a part of the body [1-3]. Also, radiotherapy can be part of the treatment and prevent tumor recurrence after surgery to remove the malignant tumor [4-6]. Radiation therapy increases the effect of chemotherapy and is used in sensitive tumors, before, after and simultaneously with chemotherapy. Radiotherapy is used in cancer treatment because of its ability to control cell growth. Ionizing radiation damages the DNA of the irradiated tissue and causes cell death. In order to preserve the healthy tissue [7-9], the shaped beam beams are irradiated to the tumor at

*Corresponding Author: Amirhossein Ahmadivand Koshki (Ahmadiamirhosein141@gmail.com)

different angles so that the maximum amount of dose is absorbed in the tumor, not the surrounding healthy tissues [10-12]. Sometimes the treatment area includes lymph nodes in addition to the tumor itself. Due to the uncertainty in the same condition of the patient and movements in the body, there should be a margin of healthy tissue in the treatment area in addition to the tumor itself [13-15]. These uncertainties can arise as a result of the internal movements of the body and the movement of skin surface marks that are placed on the body to determine the tumor area. Radiation oncology is a medical specialty related to the administration of radiation and is distinct from radiology, the use of radiation in medical imaging and diagnosis [17-19]. Administration of radiation can be for curative or adjuvant treatment. Also, sometimes radiation is used for palliative treatment or therapy. Also, combining radiotherapy with surgery, chemotherapy, hormone therapy or immunotherapy or any of them is a common method. Most common types of cancer can be treated in some way with radiotherapy. The main purpose of curative, adjuvant, neoadjuvant, curative or palliative radiotherapy depends on the type of tumor, its location, its stage and the general health of the patient [20-22].

Total body irradiation (TBI) is a technique in radiotherapy used to prepare the body to receive a bone marrow transplant. Brachytherapy is another method in which the source of radiation is placed inside or in the desired area for treatment, and it causes the irradiation of healthy tissues to be reduced during the treatment of cancers such as prostate, endometrium, breast, etc [23-25].

Radiation therapy has many applications in non-malignant diseases, such as the treatment of trigeminal neuralgia, acoustic neuroma, pterygium, severe eye disease caused by thyroid, pigmented villundular synovitis and prevention of colloidal scar growth, re-narrowing of vessels and heterotopic ossification [26-28]. The use of radiotherapy in non-malignant diseases is severely limited due to its risks and the increased possibility of radiation-induced cancer.

The mechanism of action of the beam

Radiotherapy affects the DNA of tumoral cells. This damage to DNA is caused by one of two forms of energy, photons or charged particles. This damage can affect the DNA chain in the form of direct or indirect ionization. In photon therapy, the effect of the rays is mostly through the creation of free radicals and thus damage to DNA [29-31]. Since cells have a single-stranded DNA damage repair mechanism, it has been observed that double-stranded DNA damage is the most important technique that leads to cell death. Cancer cells, which are undifferentiated and similar to stem cells, usually multiply more than differentiated healthy cells and have little ability to repair damage [32-34].

DNA strand damage is transferred to new cells during cell division. Cancer cell DNA damage leads to cell death or slows down their reproduction. One of the limitations of photon radiotherapy is that the cells of solid tumors are deprived of oxygen.

Solid tumors can strengthen their blood vessels as a result of reduced oxygen. Oxygen is a strong sensitizer to radiation and increases the effect of radiation dose by creating DNA damaging free radicals. Tumor cells in a hypoxic environment are 2 to 3 times more resistant to radiation than cancer cells in an oxygen environment. Much research has been devoted to overcoming hypoxia, including the use of high-pressure oxygen tanks, blood substitutes that carry a lot of oxygen, hypoxic cell sensitizers such as misonidazole [35-37], and hypoxic cytotoxins such as tirapazamine. New research on the use of oxygen-enhancing compounds such as trans sodium crocetinite (TSC) as radiosensitizers is underway. Charged particles such as proton,

boron, carbon and neon ions cause direct damage to the DNA of cancer cells (Figure 1), they have an anti-tumor effect independent of the amount of tissue oxygen [38-40].

Because it affects mostly by breaking two strands of DNA. Because these particles are relatively heavy, they are more dispersed throughout the tissue. The beam of radiation does not spread much, it remains focused on the tumor and causes few side effects to the surrounding tissues.

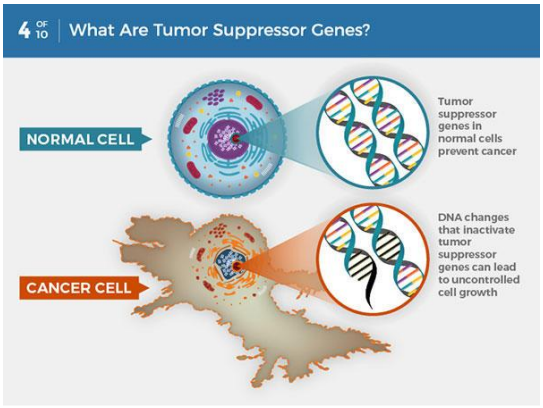

Figure 1. DNA of cancer cells

Also, due to their special physical characteristics, they target the tumor more precisely. For example, in proton therapy, the damage to the healthy tissues around the tumor is very low. This helps tumors that are in sensitive areas to be treated more accurately and with minimal damage to the surrounding tissues. Radiation is harmful to children. Because they are growing [41].

What is external radiation therapy?

External beam radiation therapy is a method of radiotherapy in which radiation is supplied from a device and its purpose is to treat cancer. This is a topical treatment, meaning it treats a specific part of your body. Radiation rays used in external radiation therapy consist of three types of particles:

1- Photons: Most radiation therapy devices use photon rays. Photons are also used in X-rays, but at lower doses. Photon beams can reach tumors deep in the body. When photon beams pass through the body, they scatter some radiation along the way [42-44]. These rays do not stop once they reach the tumor, but also go to the normal tissue.

2- Protons: Protons are positively charged particles. Proton beams, like photon beams, can reach tumors deep in the body. However, proton beams do not scatter on their way through the body and stop once they reach the tumor. Doctors believe that proton beams may reduce the amount of normal tissue that is exposed to radiation. Clinical trials comparing radiation therapy using proton beams with photon beams are underway. Some cancer centers use proton beams in radiation therapy, but the high cost and size of the devices limit their use [45].

3- Electrons: Electrons are negatively charged particles. Electron beams cannot penetrate body tissues. Therefore, their use is limited to tumors on the skin or near the surface of the body.

Types of external radiotherapy

There are different types of external beam radiation therapy, the main goal of which is to deliver the highest prescribed dose of radiation to the tumor, while the surrounding normal tissue is less damaged. Each type relies on computers to analyze tumor images to calculate the most accurate dose and course of treatment possible [46].

Types of external radiation therapy

1- 3D adaptive radiotherapy: 3D adaptive radiotherapy is the most common type of external radiation therapy. In this method, CT, MRI and PET scan images are used for precise planning of the treatment area, which is called the simulation process [47-49]. A computer program is used to analyze the images and design radiation beams according to the shape of the tumor. Three-dimensional adaptive

radiotherapy produces a precise image of the tumor by transmitting rays from different directions. Accurate imaging allows higher doses of radiation to be applied to the tumor while leaving normal tissue more intact. Most people need treatment once a day. The number of treatment sessions varies from person to person based on the details of the cancer, including the type and stage of the cancer and the size and location of the tumor [50].

2- Intensity modulated radiation therapy (IMRT): IMRT is a type of three-dimensional adaptive radiation therapy. In this method, like 3D adaptive radiotherapy, the tumor is targeted from several directions [51-53]. IMRT uses smaller beams than 3-D adaptive, and the resistance of the beams can be changed in some areas to give higher doses to specific parts of the tumor. Most people need treatment once a day. The number of treatment sessions depends on the details of the cancer, including the type and stage of the cancer and the size and location of the tumor in different people [54].

3- Image guided radiation therapy (IGRT): IGRT is a type of IMRT. However, it uses imaging scans not only for treatment planning before radiation therapy sessions, but also during radiation therapy sessions. During treatment you will have frequent scans such as CT, MRI or PET scan [55-57]. These scans are processed by computers to detect changes in the size and location of the tumor. Repeated imaging allows your position or radiation dose to be adjusted as needed. These adjustments can improve the accuracy of the treatment and help preserve as much of the natural tissue as possible. Most people need treatment once a day. The number of treatment sessions depends on the details of the cancer, including the type and stage of the cancer and the size and location of the tumor in different people [58].

4- Tomotherapy: Tomotherapy is a type of IMRT that uses a device that is a combination of a CT scanner and an external radiation device. The tomotherapy device takes pictures of the tumor before the treatment sessions to enable precise targeting of the tumor and protection of normal tissues (Figure 2). This device rotates around you during the treatment and directs the radiation in a spiral [59-61]. Tomotherapy may be better than 3D adaptive radiation therapy in relative preservation of normal tissues, but has not yet been tested in clinical trials. Most people need treatment once a day. The number of treatment sessions depends on the details of the cancer, including the type and stage of the cancer and the size and location of the tumor in different people.

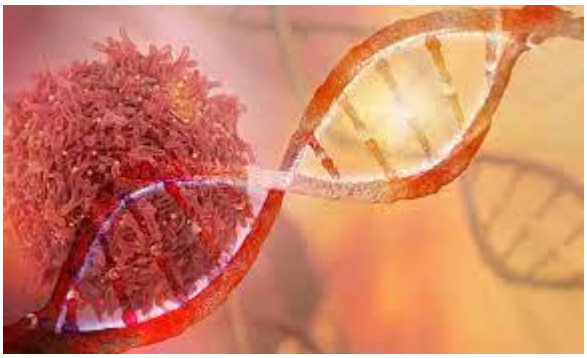

Figure 2. How RNA molecules control repair of human DNA in cancer cells

5- Stereotactic radiosurgery: Radiosurgery or stereotactic radiosurgery is the use of focused and high-energy rays to treat small tumors with well-defined edges in the brain and central nervous system [62-64]. If your health is at risk due to age or other problems, or if surgery cannot reliably reach the tumor, this method is the best option. Gamma Knife is a type of stereotactic surgical beam. You will be placed in a head frame or some other device to ensure that you do not move during the treatment. In stereotactic radiosurgery, many small beams of radiation target the tumor from different directions [65-67]. Each beam has very little effect on the tissue it passes through, but a

precisely targeted dose of radiation is delivered to the spot where all the beams converge. The treatment schedule may vary, but treatment is usually done in one dose. In some cases, you may receive up to five doses given once a day [68-70].

6- Stereotactic body radiation therapy: Stereotactic body radiation therapy is similar to stereotactic radiosurgery, but is often used for small and isolated tumors outside the brain and spinal cord, liver, or lung. This is an excellent option when you cannot undergo surgery due to age, health problems or the location of the tumor.

As with stereotactic radiosurgery, stereotactic body radiation therapy uses special equipment to keep you still during treatment. Provides a very precise beam to a limited area. Tumors outside the brain are more likely to move with normal body movement, such as breathing or digestion. Therefore, the beams cannot be aimed precisely as they are in stereotactic radiosurgery. For this reason, stereotactic body radiation therapy is usually prescribed in more than one dose. You may have up to five doses administered once a day [71].

Duration of external radiotherapy

Most people receive external beam radiation therapy once a day, five days a week. Radiation is done in a series of treatments so that healthy cells can recover and make the radiation more effective. How many weeks the treatment lasts depends on the type of cancer, the treatment goal, the radiation dose and the radiation schedule. The treatment interval from the first radiation therapy session to the last session is called a treatment period [72-74].

Investigating the difference between electron and photon radiation in radiotherapy

The classical model of an atom consists of a nucleus with positively charged protons and uncharged neutrons surrounded by electrons in shells or orbitals [75-77].

The innermost layer is called the K layer. After that layer L then layer M and so on. L layer has 3 sub-layers LI, LII and LIII. M layer has 5 sub-layers MI, MII, MIII, MIV and MV. K layer can have 2 electrons, L layer, 8 electrons and M layer, 18 electrons.

The energy of an electron depends on the shell it occupies and the element it belongs to [78-80]. When an atom is irradiated, particles with sufficient energy, such as X-ray photons, can remove an electron from the atom. This event leads to the formation of a hole in the electron layer and the atom is placed in an unstable excited state with higher energy. As the atom tends to return to its original state, the electron is transferred from an outer layer such as the L layer to a hole in the K layer. The L layer electron has a higher energy than the K layer electron, and when the L layer electron is transferred to the K layer, the excess energy can be emitted as X-ray photons, which can be seen as a line in the spectrum [81-83].

The energy of the emitted X-rays depends on the energy difference of the layer with the hole and the transferred electron. Sometimes the radiation is emitted from a device outside the body, sometimes from a source inside the body or from uncovered radioactive materials that reach the whole body. The type of radiation depends on the type of cancer, its location, the required penetration depth of the radiation in the body, the general health status and medical history of the patient, whether the patient uses another type of cancer treatment, or not, and other factors.

Most of the people who receive radiation therapy have external radiation. Some patients have both internal and external radiation or systemic radiation therapy [84-86], one after the other or at the same time. External radiation therapy is usually performed on an outpatient

basis. Most patients do not need to be hospitalized.

External radiation therapy is used to treat most types of cancer such as bladder, brain, breast, cervix, larynx, lung, prostate and vagina. In addition, external beam radiation is used to reduce pain or improve other problems when cancer spreads from the primary site to other parts of the body [87].

Radiation therapy during surgery

It is a type of external radiation therapy that is used during surgery. IORT is used to treat localized cancers that cannot be completely removed, or are at high risk of recurrence. After all, or part of the cancer has been removed, a large amount of high-energy radiation is sent directly to the tumor site during surgery. The patient is admitted to the hospital to return to normal. IORT is used to treat thyroid cancer, colon and rectal cancer, women's cancers, small intestine cancer and pancreatic cancer. This method is also being studied in clinical research to treat some types of brain tumors and pelvic sarcoma in adults [88].

Prophylactic cranial irradiation

It is a type of external radiation that is given to the patient when the primary cancer is at high risk of spreading to the brain. Internal radiation therapy, which is also called brachytherapy, uses radiation near or inside the tumor. Implants are sometimes in the form of thin wires, plastic tubes called catheters, strips, capsules, or seeds. The implant is placed directly inside the body. For internal radiation therapy, you have to be admitted to the hospital [89].

Prophylactic cranial irradiation

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Internal radiation therapy or brachytherapy

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1- Interstitial radiotherapy: they work near the tumor site and are used to treat tumors of the head and neck, prostate, cervix, ovary, breast, and around the anus and pelvis. Some women who use external beam radiation to treat breast cancer receive a booster dose of radiation, either in the form of interstitial radiation or external beam radiation.

2- Intracavity or intraductal radiation therapy: they work with an applicator in the body. This method is usually used in the treatment of uterine cancer. Researchers are also studying the use of this type of radiation therapy to treat other cancers, including breast, bronchus, cervix, gall bladder, mouth, rectum, trachea, uterus and vagina.

3- Systemic radiotherapy of radioactive substances: It uses like iodine 131 and strontium 89. These substances are introduced into the body through mouth or injection. Systemic radiation therapy is sometimes used to treat thyroid cancer and non-Hodgkin's lymphoma in adults. Researchers are tasked with treating other types of cancer. The amount of radiation that is absorbed by tissues is called radiation dose. Prior to 1985, radiation dose was measured in a unit called the rad. Today, this unit is called Gray. One Gy is equal to 100 Rad and one Centigrade is equal to 1 Rad. Different tissues tolerate different amounts of radiation. The liver can tolerate 3000cGy, while the kidney can only tolerate 1800cGy. The total amount of radiation (total dose) is usually divided into several times of less radiation that are given daily in a certain cycle. With this operation, more

cancer cells are destroyed and at the same time less healthy tissues are destroyed.

The doctor works with a coefficient called the therapeutic ratio. This coefficient shows the ratio of damage to cancer cells to the damage of healthy tissues. Methods are available to increase the amount of damage to cancer cells without further damaging healthy tissue. These methods are discussed in the following questions [90].

What are the energy sources for external beam radiation therapy?

The energy used in radiation therapy comes from these sources:

A) X-ray or gamma ray: Both are forms of electromagnetic radiation. Although they are produced in different ways, they both use photons. X-rays are produced by devices called linear accelerators (Figure 3). Depending on the amount of energy that X-rays have, they destroy cancer cells on the surface of the body or deep in the tissues and organs. Compared to other types of radiation, X-ray radiates the radiation to a relatively wider area. Gamma rays come from isotopes of certain elements such as iridium and cobalt 60, which release energy and radiation when they break.

Each element breaks in a certain amount and each of them releases a different amount of energy, which affects the amount of penetration in the body. Particle radiation uses high speed subatomic particles instead of photons. Particle radiation is produced by linear accelerators, synchrotrons and cyclotrons, which produce and accelerate the particles required for this type of radiation therapy. Treatment with particle radiation from electrons produced by an X-ray tube. Neutrons produced by radioactive elements and special equipment, heavy ions and py mesons, which are small negatively charged particles, produce an accelerator and magnetic system.

Figure 3. Energy sources for external beam radiation therapy

Unlike x-rays and gamma rays, some particle radiations penetrate only a little deep into the tissue. Therefore, they are usually used in the treatment of superficial cancers or cancers that are located just under the skin.

4- Proton radiation therapy: It is a type of particle radiation radiation therapy. Protons concentrate their energy in a small area called Bragg peak. Bragg peak is used to target a large amount of proton beam on the tumor, while causing the least damage to the tissues in front and behind the tumor. Proton radiation therapy is available at only a few centers in the United States.

It is usually used only for cancers whose surgery is difficult or dangerous, or in combination with other types of radiation. Proton radiation therapy is also used in clinical research for intraocular melanoma, retinoblastoma, rhabdomyosarcoma, some head and neck cancers, and prostate, brain, and lung cancers.

5- Stereotactic radiosurgery: In stereotactic radiosurgery, a high amount of radiation is used to destroy tumor tissue in the brain. This method does not involve actual surgery. The patient's head is placed in a special mold that is attached to the skull. The mold is used to direct high-dose radiation to the tumor inside the patient's head.

The amount of radiation and the area to be irradiated are precisely calculated. In this method, the tissues around the tumor will generally be spared from damage. Stereotactic surgical radiation is performed in three ways:

- ✓ The common method is to use a linear accelerator to radiate high-energy photon rays on the tumor, which is called linear-based stereotactic radiosurgery.
- ✓ The gamma knife is the second most common method of Cobalt 60 for radiation.
- ✓ In the third method, heavy charged particles such as protons and helium ions are used for stereotactic radiation of the tumor.

Stereotactic radiosurgery is mostly used in the treatment of small benign or malignant brain tumors as well as in the treatment of other diseases. In addition, stereotactic radiosurgery is used in the treatment of metastatic brain tumors alone or together with whole brain radiation therapy.

6- Stereotactic radiation therapy: In this method, the same method used in the stereotactic surgical radiation method is used to radiate radiation to the target tissue. However, in stereotactic radiation therapy, they use a low amount of radiation in several times instead of a high dose. Small and multiple doses improve the result, minimize side effects. Stereotactic radiation therapy treats brain tumors as well as tumors in other parts of the body. In clinical research, the usefulness of stereotactic radiosurgery and stereotactic radiation therapy alone or together with other radiation therapy methods is under investigation [91].

What sources of energy are there for internal radiation therapy?

The energy used in internal radiation therapy is obtained from the radioactive isotope in radioactive iodine and from strontium-89, phosphors, palladium, cesium, iridium, phosphate, or cobalt.

What methods are used or studied to improve the quality of external radiation therapy?

A number of correction techniques and methods that are used or studied to improve the effectiveness of external radiation therapy are as follows:

3D adaptive radiation therapy: unlike the old treatment plans that were done in 2D, it is 3D and uses a computer to target the tumor more precisely and allows doctors to target the tumor more accurately with radiation rays. Today, most radiation oncologists use this method. Three-dimensional images of the tumor are prepared using computerized tomography, magnetic resonance imaging, PET positron emission tomography, or single-photon emission computerized tomography, and with the help of special software, they design beams that match the shape of the tumor. Because in this healthy tissue around the tumor, it is widely away from radiation, higher amount of radiation can be used to treat the tumor. The use of 3D adaptive radiation therapy in pharynx, nose, prostate, lung, liver and brain tumors has obtained better results. Intensity modulated radiation therapy (IMRT) is a new type of three-dimensional adaptive radiation therapy that uses beams of different intensities to deliver different amounts of radiation to small areas of tissue simultaneously. In this technology, a high amount of radiation reaches the tumor and a lower amount of radiation reaches the surrounding healthy tissues. In some techniques, the patient receives more radiation every day, and the total treatment time decreases and the success of the treatment increases. IMRT reduces side effects during treatment. In this method, radiation is performed by a linear accelerator equipped with a Multileaf collimator. By rotating the device

around the patient's body, the rays enter the tumor from the best angles.

The beams adapt to the shape of the tumor as precisely as possible. Because the IMRT machine is very specialized. Not every oncology center is equipped with this device. This new technology is used to treat brain, neck, throat, nose, breast, liver, lung, prostate and uterus tumors. Although IMRT is not used for every patient or every type of tumor. Long-term results with IMRT will soon be available.

What are low LET rays and high LET rays?

Linear energy transfer LET represents the amount of energy left by the beam while passing through the tissue. By absorbing more energy, more cells are destroyed with the amount of radiation given. Different rays have different LET levels.

For example, X-rays, gamma rays and electrons are known as low LET, and pions and neutrons are high LET heavy ions. The most common use of high LET radiation is in research treatments.

Who is responsible for the design of treatment and radiation in radiation therapy?

The staff of each radiation therapy center help to design and treat the patient. Radiation therapy group includes cancer radiation specialist, dosimetrist, radio physicist and radiation therapist. Radiation therapy is usually a part of the patient's treatment. It is common to use multidimensional therapy using drug therapy. The radiation oncologist collaborates with the pediatric oncologist, surgeon and radiologist, pathologist, and others who plan the patient's entire course of treatment. Close working relationship between radiation oncologist, pediatric oncologist, surgeon, radiologist and pathologist is important in planning the entire treatment.

What is treatment design and why is it important?

Due to the diversity of rays and radiation methods, treatment design is the first and important step in the treatment of every patient who is undergoing radiation therapy. Before radiation therapy, the radiation therapy team determines the amount and type of radiation. If the patient is to receive external radiation therapy, the radiation therapist uses a method called simulation to determine the target of the radiation. During the simulation, the patient lies quietly on the bed until the radiation therapist uses a special X-ray device to determine the treatment channel, the exact place on the body where the radiation should be sent. Most patients have more than one treatment channel. Simulation also includes CT scans or other imaging methods to help the radiation therapist plan the correct radiation. Simulation causes changes in the design of treatment and as a result more protection of healthy tissue from radiation. The points to be irradiated are marked with a permanent or temporary marker such as a small dot or tattoo.

These indications also determine where exactly to start treatment if the patient needs radiation therapy later. Depending on the type of radiation therapy, the radiation therapist uses casts or other devices to keep the patient still during the treatment. These devices are usually made of foam, plastic or plaster.

In some cases, the radiation therapist uses sheets to prevent the penetration of radiation into the organs and tissues around the treatment site. When the simulation is complete, the radiation therapy team decides on the amount of radiation needed, how to deliver it to the desired location, and the number of treatment sessions to be performed on the patient.

What are radiation sensitizers and radiation protectors?

Radiosensitizers and radioprotectors are chemicals that change a cell's response to radiation. Radiosensitizers are drugs that make cancer cells more sensitive to radiation therapy. Some of these compounds are under study. In addition, some anticancer drugs such as 5-flaurouracil and Cisplatin make cancer cells more sensitive to radiation therapy.

What are radiation drugs and how are they used?

These drugs, known as radionucleotides, are radioactive drugs that are used in the treatment of various types of cancer, including thyroid tumors, recurrent breast tumors, and metastatic bone tumors. These drugs have been approved by the FDA to reduce the pain of metastatic bone cancer. Both drugs are administered intravenously and usually in outpatients. Sometimes these drugs are used together with external radiation therapy. Other types of radiation are medicines such as phosphorus 32, rhodium 186 and gallium nitrate, which are not widely used today. Other drugs are under study.

What are the new methods of radiation therapy?

Hyperthermia or the use of heat combined with radiation therapy is under study. Researchers have found that the combination of heat and radiation increases the response rate of some tumors. Researchers are also investigating the use of labeled antibodies to deliver radiation directly and correctly to the tumor site, which is called radioimmunotherapy. Antibodies are special proteins that the body makes in response to the presence of antigens. Some tumor cells contain special antigens that cause the production of tumor-specific antibodies. Large amounts of these antibodies are made in the laboratory and in connection with radioactive materials. When these substances are injected into the body, they look for destroyed cancer cells. This method minimizes the risk of radiation damage to healthy cells. The success of this method depends on the correct detection of the radioactive material and the effective and safe dose of radiation used in this method. Two radioimmunotherapy treatments, ibritumomab tioxane and tositumumab and tositumumab with iodine 131 have been approved for adult non-Hodgkin's lymphoma. Clinical researches of radioimmunotherapy for a number of cancers including leukemia, NHL, colon and rectal cancer, lung, brain, prostate, breast, ovary and pancreas cancers are under investigation. Scientific advances have led to the discovery of new targets for the direct absorption of radioactive substances into cancer cells.

Conclusion

Due to the ability of the radiotherapy device to control cell growth, it is used in cancer treatment. Due to the production of positive and negative ions, ionizing radiation damages the DNA of the tissue that is exposed to radiation and eventually causes cell death. Now you know that most cancerous tumors are located in the internal parts of the body and in order for the radiation to reach the cancerous tissue, they must pass through different organs and organs. In order to preserve healthy tissue such as skin or organs that are in the path of radiation to the tumor, the radiation beams are shaped at different angles to the tumor so that the maximum dose is absorbed in the tumor, not the surrounding healthy tissues. Sometimes the treatment area includes lymph nodes in addition to the tumor itself. Due to the uncertainty in the same condition of the patient and movements in the body, there should be a margin of healthy tissue in the treatment area in addition to the tumor itself. These uncertainties can arise as a result of the body's internal movements and the movement of skin surface marks that are placed on the body to determine the tumor area. Cancer is the second cause of death in our country. According to the statistics published in the

survey of 32 cancers in 195 countries between 2005 and 2015, the incidence of cancer has increased by 33%. Radiation therapy is one of the most common methods of cancer treatment and can be used alone or together with other treatment methods such as surgery, chemotherapy or hormone therapy. Campus Cancer Institute is always by the side of dear patients to provide timely services in line with the treatment. Hoping that timely diagnosis of cancer and follow-up of treatment methods, recovery and well-being will be achieved as soon as possible for all patients. Radiation therapy is the use of ionizing radiation to destroy or shrink cancerous tissues. In this method, as a result of DNA damage, the cells in the treatment area are destroyed and it becomes impossible to continue growing and dividing. Although radiation damages healthy cells in addition to cancer cells, most healthy cells recover. The goal of radiation therapy is to destroy as many cancer cells as possible with minimal damage to healthy tissues. Radiotherapy can be used to treat all types of solid tumors including tumors of the brain, breast, cervix, larynx, lung, pancreas, prostate, skin, spinal cord, stomach, uterus or soft tissue and bone sarcoma, leukemia and lymphoma and some benign tumors.

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