Seven lecture

Physics of Radiation Therapy

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Fourth Stage

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2023- 2024

Physics of Radiation Therapy

Early attempts were not a great success; however, today radiation therapy is recognized as an important tool in the treatment of many types of cancer.

Currently three major methods are used alone or in combination to treat cancer:

1.Surgery

2.Radiation therapy

3.Drugs (Chemotherapysurgery, radiation therapy and drugs (chemotherapy).

About half of all cancer patients receive radiation as part or all of their treatment.

The success of radiation therapy depends on:

1.The type and extent of the cancer

2.The skill of the radiotherapist, the physician who specializes in the treatment of cancer with radiation

3.The kind of radiation used in the treatment.

4.The accuracy with which the radiation is administered to the tumor.

5.The responsibility of the radiological physicist (last factor).

There is evidence that an error of (5-10) % in radiation dose to tumor can have a significant effect on the results of the therapy .Too little radiation does not kill the entire tumor; while too much can produce serious complications in normal tissue.

The basic principle of radiation therapy is to maximize damage to the tumor while minimizing damage to normal tissue. This is generally accomplished by directing a beam of radiation at the tumor from several directions, so that the maximum dose occurs at the tumor.

Some normal tissues are more sensitive radiation than others. Ionizing radiation, such as x-rays and γ-rays, tearing electrons off atoms to produce (+ve) and (-ve) ions.

Principles of radiation therapy:

The basic principle of radiation therapy is to maximize damage to the tumor while minimizing damage to normal tissue.

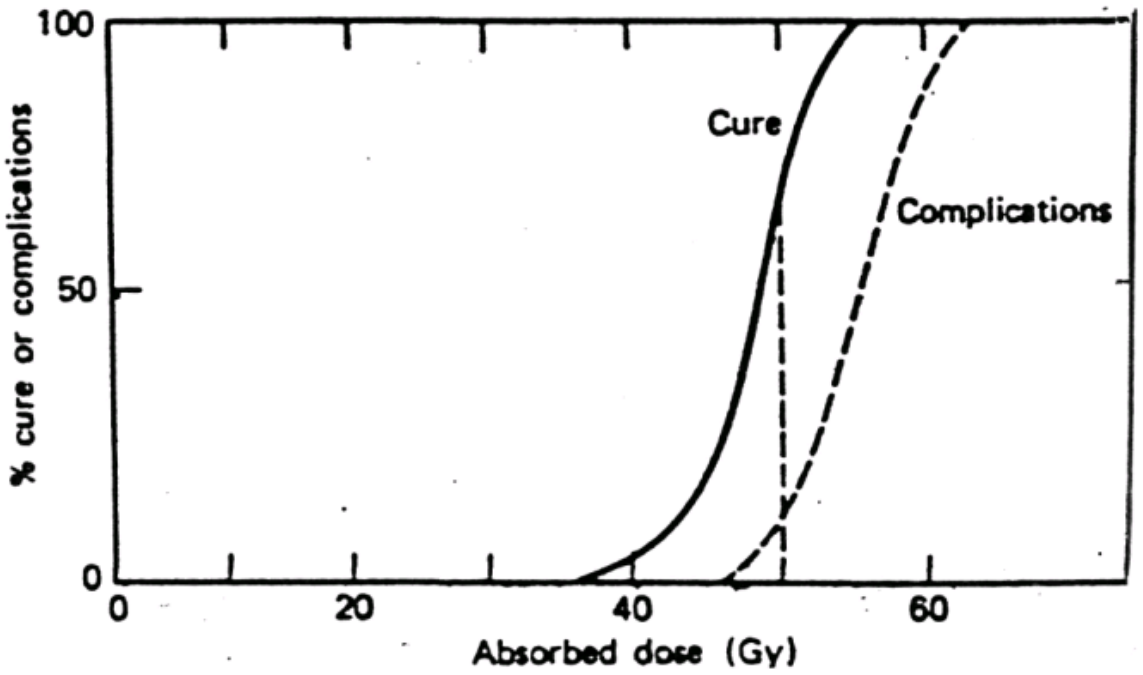
Factors that determine how much radiation is required are:-

1- The type of radiation

2- The type of cell.

3- The environment of the cell.

It also breaks up molecules; the new chemicals formed are no use to the body and can be considered a form of poison.



The units are used to measure the amount of radiation to the patient:-

Erythematic dose: - the quantity of x-rays that caused Redding of the skin.

Exposure (Roentgens (R)) .

$1R=2.58x10^{-4}$ c/kg of air.

Absorbed dose (rad).The (rad) is defined as 100 ergs/g. that is a radiation beam that gives 100ergs of energy to 1g of tissue an absorbed dose of 1(rad) or gray =100(rad).

The (rad) can be used for any type of radiation in any material; the roentgen (R) is defined only for x-rays and γ-rays in air.

The radiotherapist is a physician who has had three or four years of training in oncology (the study of cancer) and the treatment of cancer with ionizing radiation ,in a modern medical center one or more radiotherapy technologists work with him and give the treatment ,they have had two or three years of training after high school .

In addition ,a radiological physicist and a dosimetry technician ,often called a dosimetrist ,look after the calibration of the therapy equipment and aid in planning the treatment .

In the very early days of radiation therapy the unit used to measure the amount of radiation to the patient was the erythema dose –the quantity of x-rays that caused a reddening of the skin .

Stating in about 1930 radiation to the patient was measured in Roentgen (r) ,a unit based on ionization in air, the term exposure had not yet been introduced ,since the roentgens was defined in terms of ionization in air it was an inappropriate unit to use for radiation absorbed by a part of the body .

In about 1950 the quantity absorbed dose was introduced and the unit rad was defined to measure it ,from 1950 to 1975 the rad was the official unit of absorbed dose.

The rad is defined as 100ergs/g ,that is a radiation beam that gives 100 ergs of energy to 1g of tissue an absorbed dose of 1rad .

The terms dose and absorbed dose are used interchangeably in radiotherapy) ,the rad can be used for any type of radiation in any material ,the roentgen (R) is defined only for x-rays and gamma rays in

air.

The rad can be related to the exposure in roentgens ,the rad was defined so that for x-rays and gamma rays an exposure of 1 R would result in nearly 1rad of absorbed dose in soft tissue (water) ..in bone the ratio of rads to roentgens depends on the energy of the x-ray photons ,at the energies used in diagnostic radiology the ratio of rads to roentgens in bone is about 4 that is , 1 R exposure results in about 4rads of absorbed dose, at high energies used in modern radiotherapy the ratio of rads to roentgens is nearly 1for both bone and soft tissue.

In 1975 the International Commission on Radiological Units (ICRU) adopted the **gray** (GY) as the international (SI) unit of dose.

Some types of radiation are more effective in killing cells or have a higher relative biological effect (RBE).

RBE(RelativeBiological Effect)

The ratio of the number of gray of 250 KVp x-rays needed to produce a given biological effect to the number of grays of the test radiation needed to produce the same effect**.**

Radiation that produces dense ionization generally is more lethal and has an RBE greater than 1 ,the RBE depends on the biological experiment used to measure the effect and is not the same for all tissues (Look table lists some approximate RBE values for several different types of radiation).

particle	**RBE**
Electrons or beta rays	1
X-rays or gamma rays	1
Fast neutrons	5
Alpha particles	>10

In a modern radiation therapy center, a simulator is used to allow the radiation therapist planning the treatment to see what normal structures

will be in the treatment beam.

A simulator is a special fluoroscopic diagnostic x-ray unit with an image intensifier and TV screen ,the x-ray unit is positioned in the same physical arrangement as the therapy unit that will give the treatment ,that is ,it simulates the therapy unit ,the therapist can change the location and size of the beam by remote control while he watches the image on the TV screen ,after he has determined the best size and location of the beam ,he marks the beam location with colored ink on the patient's skin.

LD_{50}:-

The quantity of radiation that will kill half of the organisms in a population (cells, mice, people, …etc) is called *the lethal dose* for 50% or LD_{50}.