**International Journal of Ecosystems and Ecology Science (IJEES)** **Vol. 15 (1):** 157-160 (2025)
https://doi.org/10.31407/ijees https://doi.org/10.31407/ijees15.1

# THE DEPENDENCE OF THE RADIATION DOSE ON THE ANGLE AND THE FIELD SIZE FOR RADIATION BEAM WITH ENERGY 6 MV

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Received December 2024; Accepted January 2025; Published February 2025;

DOI: https://doi.org/10.31407/ijees15.118

## ABSTRACT

The cell proliferation is a process that takes place through the cell cycle. Normally there is a balance between cell proliferation and death, when mutations that occur in DNA interrupt this process resulting in the birth of tumors. The spread of tumor diseases has led to the need to develop different methods for treating tumors. One of the methods of treating tumors is also through radiotherapy. In the treatment of tumors through radiotherapy are used accelerators which provide radiation beams with different energies. In the treatment of tumors with radiotherapy, electronic beam can be used for tumors that are located on the surface of the human body up to a depth of 7 cm or photonic beam for tumors that are located in different organs. The treatment of tumors using the radiotherapy provided by accelerators, it is also known as external beam radiotherapy, where the patient is placed at a certain distance from the accelerator head or radiation source as it is otherwise called. In external beam radiotherapy, it is very important to know the characteristics of the beam of radiation that will be used in the treatment of a certain tumor or tumor mass. A very important element in the treatment of external beams is the knowledge of the factors that affect the radiation dose given to the tumor mass, in order to give the exact dose needed to stop the process of tumor cell proliferation. In this material we will present two important factors, which affect the given dose, which are the size of the radiation field and the angle at which the radiation beam is given by the accelerator head. The factors listed above affect the dose distribution within the tumor mass. In our case we have used an accelerator type Elekta synergy platform with radiation beam with energy 6 MV. To see the dependence of the radiation dose on the factors defined above, we take some radiation field size with different dimensions and look at the changes in the radiation dose values. We notice that with the increase of the field size we have a decrease of the value of the radiation dose compared to the cases with small field size. This dependence helps us to evaluate the dose of radiation that we must give to the tumor mass in order to damage the tumor cells. Treatment of tumors with radiotherapy requires high accuracy and resolution of difficult cases. To treat tumors in different organs of the human body, the radiation source is placed at different angles depending on the position of the tumor. In these cases a correlation is observed between the radiation dose and the angle of the radiation source. The knowledge of the behavior of the radiation dose in relation to the angle of the radiation source, is used in giving the right dose in order to protect healthy organs. We have to be careful in report with given dose on the tumor mass on purpose that we have good results.

**Keywords:** Radiation, tumor, dose, field size, accelerator.

## INTRODUCTION

The human body has nearly $10^{13}$ cells. Each somatic cell contains 23 pairs of chromosomes. Each cell contains a nucleus that houses these chromosomes. The total chromosomal content of a cell involves approximately $10^5$ genes in a specialized macromolecule of deoxyribonucleic acid (DNA).

A number of direct and indirect radiation interaction pathways can produce damage to the DNA of irradiated cells. (Richard J. Reynolds and Jay A. Schecker, 1995). DNA damage occurs by direct or indirect action of the ionization. Cells depend on their DNA for coding information to make various classes of proteins that include enzymes, certain hormones, transport proteins and structural proteins that support life. Ionizing radiation is present everywhere as part of natyral enviroment. X rays are electromagnetic wave just like visible light, but more energetic. They come from X- ray machine, particle accelerators and their equipment that produce high-voltage electron beams. (Bhawani Pathak, 1989). All these devices produce X- ray when high spreed electrons strike a metal target. Gamma rays are also electromagnetic waves that come from many but not all radioactive substances. Gamma rays are highly penetrating and can pass through the human body.

Many types of accelerator have been built for basic research in nuclear physics and high energy physics. Most of these accelerators have been modified for least some limited use in radiotherapy. Medical linac are cyclic accelerators that accelerate electrons to kinetic energies from 4 to 25 MeV using radiofrequency fields. (E.B. Podgorsak, 2006). Nowadays, the majority of the patients referred to a radiation therapy department are treated with a linear accelerator for at least part of their treatment. It is likely that this will remain true for the foreseeable future. Linear accelerators thus play and will keep plying a significant role in tumour management in general and are responsible for the therapeutic success obtained in many tumour treatment. (A. Wambersie, R.A. Gahbauer, 1989).

The figure 1, below present an accelerator that used in radiotherapy to treat tumours. The accelerators produce photons beam with high energy by the electron beam which is accelerate in a electromagnetic field and strike the metal target in head of accelerator.

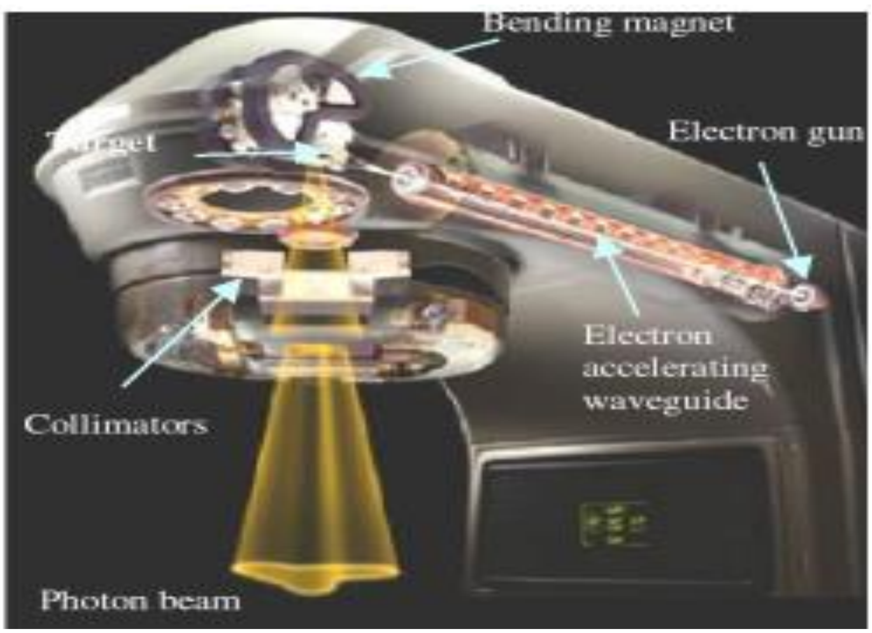


Figure 1. MV Linear Acceletator (Haijun Song Ph.D, 2002).

## MATERIAL AND METHODS

***Methods and data***

The X-ray accelerators produce radiation beams with different energies, in our case we have used an accelerator with 6 MV energy of Elekta Synergy Platform type. So, in a 8.7 cm depth, we have put the ionization chamber under five acrilic plates in 98.7 cm distance by source of radiation beam. A vertical movement mechanism controls the source-to-surface distance. The ionization chamber, an essential component, measures the dose at specific depth. The semiflex ionization chamber is connected via a cable to the multichannel electrometer, which in turn is connected to a computer to send the data to the mephisto software. The semiflex ionization chamber serves as a detector to capture the dose at the specified depth. The beam parameters are defined in the computer software, thereby commanding the accelerator according to the desired characteristics of the beam produced by the accelerator. Measurements are performed for 3 cm x 3 cm, 5 cm x 5 cm, 10 cm×10 cm, 15 cm×15 and 20 cm×20 cm field sizes and for beams with an energy of 6 MV The tables below shown the results that are obtained by measurements for 90 degree and 270 degree angles, also we have used radiation beam with different field size such as for 3 cm x 3 cm, 5 cm x 5 cm, 10 cm×10 cm, 15 cm×15 and 20 cm×20 cm.

## RESULT

The results displayed in computer with help of a specific software and the unit is nano coulomb.

Table 1. Results of radiation dose in nano coulomb unit for two different angle and field size 3x3cm$^2$.

| Energy | Angle | Dose (nc) | | | Field size |
|---|---|---|---|---|---|
| 6 MV | $90^0$ | 46.48 | 46.47 | 46.46 | 3x3cm$^2$ |
| | $270^0$ | 46.71 | 46.7 | 46.71 | 3x3cm$^2$ |

Table 2. Results of radiation dose in nano coulomb unit for two different angle and field size 5x5cm$^2$.

| Energy | Angle | Dose (nc) | | | Field size |
|---|---|---|---|---|---|
| 6 MV | $90^0$ | 45.87 | 45.88 | 45.86 | 5x5cm$^2$ |
| | $270^0$ | 46.10 | 46.11 | 46.12 | 5x5cm$^2$ |

Table 3. results of radiation dose in nano coulomb unit for two different angle and field size 10x10cm$^2$.

| Energy | Angle | Dose (nc) | | | Field size |
|---|---|---|---|---|---|
| 6 MV | $90^0$ | 44.72 | 44.75 | 44.73 | 10x10cm$^2$ |
| | $270^0$ | 44.68 | 44.73 | 44.7 | 10x10cm$^2$ |

Table 4. Results of radiation dose in nano coulomb unit for two different angle and field size 15x15 cm$^2$.

| Energy | Angle | Dose (nc) | | | Field size |
|---|---|---|---|---|---|
| 6 MV | $90^0$ | 44.79 | 44.78 | 44.77 | 15x15cm$^2$ |
| | $270^0$ | 44.65 | 44.64 | 44.66 | 15x15cm$^2$ |

Table 5. Results of radiation dose in nano coulomb unit for two different angle and field size 20x20 cm$^2$.

| Energy | Angle | Dose (nc) | | | Field size |
|---|---|---|---|---|---|
| 6 MV | $90^0$ | 43.09 | 43.07 | 44.08 | 20x20cm$^2$ |
| | $270^0$ | 43.25 | 44.27 | 44.24 | 20x20cm$^2$ |

***Discussions***

The study of various factors that influence the distribution of the dose delivered by the Elekta Synergy platform linear accelerator is a highly important element. We obtained several results regarding the impact of the gantry's angular positioning and the field size where the radiation dose is distributed. As shown, the dose values vary depending on the field size, with smaller field sizes generally resulting in higher recorded doses.

The results are consistent across different tables, indicating a uniform experimental method. For the 3x3 cm² field size, the dose is higher compared to larger field sizes like 20x20 cm².

The comparison between the angles (90° and 270°) suggests a minimal variation in dose values, indicating symmetry in beam distribution. This demonstrates the reliability of the radiation delivery system. Overall, the data provides a clear correlation between field size, angle, and dose, useful for optimizing radiation treatment planning.

Additionally, the influence of other factors, such as temperature, pressure, etc., in the environment where the accelerator is placed can also be studied. This would provide more detailed results on the impact of these factors in delivering the appropriate radiation dose**.**

## CONCLUSIONS

- The results shown that with increase of field size we have decrease of values radiation dose compared with cases when field size is smaller.
- The radiation dose per different angle has approximtly same values, it is important to have more chances in treatment of tumours in different parts of human body.
- Based on results and dates for different field size we have different distrubution dose so we choose the fit field size and angle of accelerator head according position of tumour in human body.

## REFERENCES

1. Richard J. Reynolds and Jay A. Schecker, (1995). Radiation, cell cycle and cancer. Los Alamos Science, page 58,59;
2. Bhawani Pathak, (1989). Effects of ionizing radiation. Canadian Centre Occupational Health and Safety, page 2,5,6;
3. E.B. Podgorsak, (2006). Machines for external beam radiotherapy. Mc Gill University, Montreal, page 7,20,32;
4. A. Wambersie, R.A. Gahbauer, (1989). Medical Applications of Electron Linacs. Cliniques Universitaires St-Luc, Universite Catholique de Louvain, 1200 Brussels, Belgium. Ohio State University Hospitals, Columbus, Ohio, 43210-1228, USA, page 1,3;
5. Haijun Song Ph.D, (2002). Linear Accelerators in radiation therapy. Dept of Radiation Oncology, Duke University Medical Center, page 2,3;