Verification of linear accelerator Quality at Oncology Center in Nouakchott by comparison with IAEA standards

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Abstract

Radiation therapy plays an important role in the treatment of malignant tumour.
The quality control for linear accelerator is one of the keys to ensure the correct and safe implementation of accurate radiotherapy.
The National Center of Oncology in Nouakchott is equipped with a linear accelerator which provides two energies in photon regime 6 MV and 18 MV.

The aim of this work is to control the quality of this accelerator by comparing the measured results with those calculated with Treatment Planning Systems (TPS).

The percentage depth dose (PDD), the main parameter generally used to verify the accelerator quality, was measured by ionization chambers (PTW 0.125 cm^3).

The PDD measures have been determined for 6MV and 18MV beam photon energy, for four different dimensions of the field size.

The measured results by the ionization chamber are comparable for all chosen treatment field dimensions to those calculated by TPS.

Keywords: Quality control, linear accelerator, radiotherapy, Percentage Depth Dose,

1. Introduction

The National Center of Oncology (CNO) at Nouakchott is equipped with radiotherapy, nuclear medicine and chemotherapy equipment that comply with the international standards and are controlled by the International Atomic Energy Agency (IAEA).
In general, external radiotherapy uses ionizing radiation for the tumor treatment. The use of these radiations requires the utmost vigilance on the part of the medical physicist and the personnel who use them. However, the results of the treatment depend a lot on the precision of the dose delivered to the tumor [1, 2, 3].
The main objective of radiotherapy is the treatment of cancerous tumors. All cells are sensitive to radiation and all can be destroyed by high dose. The objective of radiotherapy is to deliver a dose in order to destroy the tumor without producing significant side effects (complications) in the healthy tissues [4, 5].
In order to check the quality of the accelerator and related equipment, we have performed measurements (percentage depth dose (PDD)) in water phantom by an ionization chamber for different energies and field sizes and at different Skin- Source-Distance (SSD). The measured results have been compared to those calculated by Treatment Planning Systems (TPS), in order to compare measurements with calculation following the (IAEA) recommendations.
The (TPS) is a treatment planning software allowing to predict, according to a given ballistics, an established medical prescription, a chosen energy, an anatomical configuration, the dose at all points of the space [6,7,8].

2. Materials and Methods

Measurements of PDD were carried out using a water phantom, connected to a PC. The system is controlled for the acquisition of the dosimetric data by MEPHYSTO mc² software. The dosimetric measurements were realized using an ionization chamber associated with an electrometer and the chamber used for acquisition can move in three directions [9,10,11].

The material used in this work is:

1) Linear accelerator CLINAC 2100DHX, developed by the constrictor VARIAN MEDICAL SYSTEM, of two energies of photons of 6 MV and 18 MV.

2) Mini water tank MP3-P (water phantom): The phantom used in this work is a cubic tank with a length of 60 cm.

2) Cylindrical ionization chambers: TM31010 Semiflex chamber of 0.125 cm^3

3) PTW electrometer: The collected charge (or intensity) produced in an ionization chamber is extremely low, its measurement requires a very sensitive device called electrometer.

4) Medical Physics Control Center MEPHYSTO mc²: MEPHYSTO is a software for the acquisition of therapeutic beam data and data analysis in radiotherapy.

3. Results and comparison with TPS calculations

The measurements of PDD have carried out and compared to (TPS) calculation for 6MV and 18 MV photons beam, using the 0,125cm^3 ionization chamber, for chosen treatment field dimensions are, in general, the most used for treatment by linear accelerator.

Result for 6MV Photon Beam

Results of PDD measurement and their comparison with TPS calculations are given in figure 1 for different treatments field dimensions, and a SSD = 100 cm.

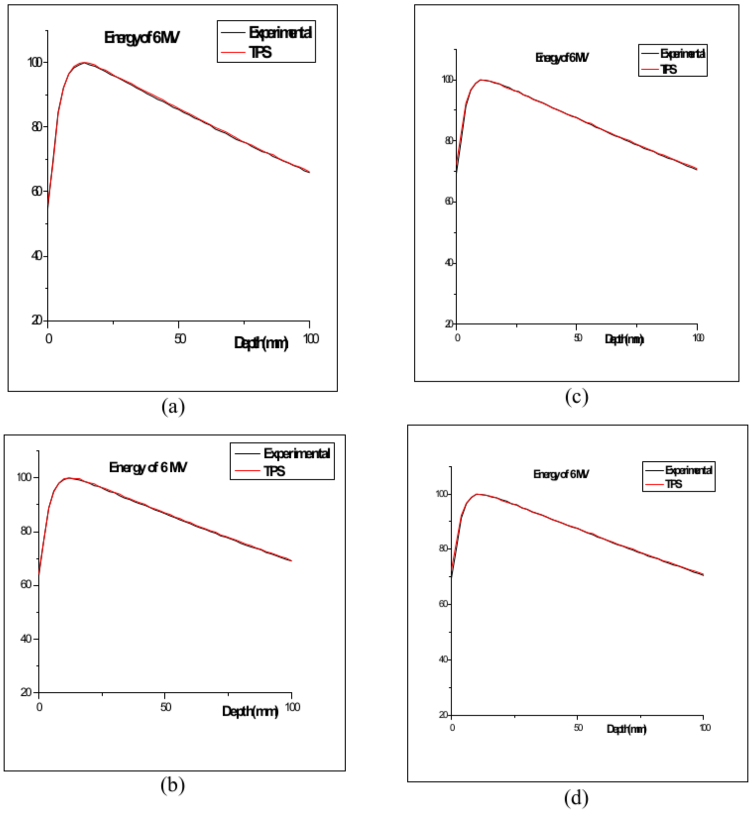

Fig.1. comparison of measured and calculated results of percentage depth dose curves of the 6MV photon beam. Fig. (a) is for field size 10 cm × 10 cm, (b) is for 20 cm × 20 cm.(c) is for 30 cm × 30 cm , (d) is for 40 cm × 40 cm.

Results for 18MV Photon Beam

The same measurement beam carried out with the same ionization chamber 0,125cm^3 and for the same treatments field dimensions for 18 MV energy.

Results of PDD measurement and their comparison with TPS calculations are given in figure 2 for different treatments field dimensions, and a SSD = 100 cm.

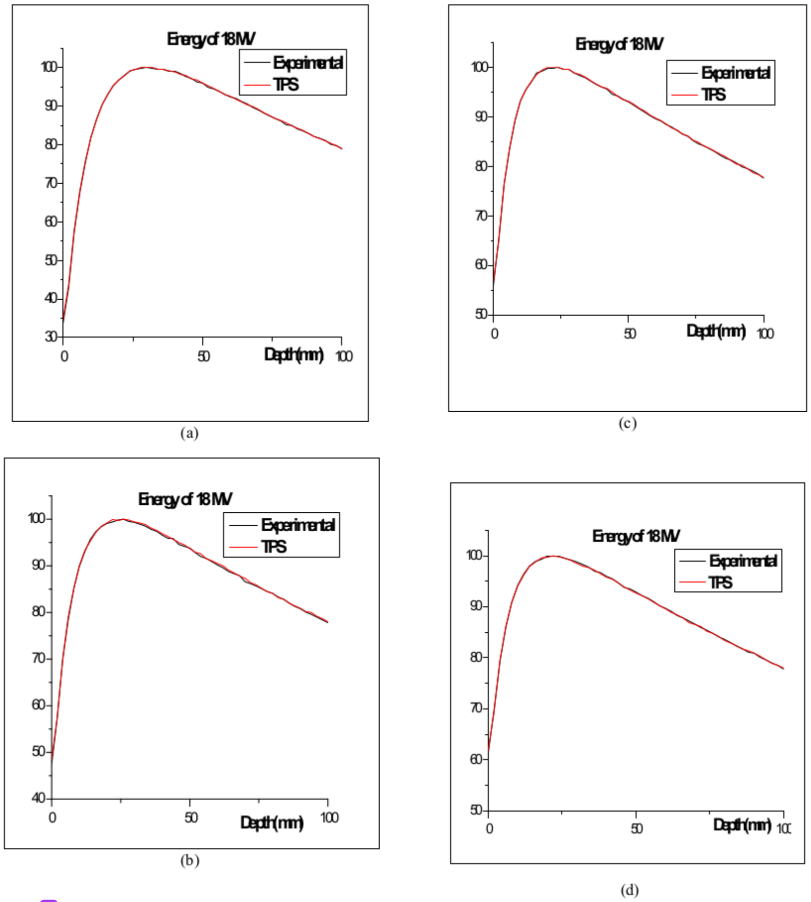

Fig.2. comparison of measured and calculated results of percentage depth dose curves of the 18 MV photon beam. Fig. (a) is for field size 10 cm × 10 cm, (b) is for 20 cm × 20 cm.(c) is for 30 cm × 30 cm , (d) is for 40 cm × 40 cm.

Figure 1 and figure 2 show that the measured PDD are in concordance with results given by TPS calculation.

4. Conclusion

In this work, we performed a general quality control, based on the depth dose measurement (PDD) by ionization chamber (PTW 0.125 cm^3) and we compare the results of the measurements depth dose with the results calculated by TPS.

The difference between measured and calculated results for the two energies is of the range of 0.2% for the 6MV photons beam, and it is of 0.7% for the 18 MV photons beam, which is inferior the limit of 2% recommended by (IAEA).

The obtained results of measured PDD for the two energies 6 MV and 18 MV and for different treatments field dimensions are comparable to those given by TPS calculations. This comparison show that the quality of linear accelerator at Nouakchott Center of Radiotherapy is good and assure the conditions of different medical interventions in this Center.

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