British Journal of Medicine & Medical Research

22(2): 1-8, 2017; Article no.BJMMR.33918
ISSN: 2231-0614, NLM ID: 101570965

Preliminary Results of Quality Control for Linear Accelerator at Oncology Center in Nouakchott

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2017/33918
Editor(s):
(1) Georgios A. Androutsopoulos, Department of Obstetrics-Gynecology, School of Medicine, University of Patras, Rion, Greece.
Reviewers:
(1) Kanwardeep Kaur, Baba Farid University of Health Sciences Faridkot, India.
(2) Ravindra Shende, Rajiv Gandhi Cancer Institute & Research Centre, India.
(3) Hui Jiang, The Second people's Hospital of Neijiang, Southwest Medical University, China.
Complete Peer review History: http://www.sciencedomain.org/review-history/19459

Original Research Article

Received 3rd May 2017
Accepted 30th May 2017
Published 10th June 2017

ABSTRACT

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 basic dosimetric data required for quality of operation, in the clinical routine of the accelerator for photon beams are percentage depth dose (PDD) curves and beam profile (BP) curves.
The aim of this work is to measure the percentage depth dose (PDD) and beam/dose profile (BP) for 6 MV and 18 MV photon beams for different field sizes and for different Skin-Source-Distance (SSD), and to compare the measured results with the results calculated by Treatment Planning Systems (TPS).
The measured results of (PDD) and (BF) are consistent with those calculated by TPS, which

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allows us to conclude that the linear accelerator at oncology Center in Nouakchott is in good condition.
Other Parameters: (energy, (SSD) and field sizes) have been also studied in this work, in order to perform a comprehensive quality study for this accelerator a unique oncology at Mauritania.

Keywords: (PDD) and (BP); (TPS); energy of 6 MV and 18 MV; (SSD); field sizes.

1. INTRODUCTION

The use of nuclear techniques are in speed extend in medical field in Africa.

The National Center of Oncology (CNO) at Nouakchott is equipped with equipment and skilled personnel able to work on sophisticated medical devices.

In addition, the Center 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 [1-3].

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 and dose profile) in water phantom by an ionization chamber for different energies and field sizes and at different Skin- Source-Distance (SSD).

To compare the measured results we have calculated the same parameters 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 [6-8].

2. MATERIALS AND METHODS

Measurements of percentage depth dose and dose profile 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 dosietric measurements were realized using an ionization chamber associated with an electrometer and the chamber used for acquisition can move in three directions [9,10].

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 (Fig. 1,(a)).
2) Mini water tank MP3-P (water phantom): The phantom used in this work is a cubic tank with a length of 60cm (Fig. 1,(b)).
2) Cylindrical ionization chambers: TM31010 Semiflex chamber of 0.125 cm^3 (Fig. 1,(c)).
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 (Fig. 1,(d)).
4) Medical Physics Control Center MEPHYSTO mc²: MEPHYSTO is a software for the acquisition of therapeutic beam data and data analysis in radiotherapy (Fig. 1,(e)).

2.1 Measures and their Comparisons with TPS Calculation

We have measured the percentage depth dose and dose profile, with ionization chamber, and we have compared measures and calculations for 6MV and 18 MV photon beams.

3. RESULTS AND DISCUSSION SECTION

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).

Linear accelerator CLINAC 2100DHX

(a)

water phantom

(b)

ionization chamber

0,125 cm^3

(c)

PTW Elecrometer

(d)

Thermometer Barometer

(e)

Fig. 1. The devices used in this work

Fig. 2 gives a comparison of measured and TPS calculated percentage depth dose curves of the 6 MV photon beam for different field sizes; the Skin-Source-Distance (SSD) is taken as 100 cm.

Fig. 3 gives a comparison of measurements and calculated results by TPS of percentage depth dose curves of the 18 MV photon beam for different field sizes; the Skin-Source-Distance (SSD) is taken as 100 cm.

Fig. 4 shows a comparison of measurements and results calculated by TPS of beam profiles curves of the 6 MV photon beam for different field sizes; the Skin-Source-Distance (SSD) is taken as 100 cm.

Fig. 5 gives a comparison of measurements and results calculated by TPS of beam profiles curves of the 18 MV photon beam for different field sizes; the Skin-Source-Distance (SSD) is taken as 100 cm.

Figs. 2,3,4,5 show a compliance between the measured results and calculated by (TPS) for percentage depth dose and dose profiles for 6MV and 18 MV.

We have observed in the previous figures (the percentage depth dose curves and the dose profiles curves) that the results obtained agree with the results calculated by TPS.

3.1 Influence of Energy

Furthermore we have studied the variation of the percentage depth dose as a function of the energy at a depth=10 cm, a (SSD)=100 cm, and a field size of (10 * 10) cm^2

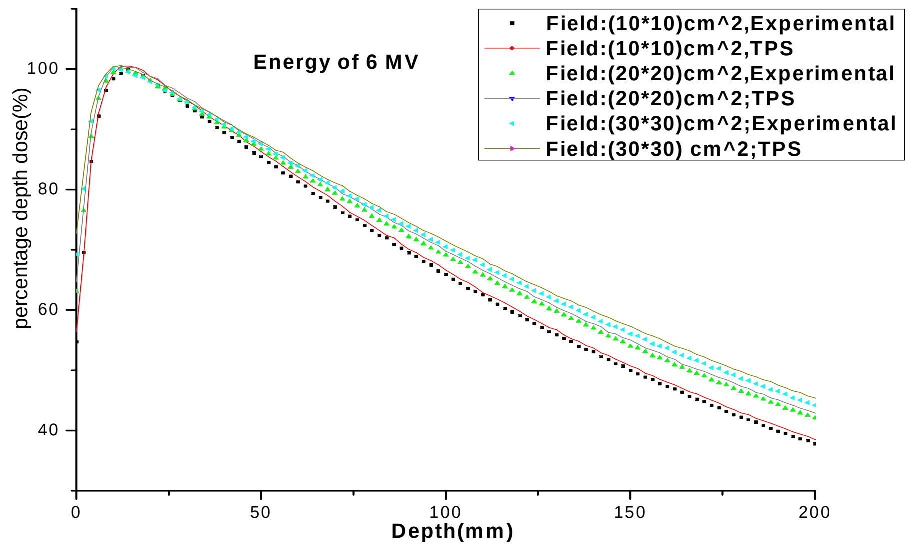

Fig. 2. Comparison of measured and calculated results of percentage depth dose curves of the 6 MV photon beam for different field sizes

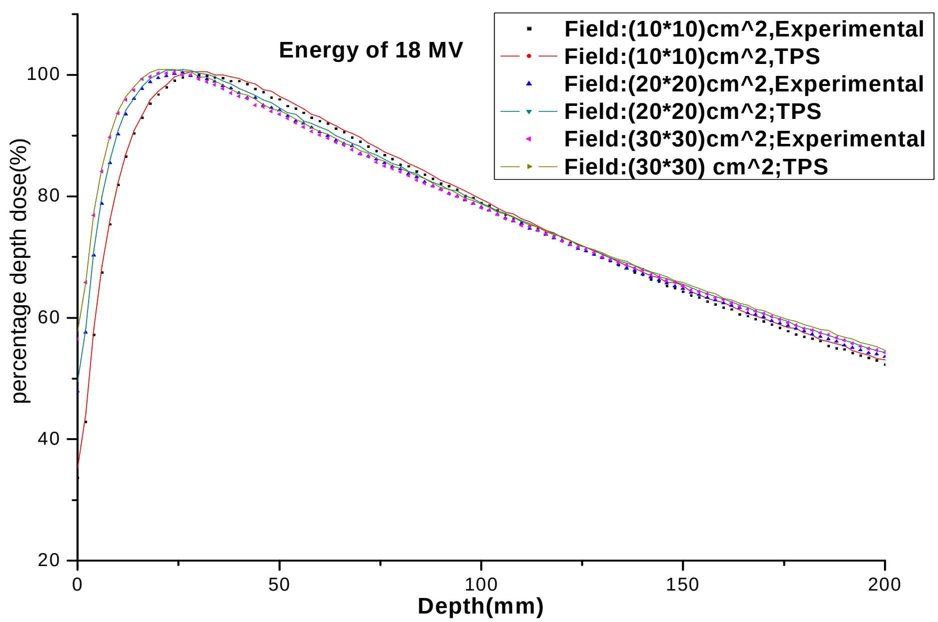

Fig. 3. Comparison of measured and calculated results of percentage depth dose curves of the 18 MV photon beam for different field sizes

We found in the first zone (Beuil-up zone) that the percentage depth dose for the energy of 6 MV is higher than the percentage depth dose for the energy of 18 MV, whereas in the last zone the efficiency depth for the energy of 18 MV is higher than the percentage depth dose for the energy of 6 MV. In the first zone, the effect is due to the scattered photons, whereas in the second zone the attenuation is less rapid.

Fig. 7 shows the variation of the dose profile as a function of the energy at a depth= 10 cm, a (SSD)=100 cm and a field size of (10 * 10) cm^2.

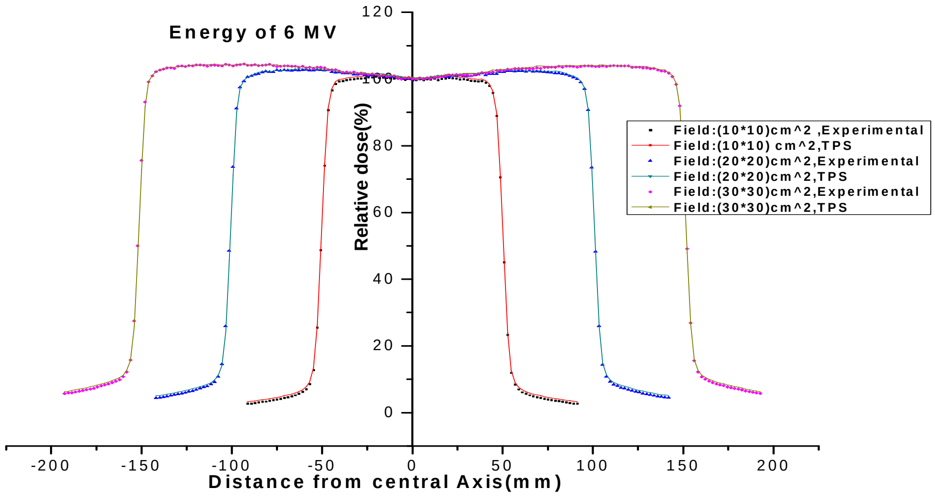

Fig. 4. Comparison of measured and calculated results of beam profiles of the 6 MV photon beam for different field sizes

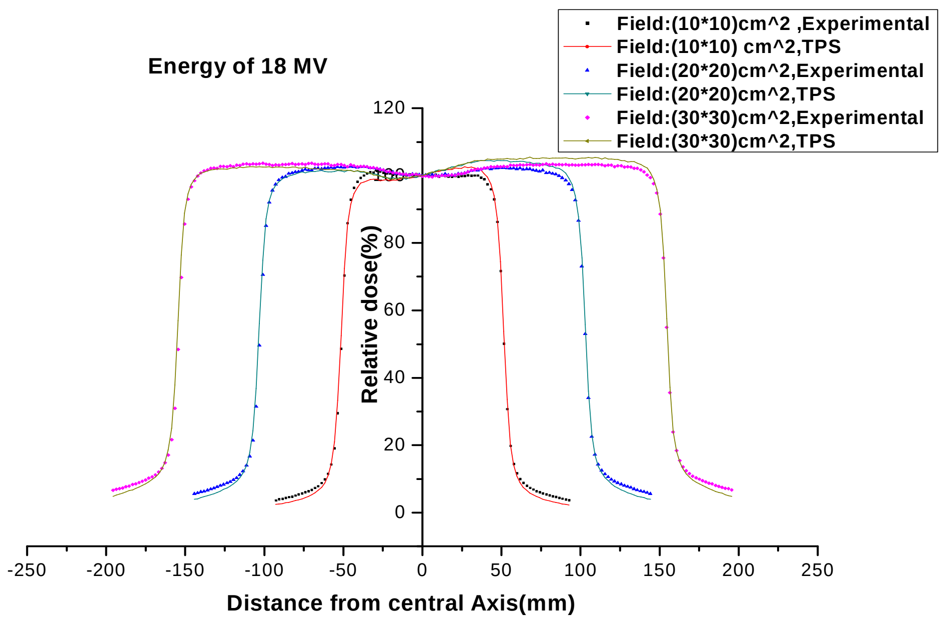

Fig. 5. Comparison of measured and calculated results of beam profiles of the 18 MV photon beam for different field sizes

A low difference is observed in the tails of the curves of the dose profiles.

The larger the field size, the more the scattering volume increases, causing an increase in the dose on the axis at all depths. As the proportion of scattered radiation is greater at depth, the increase in the dose is faster at depth than near the surface, and the percentage depth dose increases with the beam field size. It is found that this variation is greater if, energy of the beam is low.

3.2 Influence of the (SSD)

Fig. 8 shows the variation of the percentage depth dose as a function of the (SSD) for a photon beam of 6 MV and a field size of (10 * 10) cm^2:

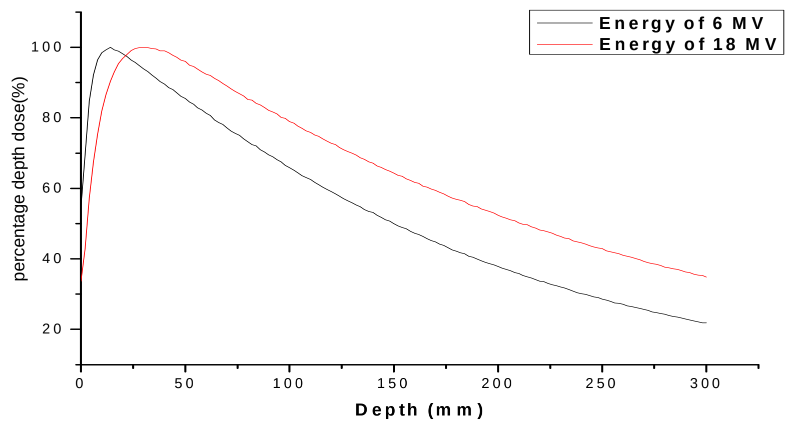

Fig. 6. Variation of percentage depth dose curve as a function of energy

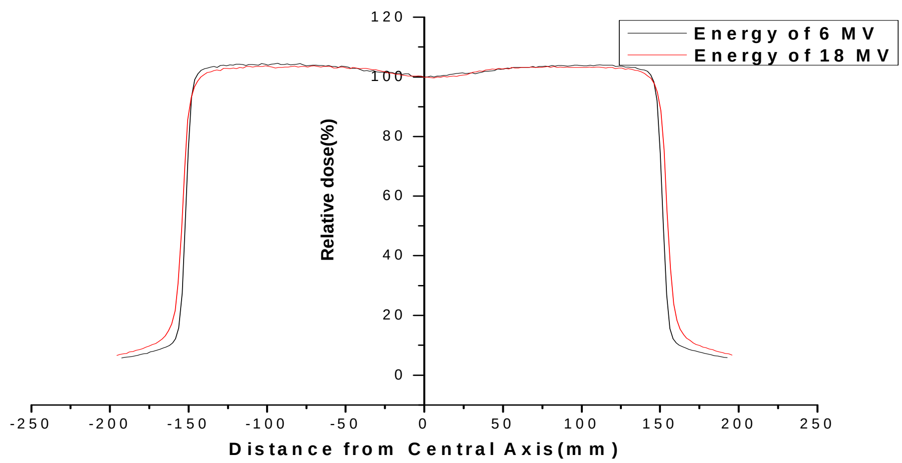

Fig. 7. Variation of the dose profile as a function of the energy

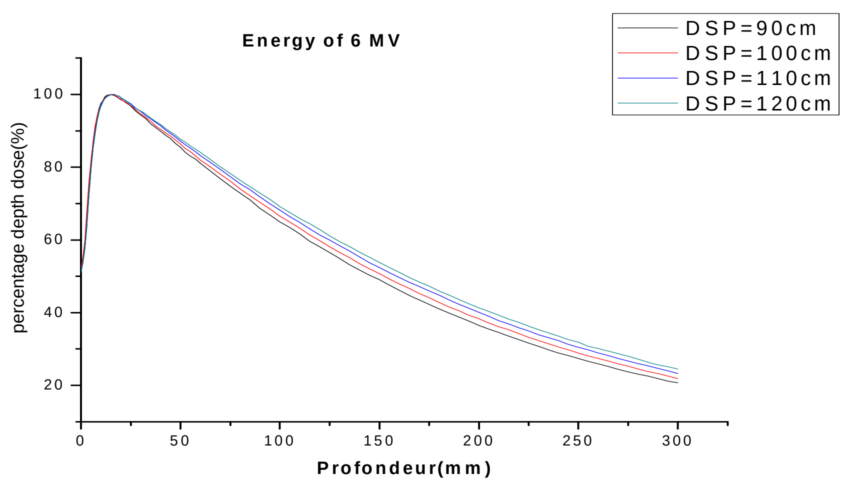

Fig. 8. Variation of percentage depth dose curves as a function of (SSD), for a 6 MV photon beam

The distance from the source to the input surface governs the geometric dispersion conditions of the beam. The (SSD) thus plays an important role in the percentage depth dose. When the (SSD) decreases, the maximum dose approaches the surface and its value increases.

4. CONCLUSION

In this work we carried out a study on the quality control of the linear accelerator located at the National Center of Oncology of Nouakchott.

This control is based on to measure and to calculate the percentage depth dose (PDD) and beam/dose profile (BP) for 6 MV and 18 MV photon beams for different field sizes and for different SSD (Skin-Source-Distance), and to compare the measured results with the results calculated by Treatment Planning Systems (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 0.7% for the 18 MV photons beam, which is inferior the limit of 2% recommended by (IAEA),which show that our measures are consistent with calculation (TPS).

The obtained results show that the percentage depth dose decreases as the energy of the photons increases, the greater the energy of the photon beam, the longer the path of the secondary electrons, in other words the depth of the maximum dose increases with energy.

We have also found that the percentage depth dose increases with the energy of the photon beam for a depth after the maximum dose depth, and that also the increase in field size increases the dose at depth.

We have observed that if the skin source distance (SSD) decreases, the maximum dose approaches the surface, and its value increases while the percentage depth dose decreases.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mawenn Le Roy. Study of national dosimetric standards for external beam radiotherapy: Application to conformal irradiations. University of Nice Sophia-Antipolis; 2012.
2. Léone Blazy-aubignac. Quality control of the treatment planning systems dose calculations in external radiation therapy using the penelope monte-carlo code. University of Toulouse III – Paul Sabatier; 2007.
3. Jean Claude Rosenwald, Laurent Bonvalet, Jocelyne Mazurier, Christine Métayer. Recommandations pour la mise en service et l'utilisation d'un système de planification de traitement en radiothérapie (TPS). RAPPORT SFPM. 2010;27.
4. George X. Ding. Energy spectra, angular spread, fluence profiles and dose distributions of 6 and 18 MV photon beams: results of Monte Carlo simulations for a Varian 2100EX accelerator. Phys. Med. Biol. 2002;47:1025–1046.
5. James A. Purdy. Buildup/surface dose and exit dose measurements for 6MV linear accelerator. Medical Physics. 1986;13: 259-262.
6. Mark J. Engler, Gary L. Jones. Small beam calibration by 0.6 and 0.2 cm3 ionization chambers. Medical Physics. 1984;11:822-826.
7. Villani N, Gérard K, Marchesi V, Huger S, François P, Noël A. Statistical process control applied to intensity modulated radiotherapy pretreatment controls with portal dosimetry. Cancer/ Radiothérapie. 2010;14:189–197.
8. Charles W. Coffey II, Larry Beach J, Donald J. Thompson, Marta Mendiondo. Xray beam characteristics of the varian clinac 6100 linear accelerator. Medical Pysics. 1980;7:716-722.

9. McKerracher C, Thwaites DI. Assessment of new small-field detectors against standard-field detectors for practical stereotactic beam data acquisition. Phys. Med. Biol. 1999;44:2143–2160.

10. Krithivas G, Rao SN. A study of the characteristics of radiation contaminants within a clinically useful photon beam. Medical Physics. 1985;12: 764-768.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/19459