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Short Communication

Dosimetric verification of calculation and measurements in radiotherapy using IMRT phantom

Aysun Inal[1,2] and Iskender Akkurt[2]*

[1]Antalya Medical Park Hastanesi, Radyasyon Onkolojisi bölümü, Antalya, Turkey.
[2]Department of Physics, Faculty of Science, Suleyman Demirel University, Isparta, Turkey.

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The main aim in radiotherapy is maximizing radiation dose into cancer cell and protecting health tissue around this cancer. Nowadays, with the development of technology the treatment of tumor becomes possible by small field size. This new technique, so called IMRT (Intensity Modulated Radiation Therapy) requires dosimetric confirmation. One of the most important things to be controlled is planned fields and treated fields in the treatment which it's especially, small field size and using multi field. The other important point is dose values according to calculated time in treatment planned unit and measured time in device.

Key words: Radiotherapy, IMRT, dosimetry.

INTRODUCTION

Cancer which is one of the most important death reason besides heart attach, can be described as the deformation on the genetic structure of the cell and its increasing, no uniformly and uncontrolled and thus, becomes hazardous around health cells. In radiotherapy, which is the most common treatment way of this disease, it is possible to kill the cancer cell. On the other hand, while giving the maximum dose to cancer cell dose should be minimized on the health cell around cancer. Moreover, the creation of the secondary neutron dose is also important to depends on the given photon beam energy (Akkurt, 2003). A number of studies have been performed on the photoneutron evaluation from LINAC. Hashemi et al. (2007) has performed a work to investigate the photoneutron spectrum and dose equivalent produced by an 18 MV Saturne linac at different points of a treatment room and its maze using the MCNP4C code. Hsu et al. (2008) has attempted to obtain both photon and neutron dose distribution using dual TLD method.

Dose distribution of cancer cell can be varied with the energy and also field size, dose angle and physical properties of the device. Nowadays, Intensity Modulated Radiation Therapy (IMRT) which is an advanced mode of high-precision radiotherapy that utilizes computer-controlled linear accelerators (LINAC) to deliver precise radiation doses to a malignant tumor is the most commonly used treatment method. Here, it is possible to control whether the treatment (dose value, treated field) is correct. In the literature there are some work performed for dose verification in radiotherapy treatment. Lee et al. (2008) has developed a system to verify dose in radiotherapy radiation. Daniel et al. (1998) has experimentally determined the accuracy of dose calculation and delivery of a commercial serial tomotherapy treatment planning and delivery system.

Stathakis et al. (2009) has investigated the ability of commissioning a flattening filter free photon beam in a commercial treatment planning system (TPS) and seek to verify the model through delivery of IMRT treatment plans using a 6 and 18 MV photon beam. Steven et al. (2007) performed a work for IMRT dosimetry Verification using portal Vision Images and dosimetry check. Wiezorek et al. (2009) has performed a work to quantify the relative peripheral photon doses (PD) to healthy tissues outside the treated region for different IMRT technologies and linear accelerators.

In this study the confirmation of dose values and

*Corresponding author. E-mail: iskender@fef.sdu.edu.tr.

Abbreviations: IMRT, Intensity modulated radiation therapy; **PET,** pozitron emisyon tomografi; **CT,** computer tomograph.

Figure 1. A typical measurement with the phantom.

planned field using IMRT phantom is presented.

In this study, the confirmation of dose values and planned field using IMRT phantom which was also used in previous studies (Steven et al., 2007; Daniel et al., 2008; Stathakis et al., 2009; Wiezorek et al., 2009) will be done.

MATERIALS AND METHODS

In this study, 0.625 mm thickness of total 369 field have been used in GE model PET (Pozitron Emisyon Tomografi) – CT (Computer Tomograph) devices using Scanditronix model IMRT phantom. A picture from devices can be seen in Figure 1. Before fields have been taken 0.65 cc ion cham-ber was located inside of the phantom. Each field has been sent online via DICOM into Precise Plan model treatment planned system. Ion chamber positions were drawn for all fields. The isosentric (constant source, ion chamber distance) plan has been made for 7 different fields each have 6 x 6 cm size at 6 and 18 MV. A total dose of 100 cGy has been given for each field for the same period at 6 MV (24 MU). Dose value for each field has been calculated at this period. Those were also done for 18 MV.

Transverse fields has taken planned system has been imaged 3D. For each field described in the system DRR images has been created. Those images have been sent to Elekta model digital imagine system (iview) in order to get digital image. IMRT phantom has been placed to be irradiated by Elekta model synergy. LINAC Source ion chamber has been designed and digital images have been taken for each field by digital images system. Taken images has been compared with the DRR images and variations from X, Y and Z axis has been obtained. The dose has been obtained as cGy by ion chamber placed into phantom. The same procedure applied for 18 MV photons.

RESULTS

The dosimetric verification of calculation and measure-ment has been performed using IMRT phantom in radiotherapy.

Planned field and DRR-iview images have been compared on the Portal images devices and it can be possible to find out and correct irradiated field and variation value. The maximum of 1.27% variation has been found between calculated and measured dose. Although, those values are within the limits before IMRT technique applied that this value should be kept within 1% in radiotherapy. In comparisons, the highest variation has been obtained on 12 mm Y axis for total fields. Before, measurement necessary tuning has been done. The measured results have been tabulated in Table 1 for 6 and 18 MV, respectively. Those are also displayed in Figures 2 and 3 for 6 and 18 MV, respectively. It can be seen from these figures that, the correlations are well between dose values. It can also be seen from this figure that the correlation between measurement and calcu-lation has been found as R2=0.9758 for 6MV photons and 0.975 for 18 MV photons.

DISCUSSION

It is clearly seen from the figures that, the comparison of the DRR images created in the treatment planning sys-tem with the iview images obtained during the irradiation process is important criteria for the estimation of the interested fields to be irradiated. Using IMRT method is also feasible technique to verify dose given to the patient during the treatment.

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Table 1. Calculated and measured dose obtained from 6 and 18 MV photons.

		18 MV photons		6 MV photons	
Field	**Irradiation angle**	**Calculated dose (cGy)**	**Measured dose (cGy)**	**Calculated dose (cGy)**	**Measured dose (cGy)**
Front	0	17	17,450	19	19,180
Right	270	13	13,460	12	12,500
Left	90	13	12,700	12	12,400
Right-front oblic	300	14	14,160	14	14,190
Right-back oblic	230	14	14,240	14	13,830
Left-front oblic	50	15	15,350	15	15,600
Left-back oblic	120	14	13,930	14	13,580
total dose		100	101,290	100	101,070

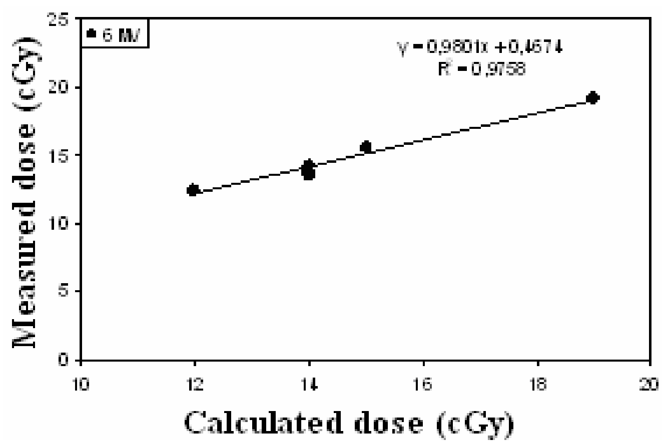

Figure 2. Correlation between calculated and measured dose obtained from 6 MV photons.

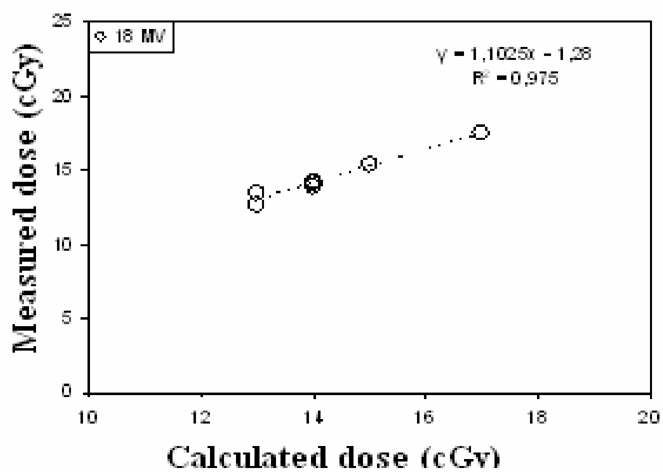

Figure 3. Correlation between calculated and measured dose obtained from 18 MV photons.

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