Influence of detector specific correction factors in dose distributions for small photon beams

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Introduction

The problems related to the dosimetry of small photon radiotherapy beams are highlighted in the literature (Das 2008). To perform the dosimetry of such beams, the detectors employed with more frequency are silicon diodes. Nerveless, these detectors over-respond in non-equilibrium conditions. For that reason, it is necessary to apply correction factors according with the new formalism for small photon beam dosimetry. Particularly, the interest of this work is the application of the correction factors to depth and off-axis dose curves. The goal of this work was to assess the influence of theses correction factors in clinical dose distributions.

Material and Methods

This study was divided in three steps: i) the collection of dosimetric data for circular collimators using a silicon diode (model SFD, IBA-Dosimetry, Germany), ii) the Monte Carlo calculation of depth and off-axis correction factors, and iii) the incorporation of the commissioning data sets into the planning system (iPlan RT 4.1, Brain-LAB, Germany). The dosimetric measurements were performed in a Novalis® linac (BranLAB, Germany) with nominal energy of 6 MV. For calculating of correction factors the Monte Carlo codes used were DOSXYZnrc and DOSRZnrC. The parameters used for the simulation Novalis were: 6.1 Mev monoenergetic with a circular symmetric Gaussian FWHM for 1.5 mm. The correction factors were calculated based in formalism proposed by Alfonso et al, and Francescon et al. to the total scatter factors (TSF), tissue phanom-ratios (TPR) and off-axis ratios (OAR). Finally, a clinical treatment plan was simulated based on an arbitrary patient head. The calculated dose distributions in the treatment planning system was compared and analyzed as following: a) measured data sets and Monte Carlo calculations, b) dose distributions analysis with and without corrections factors and finally c) monitor unit (MU) analysis.

Results

The correction factors calculated in this work show a similar behavior to those reported in the literature, a quantitative comparison was not possible because there are no data reported for the accelerator and detector used in this work. The comparison of measured data sets and Monte Carlo calculations was done by an analysis of percentage differences for TSF and TPR. Particularly for OAR, a gamma index 1D analysis was made and a full width at half maximum (FWHM), the 80%–20% penumbrae and 90%–10% beam penumbrae comparison. All results of these data sets show no significant differences. For dose distributions, the gamma index analysis criteria employed 1%/1mm, 1%/3mm, 1%/5mm, 2%/2mm, 2%/3mm and 3%/3 mm. In all case except in 1%/1mm, the gamma index analysis show that 100% of the points meet the established criteria. Finally, the results of MU show a percentage difference up to 6%. The UM analysis shown the biggest differences found in this study.

Conclusions

The new formalism for small photon beam established the necessary correct the response with a detector specific beam correction factors. In this work, evaluation of the influence of theses correction factors in dose distribution was performed. The biggest percentage difference was to MU. The rest of the analysis show no significant differences for the calculation dose distributions with and without correction factors. Therefore, these results suggest that the correction factors have influence on the TSF.

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