Implementation of an algorithm for absorbed dose calculation in high energy photon beams at off axis points

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Abstract

A semiempirical algorithm for absorbed dose calculation at off-axis points in irregular beams was implemented.

It is well known that semiempirical methods are very useful because of their easy implementation and its helpfulness in dose calculation in the clinic. These methods can be used as independent tools for dosimetric calculation in many applications of quality assurance. However, the applicability of such methods has some limitations, even in homogeneous media, specially at off axis points, near beam fringes or outside the beam. Only methods derived from tissue-air-ratio (TAR) or scatter-maximum-ratio (SMR) have been devised for those situations, many years ago. Despite there have been improvements for these manual methods, like the Sc-Sp ones, no attempt has been made to extend their usage at off axis points.

In this work, a semiempirical formalism was introduced, based on the works of Venselaar *et al*. (1999) and Sanz *et al*. (2004), aimed to the Sc-Sp separation. This new formalism relies on the separation of primary and secondary components of the beam although in a relative way. The data required by the algorithm are reduced to a minimal, allowing for experimental easy. According to modern recommendations, reference measurements in water phantom are performed at 10 cm depth, keeping away electron contamination. Air measurements are done using a miniphantom instead of the old equilibrium caps. Finally, the calculation at off-axis points are done using data measured on the central beam axis; but correcting the results with the introduction of a measured function which depends on the location of the off axis point. The measurements for testing the algorithm were performed in our Siemens MXE linear accelerator.

The algorithm was used to determine specific dose profiles for a great number of different beam configurations, and the results were compared with direct measurements to validate the accuracy of the algorithm. Additionally, the results were compared with calculations of the commercial TPS Win PLT 3D ®, which uses the convolution-superposition technique for dose determination.

The results of comparing profiles were evaluated quantitatively using the gamma index method.

The comparison among profiles when validating the algorithm showed excellent concordance: the gamma-index was lesser than 1, indicating an agreement to within 2%-3 mm.

Comparisons with the treatment planning system were also very accurate. For this case, monitor units were calculated for different conditions, in all cases the percentage difference being less than 1 %.

The proposed algorithm showed to be easy for implementation, with a great predictable capacity, being therefore a useful tool for routine dosimetry

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and quality assurance in radiotherapy. Even though, this work only considered irregular fields formed by cerrobend blocks. However, the introduction of other beam modifiers can be done easily. Furthermore the algorithm could be used in multileaf collimators as well.

KEYWORDS: Semiempirical method, off-axis, quality assurance, treatment planning system (TPS).

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