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Methods of Parameterization of the Output Factor for Electron Therapy Fields

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Background, Motivation and Objective. The most common type of cancer is the non-melanoma skin, with lesions varying in depth and extent. Generally, its treatment is done with electron therapy, in which the fields of electron irradiation are defined by blocks of cerrobend (a metal alloy equivalent to 83% of lead density) that are made according to the shape and extent of the lesion. With the use of this block, it is necessary to add a correction factor to the dose calculation. This factor is called the output factor (F_{output}) and is determined as a function of the treatment field and the energy of the electron. The dosimetry of each block to be used delays the beginning of the patient's treatment and this difficulty can be solved if $F_{outputs}$ were previously obtained for several field energies and sizes (AKINO *et al*, 2015; JURSINIC and MUELLER, 1997; GAJEWSKI, 2009; CHOI *et al*, 2003). In this way, the objective of this work is to determine the $F_{outputs}$ of several fields, using ionization chamber and radiochromic films and the sectoral integration method, which takes into account the variation of the electron fluence in the lateral scattering equilibrium and in the scattering that occurs by the edges of the blocks.

Methods. The dosimetry of 16 cerrobend blocks (Figure 1) coupled to the 6x6 cm^2 applicator for three electron beam energies of a Varian Clinac 2100 linear accelerator (Palo Alto, CA, USA) was done. First, the dose percentages in the depth (DPD), with an ionization chamber, for each block/energy combination, at the source-surface distance (SSD) of 100 cm, were measured to find the maximum dose depth (d_{max}). At this point, the values of output (dose at a certain point of the phantom) were obtained with the chamber (inside a water phantom) and with radiochromic films (between solid water plates), as can be seen in Figure 2. After irradiation, the $F_{outputs}$ were obtained by the ratio between the readings for each block by the readings of the reference block (6x6 cm^2), in the respective d_{max}. The reliability of the results obtained for the rectangular blocks was verified by a study of the recommendations for electron beam dosimetry (Gerbi *et al*, 2009) through the equation $F_{output} = \sqrt{(\text{Output X} * \text{Output Y})}$, where the output X and output Y are reference values of the square blocks. From this dosimetry, we intend to obtain the parameterization of the output factor for larger fields with the sectorial integration method: the area of each block will be divided into 16 equally spaced areas from the center of the field and, from the average of the factors output of the 16 areas, the F_{output} of the block is obtained.

Results. The $F_{outputs}$ obtained with the radiochromic films and the ionization chamber were similar, and, because of this, the films are shown as an alternative for the measurement of the F_{output} for electrons. Figure 3 shows the output factors for the square blocks with radiocromatic film and the ionization chamber. Comparing the $F_{outputs}$ (obtained with the detector and calculated using the TG 25 equation), it was observed that the results presented an error of ± 5%, which is acceptable for the dosimetry of blocks according to the recommendations of TG 25 (Gerbi *et al*, 2009). Likewise, the other blocks presented the same tendency of the results. In this way, the dosimetry was considered acceptable. As the F_{output} are correct, calculations will be performed by the sectorial

integration method, to have another method of parameterizing results. The calculated $F_{outputs}$ will be analyzed and compared to the $F_{outputs}$ measured by the ionization chamber and by the radiochromic film, in order to verify the reliability of the results.

Discussion and Conclusions. Due to the proximity of the results obtained with films and ionization chamber, the films are shown as an alternative for the measurement of the F_{output} for electrons. By obtaining these output factors, we can match the F_{output} of these regular fields with irregular fields of nearby areas. Having parameterization of the output factor by three methods, we have greater validation of the results and it is possible to streamline the planning process in the radiotherapy service.

Figure 1: Cerrobend blocks made with various fields for the cone 6x6cm²

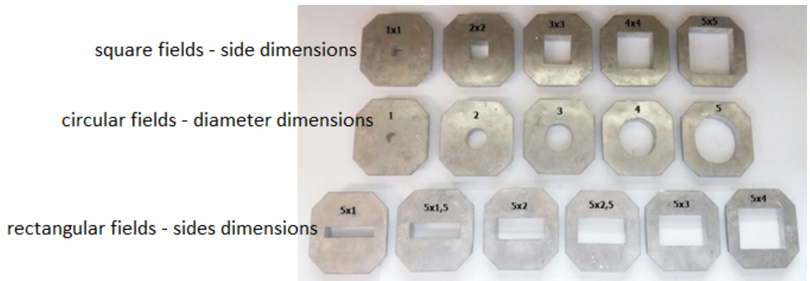


Figure 2: A) Ionization chamber in a water phantom, B) Radiochromic films in solid water plates.

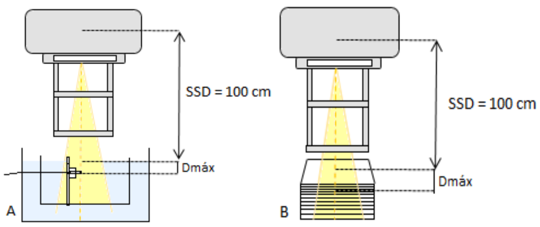
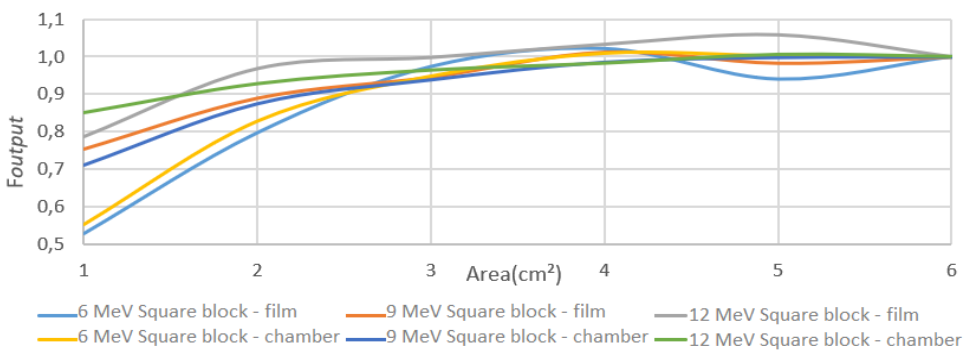


Figure 3: F_{output} with radiochromic film and ionization chamber for square blocks



Keywords. Output factor; dosimetry; electrotherapy; radiochromic film; sector integration method.

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