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VERIFICATION OF DOSES IN ELECTRON BEAM RADIOTHERAPY

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ABSTRACT

Entrance doses measured in 50 patients treated by electron beams were compared with planned values as the percentage difference between the given dose and its planned value. Electron beams of energy 6, 9, 12, 15, 18 and 22 MeV were generated by the Clinac 2300 C/D linear accelerator (Varian). Semiconductor EDE-5 diodes connected to a DPD-510 (Scanditronix) electrometer were applied for entrance dose measurements. In our investigations, the mean values of doses administered agreed well with the values of planned doses. The observed relatively large discrepancies in a few patients (up to 12%) should be carefully investigated.

INTRODUCTION

A good agreement between the dose delivered to the patient and its planned value is one of the basic conditions of efficient radiotherapy. The aim of this paper is to present our preliminary results of *in vivo* measurements of the entrance dose for electron beams of energies ranging between 6 MeV and 22 MeV. Methods of direct dose measurements of γ-ray and X-ray beams are well established and used in clinical practice in a number of oncological centres (Adeyemi and Lord, 1997; Heukelom et al., 1991; Maniakowski et al., 1995; Rikner and Grusell, 1987). On the other hand, we have not found in the literature any appropriate method applicable to electron beams. For this reason, we put to trial the method of *in vivo* dosimetry for electron beams. The method of direct dose measurements presented in our earlier work (Orlef et al., 1998) is patterned upon the well-known and checked method for γ ^{60}Co and X-ray beams. Therefore, appropriate calibration and correction factors for electron beams have been determined. It turns out that the number of correction factors which have to be taken into account is greater than that in the case of photon beams.

MATERIAL

The applied electron beams of energy 6, 9, 12, 15, 18 and 22 MeV were generated by a Varian linear accelerator - Clinac 2300 C/D. A set of five EDE-5 p-type semiconductor diodes was used together with a Scanditronix DPD-510 electrometer. For calibration of the diodes, a 0,6 cm^3 thimble ionization chamber (type NE 2571) and tissue equivalent material phantom composed of 30 cm x 30 cm slabs were employed.

METHOD

Diodes were calibrated in the tissue equivalent material phantom. Each diode was placed on the surface of the phantom with its base perpendicular to the central axis of the beam. The calibrated ionization chamber giving the absolute value of the dose in water was inserted at the depth of the maximum dose rate d_{max} (i.e. at 1,5 cm for electron beams of 6 MeV, 2 cm for electrons of 9 MeV and 3 cm for electron beams of 12, 15, 18 and 22 MeV).

The calibration factor was expressed by the following formula:

$$F_{en} = D_{i.ch}/R_{DPD,en} , \qquad (1)$$

where $D_{i.ch}$ is the dose determined with the ionization chamber at the depth d_{max}, and $R_{DPD,en}$ is the response of the semiconductor detector placed on the phantom surface. From the practical point of view, the calibration has been carried out for the chosen irradiation conditions - called standard conditions. In our studies the standard conditions were as follows:
- field size S = 10 cm x 10 cm,
- SSD = 100 cm,
- temperature of the phantom surface during the calibration,

- angle between the central axis of the beam and the normal to the base of the detector $\varphi = 0^{\circ}$.

The calibration factor for other conditions can be expressed as a product of the calibration factor under standard conditions $F_{en,st}$ and appropriate correction factors:

$$F_{en} = F_{en,st}\,\Pi C_i . \qquad (2)$$

The entrance dose can be calculated from the following formula:

$$D_{en} = R_{DPD}\,F_{en,st}\,\Pi C_i ,$$

where R_{DPD} is the response of the semiconductor detector placed on the patient's skin at the central axis of the beam. The other details of our procedure can be found in our earlier work (Orlef et al., 1998).

RESULTS

Results of our direct entrance dose measurements are shown in figure 1.They are presented in the form of a histogram of percentage differences between the measured and planned entrance doses.

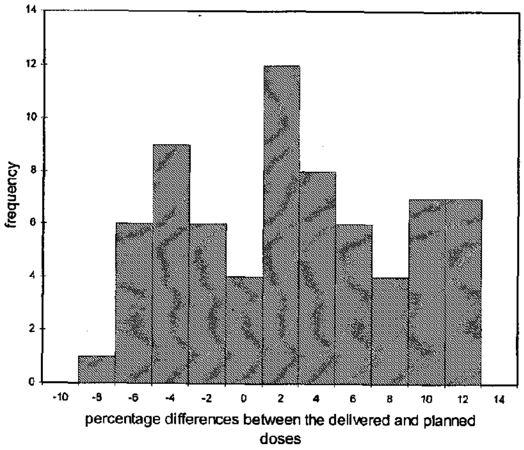

Figure 1. Results of in vivo dose measurements for electron beams.

Measurements of the entrance dose (N=70) were performed in 50 patients. The average percentage difference between the measured dose and the planned one was 1.7 %. The standard deviation was 5.7 %. The mean given dose is seen to be in good agreement with the planned one. However, relatively large discrepancies for individual patients (up to 12%) can be observed. One of the reasons for this may be due to the algorithm for treatment time calculation used in the treatment planning system. This problem is under study.

CONCLUSION

According to our preliminary results the mean value of the given dose agrees well with the value of the planned dose. The observed relatively large discrepances from patient to patient (up to 12%) should be carefully analyzed, and will be under further investigations.

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