PERIPHERAL DOSE MEASUREMENT FOR 6 MV PHOTON BEAM

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Abstract: The objective of this study is to measure the peripheral dose (PD) at different depths and field sizes using film dosimetry. PD of 6 MV Siemens Primus linear accelerator photon beam for 10 cm square field and 2.5 cm diameter cone were measured at 1.5 cm and 10 cm depth, 100 cm source surface distance (SSD) with Kodak EDR2 film. PD for 10 cm square field and 2.5 cm cone were measured for the distance 1 cm to 5 cm from the geometric field edge. PD was calculated as a percentage of the central axis dose. The PD for both field sizes decreased with increasing distance from the beam edge. PD was also larger for 10 cm square field compared to 2.5 cm circular field for both depths. At 10 cm depth, the measured PD was 20% and 10% higher compared to that of 1.5 cm depth for 10 cm and 2.5 cm field size respectively. The PD for a given beam energy is a function of distance from the beam edge, field size and depth. At any depth measured, PD increases as the field size increases due to radiation scattered from the beam and scatter arising from within the medium. At deeper depth, more Compton electrons are produced and scattered to the peripheral region hence causes the PD to increase with depth. At any field size measured, peripheral dose increases as the depth increases. PD also increases as the field size increases.

***Keywords**: Peripheral dose, EDR2 film*

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I. INTRODUCTION

Peripheral dose (PD) is the radiation dose received at points beyond the collimated radiotherapy field edge. In order to ensure that radiosensitive structures outside the treatment field do not receive doses approaching their tolerance levels, extensive knowledge of the magnitude and spatial distribution of the PD may be necessary [1].

Sources contributing to the total PD include the photon leakage from the treatment head of the machine, the scatter from the collimators and beam modifiers, and radiation scattered within the treatment volume [2].

Commercial treatment planning systems (TPS) should not be used to evaluate the risk of secondary cancer since they do not provide accurate modeling of peripheral dose. Differences up to 70% between TPS and Monte Carlo calculated PD was observed [3]. Another study shows that the TPS underestimated the PD by 28% to 40% as the distance from the treatment field increased and this underestimation was greater at shallow depths than at deeper depths. [4]

PD received by radiosensitive structures, such as eye lens, contralateral breast, thyroid gland, ovaries, testes, and fetus, located outside the boundaries of the primary radiation field is of clinical interest and may lead to secondary health issues [5]. Second primary malignancies occurring after radio-oncologic treatment have become a major concern during the past decade. With major improvement of long-term survival, longer follow-up, cancer registries and end-result programs, it was found that the cumulative incidence of second primary malignancies could be as high as 20% of patient treated with radiotherapy [6].

Kodak EDR2 film is relatively insensitive to x-ray energy selection, easy to process, and field size and depth had little effect on the calibration curve [7].

The objective of this study is to measure the peripheral dose at different depths and field sizes using Kodak EDR2 film.

II. MATERIALS AND METHODS

All irradiations were performed by using 6MV photon beam of the Siemens Primus linear accelerator (linac) in the 30 x 30 x 20 cm^3 solid water phantom. The linac is equipped with multi-leaf collimator. The output of the linear accelerator was calibrated using IAEA TRS-398 protocol in water phantom [8].

A. Film Calibration

Kodak EDR2 films taken from the same batch were irradiated by 6 MV photon beam in the 30 x 30 x 20 cm^3 solid water phantom at the centre of 10 x 10 cm^2 field size at depth of dose maximum (1.5 cm) with source to surface distance (SSD) of 100 cm. Calibration was carried out in perpendicular geometry for doses ranging from 25 cGy to 500 cGy. An unexposed film was developed for background reading. The dependence of the EDR2 film on depth and field size was checked. All films were processed and analyzed with Vidar Dosimetry Pro Advantage film scanner.

B. Measurement of Peripheral Dose

The peripheral dose (PD) was calculated as the percentage of dose at any depth and distance from the beam edge for a given field size to the dose in the central axis at 1.5 cm depth for the same field size. PD was measured using EDR2 film for distance 1 cm to 5 cm from the geometric field edge for 10 x 10 cm^2 field and 2.5 cm circular field at both 1.5 cm and 10 cm depths. All measurements were corrected for film depth and field size dependence.

III. RESULTS AND DISCUSSION

At any depth measured, PD increases as the field size increases due to the increased intensity of the primary photon beam. Higher intensity of the primary beam contributes to higher scattered radiation. The increment is higher for the distance closer to the beam edge and is due to the scatter within the phantom from the treatment beam [2].

Table 1 shows the measured peripheral dose for 10cm square field and 2.5 cm circular cone at different depths.

Field size	10 cm x 10 cm		2.5 cm	
Distance from beam edge (cm)	1.5 cm depth	10 cm depth	1.5 cm depth	10 cm depth
1	5.69	6.58	1.13	1.52
2	3.67	4.63	0.25	0.74
3	2.58	3.58	0.2	0.35
4	1.99	2.67	0.19	0.23
5	1.57	2.03	0.21	0.22

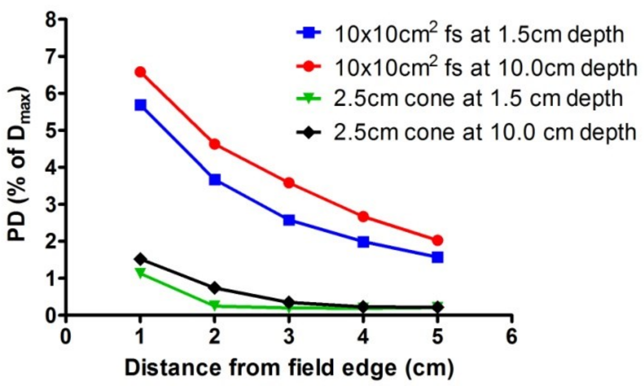

Figure 1. The measured peripheral dose for 1.5 cm and 10 cm depth for 10 cm square field and 2.5 cm circular cone.

Although the PD for both field size increases as the depth increases, the change is not as significant as the changes with field size. At deeper depth, internal (phantom) scatter dominates; causing the PD to increase with depth [9].

IV. CONCLUSION

The peripheral dose for a given beam energy is strongly dependent on distance from the beam edge, field size and depth. The measured PDs for both field sizes and for both depths decrease approximately exponentially with distance from the field edge. At any depth measured, PD increases with increasing field size. The PD also increases as the depth increases for any field size.

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