Small-Field Dosimetry in A 6 MV Photon Beam Using Alanine and Liquid Ionisation Chamber - DTU Orbit (01/04/2019)

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Purpose/Objective: Dosimetry of small field sizes in MV photon beams is an increasingly important subject, and a generally accepted guideline for clinical measurements is still lacking. The present comparative study was carried out to further investigate the use of alanine and the PTW microLion ionisation chamber for small-field dosimetry in liquid water.

Materials and Methods: The measurements were carried out on a Siemens Primus 58 leaves MLC. The alanine dosimeters were cylindric Ø4.9 mm × 3.0 mm and density of 1.2 g/cm3. The alanine dosimeters were placed on the top of a solid water stick of Ø4.9 mm × 88 mm. The stick was held vertically in a PTW MP3 water tank. A latex sleeve of Ø5 mm was used to protect the dosimeter from the water. Measurements were carried of at four depths, 0.2, 15, 100 and 200 mm. The distance from the target to the water surface was 100 cm in all experiments. In addition, the measurements were carried out at seven symmetric field sizes with the length of the field edges at the water surface: 0.8, 1.0, 1.4, 2.0, 3.0, 4.0 and 10.0 cm. As a minimum three dosimeters were irradiated to 2500 MU in each configuration. The dosimeters were placed in the dose maximum of each field and depth. This dose maximum was measured for each field using a Scanditronix Wellhöfer photon field diode. The same measurements were carried out using a liquid ionchamber, PTW microLion, irradiated by 500 MU. The output of the accelerator was controlled by a PTW semiflex ion chamber placed in the radiation head of the accelerator. The calibration of the accelerator output provides 1.0 Gy for 100 MU at dose maximum. The alanine dosimeters were measured with an EMXmicro EPR spectrometer. Measurement parameters were: modulation amplitude 10G, conversion time 41 ms, time constant 82 ms, 2 times 4 sweeps with a 90° turn in between, total measurement time was 3 minutes per dosimeter. The alanine dosimetry system was calibrated using a Co60 gamma cell ensuring traceability to a national standard.

Results: The results are summarized in Table 1. At depths below 2 mm, we noted a systematic deviation between the two systems with field size. At 10x10cm, the deviations were insignificant (mean 1.01+/0.01), but at 0.8 x 0.8 cm2, the deviation was as large 10% (mean 0.90+/0.02). At 2 mm depth, the data seemed to be subject to more variability than can be expected from the readout procedures.

Conclusions: The study confirms the difficulty related with small dosimetry and the importance of detector choice (material and size) and positioning procedure. No corrections for volume averaging and spatial sensitivity of the EPR spectrometer over the volume of alanine dosimeter were applied, and this may explain part of the measured deviations. A practical difference between the two systems was that the alanine measurements were much more time consuming than the liquid ionization chamber measurements.

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