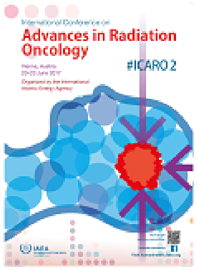

Contribution ID: **85** Type: **Poster**

Measurement of the percentage dose at surface with radiochromic films

Thursday 22 June 2017 10:30 (5 minutes)

Introduction

The measurement of the dose on the surface of a patient in radiotherapy treatments is a useful parameter for a quality assurance protocol. The surface dose can be associated to the skin dose, or entrance dose depending on the depth at which the measurement is done. The very high gradient of the percentage depth dose makes difficult to define the point of measurement for any detector. The radiochromic films (RF) are an alternative instrument to measure the dose at the surface. They are 2D detectors commonly used for quality assurance of intensity modulated radiotherapy treatments (IMRT). They are near tissue equivalent and they do not need post irradiation chemical process. Particularly, Gafchromic EBT3 has shown radiation particle independence as limited energy and dose rate independence. In this work the percentage of the dose at the surface was measured of the beam of a linear accelerator (LINAC) Novalis (BrainLab, Germany) with nominal energy of 6MV. Three different field sizes were used, two conventional (10cm×10cm, 5cm×5cm) and one considered nonconventional (1cm×1cm).

Material and methods

The measurement of the percentage dose at the surface was done indirectly with the following process, firstly the total scatter factors (TSF) were measured of the 3 different field sizes at 5cm depth of a water scanning phantom(MP3-XS PTW, Freiburg, Germany). The detectors used were in this part were two kind of ionization chambers, a semiflex of 0.125cm^3 (PTW, Freiburg, Germany) and a microionization chamber CC01 of 0.01cm^3 (IBA-Dosimetry, Germany). The daisy-chain method was used for the non conventional field size. The measure was done at source surface distance (SSD) of 100cm. The corrections according IAEA's 398 calibration protocol were applied to the chambers.
Secondly, we determined if the EBT3 Gafchromic are energy independent, measurements at three different depths (1.5, 5, 10 cm) of a solid water phantom (CIRS, Inc) were done for a field size of 10cm×10cm. The doses used were in a range from 0.5 to 10Gy and they were verified with the semiflex chamber. The RF was handled according to the manufacturer specifications and the AAPM TG55 recommendations. The RF were digitized with a scanner in transmission mode with the three color components and 16 bit depth. The images were stored in TIFF format. To analyze them the optical densities (defined as $OD=\log_{10}(I/I_0)$) was obtained and only the red component was used.
Finally, measurements at the surface for different doses with the RF were done. The doses were in the range of 0 to 6Gy for the three different field sizes. The same procedure of film analysis was applied. To calculate the percentage of the dose at the surface the dose measured at the surface was normalized with the LINAC output at 5cm depth and the TSF previously measured. The uncertainty is the standard deviation of the values.

Results

The value of the TSF measured for the field sizes of 10cm×10cm, 5cm×5cm and 1cm×1cm are 1±0.1%, 0.978±0.05%, and 0.779±1.87% respectively. They are compared with MonteCarlo simulations and the differences for the field sizes of 5cm×5cm and 1cm×1cm are 0.06% and 1.4% respectively.
Regarding the independence of the EBT3 with beam energy, the average of differences between the 5cm depth curve are 1.7% for the 1.5cm depth and 1.8% for the 10cm depth. The 5cm depth curve is taken as reference because is the calibration depth for the LINAC. In particular, for the 2Gy point the differences are 0.42% for the 1.5cm depth and 1.00% for the 10cm depth.

Finally the values of the percentage of the dose at the surface (PDS) normalized at 5cm depth are presented in the next table

$FieldSize (cm \times cm)$	10×10	5×5	1×1
PDS	26.1±1.3	21.3±2.4	20.2±2.6

It is also founded that for low doses (lower than 0.5Gy) the RF are less precise (differences up to 88% were founded). As it was expected the uncertainties increases as the field sizes diminishes. It is important to emphasize that the percentage doses founded here are at 135μm of depth, because this is the depth of the active layer of the EBT3 RF.

Conclusions

The EBT3 RF are suitable detectors for surface measurements. They are also a good candidates to use clinically because in common therapeutic doses they show an acceptable uncertainty. This study is part of an in vivo dosimetry protocol for a radiotherapy facility. Further studies need to be done to determine if EBT3 are good detectors to do in vivo dosimetry and design a protocol based in this detectors.

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Session Classification: Thursday morning - Poster Presentations - Screen4