PD-0405

Determination of reference levels for quality assurance of flattening filter free beams

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Purpose/Objective: New definitions for some dosimetric parameters for use in quality assurance of flattening filter free (FFF) beams generated by medical linear accelerators have been suggested. The present study aims to validate these suggestions and to propose possible reference levels.

Materials and Methods: The main characteristics of FFF photon beams were described in terms of: field size, penumbra, unflatness, slope and peak-position parameters. Data were collected for 6 and 10 MV-FFF beams from three different Varian TrueBeam linacs, and a Varian Clinac iX upgraded to FFF capability for its 6 MV. Measurements were performed with a 2D-array (Starcheck system from PTW-Freiburg), with a linear array (LA48 system from PTW-Freiburg) and with the portal dosimetry method GLAaS utilizing the build-in portal imager of TrueBeam.

Results: All the parameters suggested to characterize the FFF beams were measured and evaluated Little variation was observed among the different linacs. Referring to two reference field sizes of 10x10 and 20x20cm^2, at SDD=100cm and d=d_{max}, from the portal imaging data converted into dose map with the GLAaS method, the following results were obtained, averaged on X and Y profiles. Field size: 9.95±0.02 cm and 19.98±0.03 cm (including allenergies. Penumbra: 2.7±0.3 mm and 2.9±0.3 mm for 6MV-FFF; 3.1±0.2 mmand 3.3±0.3 for 10MV-FFF. Unflatness: 1.11±0.01 and 1.25±0.01 for 6MV-FFF; 1.21±0.01 and1.50±0.01 for 10MV-FFF. Slope: 0.320±0.020 %/mm and 0.43±0.015 %/mm for 6MV-FFF; 0.657±0.023%/mm and 0.795±0.017 %/mm for 10MV-FFF. Peak Position: -0.2±0.2 mm and -0.4±0.2 mm for 6MV-FFF; -0.3±0.2 mm and 0.7±0.3 mmfor 10MV-FFF. Results would depend upon measurement depth.
With thresholds set to at least 95% confidence level from the measured data, and to account for possible variations between detectors and methods and experimental settings, a tolerance set of: 1 mm for field size and penumbra, 0.04 for unflatness, 0.1 %/mm for slope and 1 mm for peak position could be proposed from our data.

Conclusions: The parameters proposed to characterize the FFF profiles (in particular the unflatness, the slope and the peak position) appear to be a viable solution for routine checks, also presenting strong similarity to the conventional parameters used for flattened beams. The results from three different TrueBeams and a Clinac-iX suggested the robustness of the methods and the possibility to use general tolerances for the parameters. The data suggested also the reproducibility of beam characteristics among different systems (of the same vendor) and could therefore be possibly generalized.

PD-0406

Three-point method for IMRT verification with radiochromic film dosimetry without previous calibration

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Purpose/Objective: A new method for IMRT verification with EBT3 has been developed, avoiding the need of a previous calibration. Performing a single scan gives the possibility to obtain results in less than one hour and avoids environmental and interscan variability. We have developed a method to evaluate measurements of two-dimensional dose distributions following the protocol described by Lewis et al, without the need of a previous calibration curve.

Materials and Methods: Based on the results showed by Lewis et al,we have selected a rational function for the fit of the response curve which requires a minimum of three points. For this reason we need one film for measuring an IMRT plan and two reference films: one exposed to a known dose (20 % of the maximum dose expected from IMRT) and one unexposed.
For IMRT QA, the film was placed inside an RW3 phantom and irradiated by all fields of the treatment plan.
A third point is needed to obtain the response curve. We selected an interest point from the IMRT plan on our TPS, with a dose in the range of about 50% of the maximum dose expected, and a low gradient,in order to have three good choices covering the whole clinical range.
Once we have chosen the third point, an empirical measurement is performed with the same conditions as the IMRT, with a cylindrical ionization chamber instead of the film. With this measurement, we are able to choose an ROI on IMRT film which corresponds to this point, and associate this measure dose to a signal value. Therefore, we have three points and we can fit the data response curve to a rational function.

Results: An uncertainty analysis on the selection of the third point has been carried out and the response curve obtained with this method has been compared with the one obtained by DavidLewis et al. (Figure1)

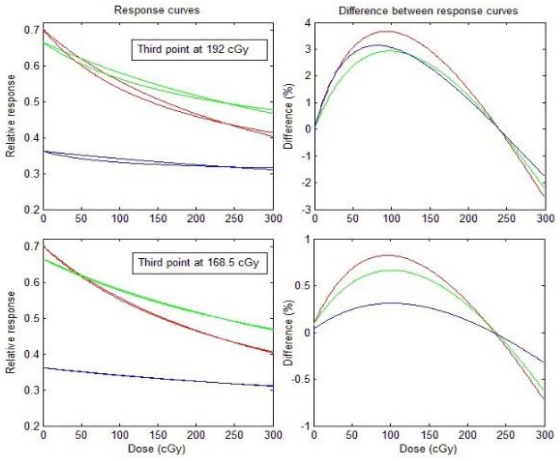

Figure 1: Response curve analysis using triple-channel dosimetry method

In a typical IMRT case, head and neck, with a maximum dose of 200 cGy,the election of the third point about 192 cGy produces a difference between the two response curves around 3.8 %. However, if the third point is selected with a dose about 165 cGy (close to the dose distribution´s mode), the difference is below 0.8 % in the worst case. This election will also minimize the difference between the dose maps in a more effective way than for a point close to the maximum.
Three different clinical cases have been used to compare this method with the one which needs generic calibration curve and two points rescale (MLX method). The results are given in Table 1.

		Gamma criteria		
		Global 2% 2 mm	Global 1% 2 mm	Local 2% 2 mm
Case 1	MLX method	98.17	95.95	95.82
	3point method	97.33	94.5	94.7
Case 2	MLX method	93,98	90,82	89,64
	3point method	94,82	92,36	90,61
Case 3	MLX method	97,88	96,79	94,92
	3point method	95,71	95,02	92,51

TABLE 1

Conclusions: According to the uncertainty analysis, it can be concluded that the choice of the third point is essential. We can actually obtain a good fit with three points, with differences below 0.8%. Moreover, setting the third point close to the mode of the dose distribution assures better agreement between the two methods.
The proposed calibration method avoids the need of a previous response curve and two point rescale. The results of a 2%, 2mm gamma analysis are similar for both methods. Thus, an individual, fast and reliable valid calibration is obtained for each IMRT treatment.

PD-0407

Improving safety in radiotherapy: The implementation of the Global Risk Analysis method

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