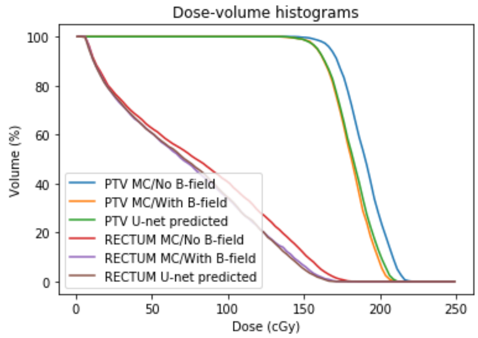

Conclusion

Even with a limited number of patients, a CNN can be quickly trained to accurately determine the magnetic field corrections on the dose distributions for the target volume of IMRT prostate treatments. In the lower dose regions, additional effort is still required. The ease and speed of training indicates that training patient-specific CNNs before treatment starts is also an option.

EP-1792 Straightforward and easy way to determine MLC parameters (DLG, T) for FFF beams in Eclipse TPS

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Purpose or Objective

In order to perform dose calculations for dynamic techniques in Eclipse TPS (Varian) user has to set MLC parameters: Dosimetric Leaf Gap (DLG) and MLC Transmission (T). The values of DLG and T are usually obtained in trial and error process minimizing the difference between measurements and calculations in TPS [1]. Alternatively we propose to use gradient optimization method.

Material and Methods

Chair shape plans were prepared for 6FFF and 10FFF beams for two SSD/depth setups (90/10cm and 95/5cm). Dynamic MLC pattern calculated on the basis of optimal fluence was saved. Measurements, corrected for beam stability, were done in water phantom with Semiflex Chamber (PTW 31010) on two TrueBeam machines. The chair shape dose distribution was divided into 9 regions (Fig. 1). The cost function F was defined as $F=\Sigma_i w_i(D_c-D_m)^2$, with i number of evaluated points, w - point priority, D_m - measured dose, $D_c=D_c(DLG,T)$ - calculated dose being a function of DLG and T. Starting values for optimization were taken from sweeping gap measurements recommended by Varian to determine DLG and T values. F was calculated for 9 points surrounding starting value and grad$F$ was calculated in both directions leading to a next iteration direction and step. Procedure was repeated until the global minimum was found. Priorities w were chosen arbitrarily (Fig. 1). Regions B, C and H in which the T has the higher role were given priority 3. Region A with higher DLG influence was given priority 9. Regions D, E and F for which both DLG and T have impact were given priority 2. Regions G and I with week T impact get priority 1. Priorities used at both setups were the same. For each recalculation of dose distribution in TPS the same MLC pattern was used. Verification of optimized value of DLG and T was performed by comparing measured and calculated dose for sweeping gap performed with dynamic MLC (width: 0.2-20.0 mm). Pretreatment verifications for ten clinical IMRT/VMAT plans were performed as well. We used Octavius device with PTW729, EPID and measurement done with ionization chamber in water and solid phantom.

6FFF			10FFF		
A Priority: 9 90cm: -0.2% 95cm: 0.1%	B Priority: 3 90cm: 0.9% 95cm: 2.6%	C Priority: 3 90cm: -2.3% 95cm: 0.4%	A Priority: 9 90cm: -0.2% 95cm: 0.2%	B Priority: 3 90cm: 1.6% 95cm: 2.9%	C Priority: 3 90cm: -2,3% 95cm: -0.6%
D Priority: 2 90cm: 0.0% 95cm: 0.1%	E Priority: 2 90cm: -0.1% 95cm: -0,3%	F Priority: 2 90cm: -0.2% 95cm: -0.2%	D Priority: 2 90cm: -0,4% 95cm: -0.1%	E Priority: 2 90cm: -0.4% 95cm: -0,2%	F Priority: 2 90cm: 0.0% 95cm: 0.3%
G Priority: 1 90cm: 0.5% 95cm: 0.5%	H Priority: 3 90cm: 0.3% 95cm: -0,8%	I Priority: 1 90cm: 0.8% 95cm: 0.9%	G Priority: 1 90cm: 0.2% 95cm: 0.5%	H Priority: 3 90cm: 1.4% 95cm: 1.4%	I Priority: 1 90cm: 1.0% 95cm: 1.4%

Figure 1. Chair shape test divided into regions. Agreement between measurements and TPS calculations for 6FFF (left) and 10FFF (right) for two setups and optimal DLG and T are shown. Comparisons were done for points located in the center of each region.

Results

The shape of quadratic cost function used in optimization procedure can be seen in Fig 2. The optimal values of DLG and T were: 0.75mm and 1.35% for 6FFF, 0.90mm and 1.60% for 10FFF beam. For chair pattern the greatest difference between measurement and TPS are obtained for regions strongly influenced by T (up to 2.6% for 6FFF, 2.9% for 10FFF). Dose difference between measurement and TPS for sweeping gap fields was not greater than 0.3%. Results of pretreatment verification for all clinical plans passed our institution QA criteria.

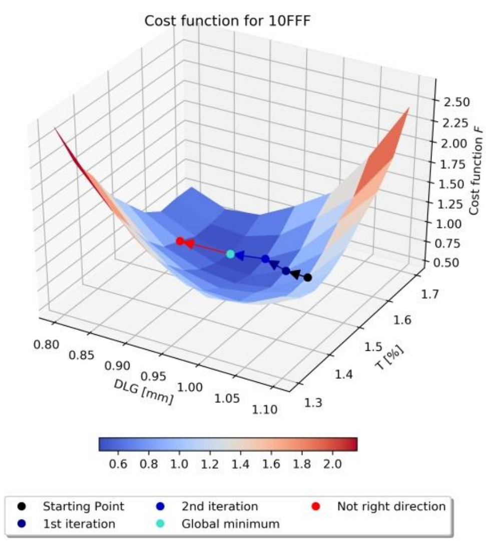

Figure 2. Shape of cost function. Starting point and points achieved in 3 following iterations are shown. Arrows indicate steps of iteration. The red dot is showing the next iteration step which would lead to a greater cost function and therefore was neglected.

Conclusion

Proposed method of DLG and T determination is straightforward, easy, low time consuming and leads to a very good agreement between calculations and measurements confirmed in independent verification. The same methodology can be used for WFF beams.

[1] Van Esch et al., Radiotherapy and Oncology 65 (2002), 53-70

EP-1793 Verification and Measurement of the Tongue and Groove Effect in an Electronic Portal Imaging Device

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Purpose or Objective

Varian's Portal Dosimetry prediction algorithm was recently updated to improve the re-sampling of the fluence in the portal dose calculation algorithm (PDC). From version 13.5, the fluence resolution used in PDC inherits the dose calculation resolution used in AAA. Recently, the asynchronous sweeping gap (aSG) tests were introduced [1] to test the Tongue and Groove (TG) effect in the TPS with dynamic beams. The goal of this study is twofold: On one hand to perform a measurement of the TG effect with the EPID and on the other hand to study how the resolution used in AAA affects the agreement of the PDC with measurement.

Material and Methods

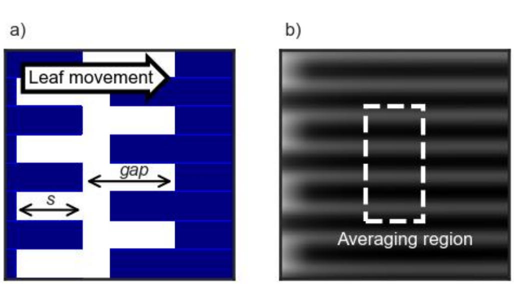
The aSG tests consist in different sweeping gaps where adjacent leafs are shifted a given amount *s*(see Figure 1a). When *s*=0, the standard sweeping gap test is recovered.

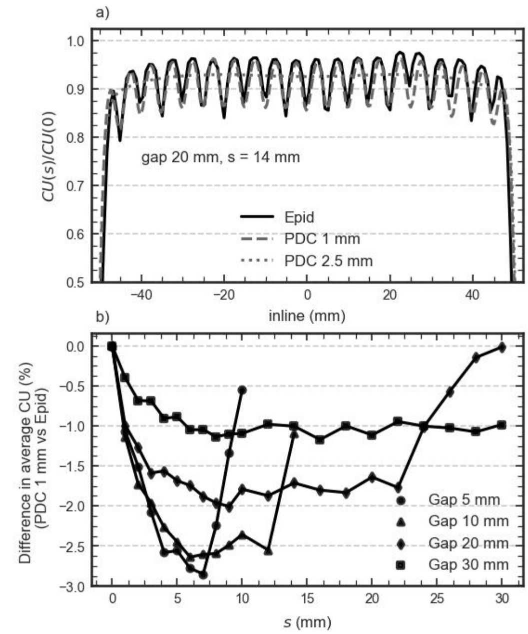
We tested version 13.6 of the algorithms (PDC & AAA) with a Millennium MLC. First, we calculated the aSG tests in a water phantom in isocentric conditions for two resolutions: 2.5 and 1 mm. From the AAA calculation, verification plans were generated with the PDC algorithm (Fig1b shows the predicted planar dose for a 20 mm gap and s=14 mm). The predicted planar dose distributions were exported and analyzed externally with an in-house software in MatLab that parsed the information contained in the *.dxf files and calculated an average central value (see Fig1b) for each gap and leaf side *s*. In order to isolate the TG effect, for each *gap*, the ratio of dose for a given *s* to *s*=0 was obtained. This ratio also allows to compare AAA with PDC despite the different dose units (Gy and CU).

Finally, the tests were irradiated on an aS500 EPID. The measured planar distributions were also exported for analysis and to obtain average values to compare with the PDC prediction.

Results

The largest difference due to TG between PDC and AAA was <0.5% regardless of the gap and dose resolution used. The predicted portal dose distributions with the 1 mm resolution exhibited excellent spatial agreement with the EPID measurements as shown in Fig2a. However, the average values obtained with the PDC algorithm overestimated the dose reduction due to the TG effect (see Fig2b). In particular, for the 1 mm-generated PDC the largest relative difference is -2.6%, while for the 2.5 mm-generated PDC the largest difference is -1.6% in both cases for the 10 mm gap and *s*=6mm. The overestimation of the average TG effect is particularly significant within the first 10 mm of *s*regardless of the gap and uncovers the fine details of the leaf tip model.





Conclusion

The TG model of the MLC as used in AAA was adequately transferred to the fluence used in the PDC algorithm regardless of the resolution used. The response of the EPID captures the TG effect that causes a dose reduction for increasing *s*in the aSG tests. The agreement between PDC and EPID is excellent for a 1 mm dose resolution. PDC would thus benefit from always using a 1 mm fluence resolution regardless of the resolution used in AAA.

[1] Phys Med Biol 62;2017:6688–6707

EP-1794 Bias-free comparison of PTW arrays in terms of ability to detect clinically significant MLC errors

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Purpose or Objective

There are several types of pre-treatment verification QA devices with different types of detectors, resolution and design. Woon et al. (2018) and Saito et al. (2018) used the method of introducing known errors into the RT plans in order to analyze the sensitivity of various gamma index passing rates using different types of detectors with different resolution.To the best of our knowledge there is no work comparing three types of PTW arrays (Octavius: 729, 1500, 1000SRS). The aim of our study was to test ability of these arrays to detect clinically significant MLC errors.

Material and Methods

We used 40 clinical plans (10 plans for each: brain, prostate, head & neck, gynecology) in the analysis. MLC errors: gap width (both banks moved in opposite direction) and shift error (both banks moved in the same direction) were introduced for all plans. Magnitudes of errors were 0.5 - 3.0 mm. Dose distributions were recalculated in patients' CT and Octavius 4D phantom (diameter 32cm) was used to create verification plans for all analyzed plans. Dose distributions were calculated in Eclipse (13.6.23 AAA, Varian). In order to get the bias-free comparison Python script was used to change the TPS dose distribution into the artificial measurement file mimicking the real measurement. So created artificial measurements