IMRT pre-treatment verification using EBT3 film and FilmQA Pro software

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Purpose

The purpose of this study was to investigate the accuracy of the new Gafchromic EBT3 film[1] in combination with FilmQA Pro software[1]. Gafchromic EBT3 film has only been commercially available since the end of 2011, and is the successor of EBT1 and EBT2. This study was carried out with a view to implementing this technique in our clinic for pre-treatment verification of prostate IMRT

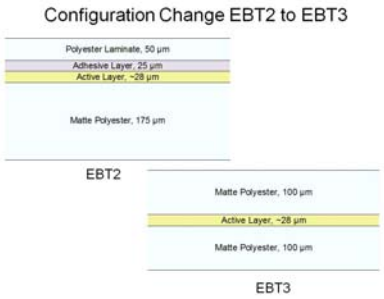

Fig 1 Comparing Gafchromic EBT2 and EBT3 film

Methods and materials

All measurements were performed using a Varian Clinac 2100c/d, 1 cm leaves, 15 MV and dynamic IMRT. The maximum isocenter dose was 220 cGy per fraction. Calculations were performed using Brainlab Iplan 4.1.2 software.

The calculated IMRT plan was projected onto an Octavius phantom (PTW-Freiburg) using Iplan phantom mapping in such a way that the monitor units are identical to those of the original plan.

Ionisation chamber point dose measurements were performed using a calibrated type 31010 semiflex 0,125cc ionisation chamber (PTW-Freiburg). For the film dosimetry measurements Gafchromic EBT3 film was used.

Both film and ionisation chamber were irradiated at isocenter depth.

Fig 2 The Octavius phantom, with insert for positioning 8''x10'' EBT film

Films were scanned using an Epson 10000XL flatbed scanner, ±15 hours after exposure. The response of the film is dependent on its orientation, and we started off scanning all films in both portrait and landscape mode. As time progressed we changed this to just scanning in portrait mode.

The EBT3 film was calibrated using calibration patches (Mosaiq) over a range from 0-300 cGy. A new calibration film measurement was performed for each measurement session where IMRT films were irradiated.

Both films were from the same batch. We did not wish to rely on just one calibration graph per film batch.

The calculated isocenter dose was compared to both ionisation chamber and EBT3 film measurements, both for the total IMRT plan, and for each individual beam.

The dose calculated in the plane of measurement was extracted from Iplan through 2-dimensional dose matrices, and compared to the dose distribution on film. This quantitative analysis of the dose distribution was carried out using FilmQA Pro software, using the 'Triple Channel dosimetry' [2] method. The dose distributions of film and Iplan can be matched using the markings on the film. These markings, as can be seen in figure 3, are recognised automatically by the FilmQA Pro software. After this the penumbra of the profiles is fine-tuned manually. A Gamma index of 3% [differential delta] and 2 mm [distance to dose agreement] was calculated, using a dose threshold of 10 % of the maximum value.

Thanks to the 'Triple channel dosimetry method' in FilmQA Pro, a lateral correction was no longer needed.

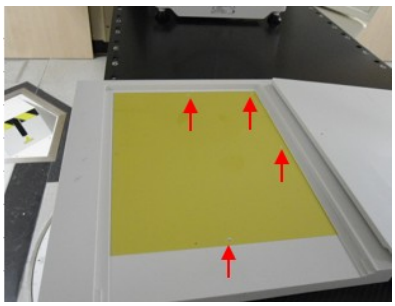

Fig 3 EBT3 film has special markings for positioning the film in both the Octavius phantom and the scanner

Results and discussion

Pointdose measurements show good agreement (all within 3 %) with the calculated isocenter dose.

De oriëntation of the EBT3 film on the flatbed scanner turned out to be of influence regarding the measured dose. Best results were obtained using portrait mode, as can be seen in table 1.

Measurment	Point dosimetrie [% dev. in ISO to TPS]	Scan Oriantation	Gamma [3%, 2 mm]	Differential Delta [3%]
IMRT Prostate 1	0,2%	Portrait	99,8%	95,0%
		Landscape	99,6%	89,0%
IMRT Prostate 2	-1,2%	Portrait	99,2%	87,2%
		Landscape	96,7%	80,3%
IMRT Prostate 3	0,6%	Portrait	99,5%	90,9%
		Landscape	99,6%	87,1%
IMRT Prostate 4	0,2%	Portrait	99,6%	96,2%
		Landscape	97,6%	85,0%

Tabel 1. films scanned in portrait mode give the best results.

According to the manufacturer the 'Triple channel dosimetry method' provides a way to separate out non dose dependent parts of a film image, such as non uniformities in the active coating on the EBT3 film as well as scanner related artifacts (such as lateral position dependence). The addition of silica particles to the polyester substrate of EBT3 prevents Newton's Rings formation.

These have indeed proven to be the case. The Newton Rings, which were such a problem in EBT2, have disappeared in the EBT3 version. The dose dependent lateral correction, which entailed that only the center part of the old EBT film could be used, no longer needed to be performed in our set-up.

We saw no significant difference in accuracy in the center part of the film as compared to the outer parts.

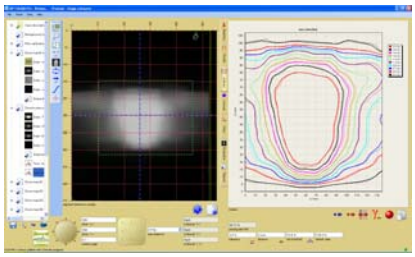

Figure 4 isodose comparison for patient 20.

The isomap shows very clearly where the gamma index of 3%, 2 mm has not been met at the edges of the IMRT fields.

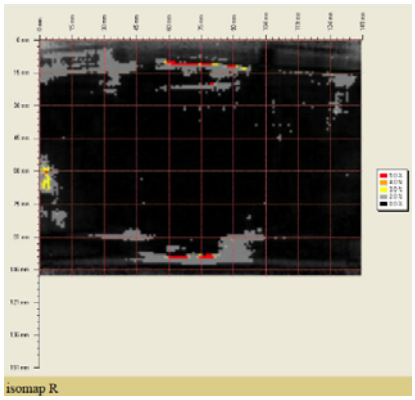

Figure 5 Isomap for patient 20.

Comparing the dose distribution on the irradiated film with the calculated Iplan isodose distribution using the FilmQA Pro software showed excellent results.

Up to April 2012 over 20 IMRT treatments were investigated. A calculated gamma (3%, 2 mm) > 99% was achieved for all these prostate IMRT plans.

Conclusions

Using EBT3 film in combination with triple channel optimalisation of the Film QA Pro software has proven to be an accurate method for the quality assurance of IMRT prostate treatments. Best results were obtained using portrait mode. A gamma (3%, 2 mm) > 99% was achieved. This method has now been taken into clinical use.

References

[1] ISP Advanced Materials Group
[2] Micke A., Lewis D.F. and Yu X., Med. Phys. 38, 2523 (2011),

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