EP-1762

Physics track: dose measurement and dose calculation

Pre-treatment quality assurance for flattening filter free dynamic arcs: a detector comparison

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Objectives/Purpose

Pre-treatment quality assurance (QA) with flattening filter free (FFF) beams is challenging because of the high dose rate and the required spatial resolution as small fields are usually used. Our current clinical practice is to perform pre-treatment QA with a chamber array in a rotational phantom. This study investigates the replacement of this process by an electronic portal imager (EPI) measurement without a phantom in place in order to shorten the QA time on the machine.

Material/Methods

Material

- Varian Truebeam linear accelerator delivering 10 MV FFF photon beams (fig.1a).
- Varian As1000 EPID at 150 cm source detector distance (fig.1a). 0.39x0.29 mm² resolution.

=> Analysis with Dosisoft EPIbeam sotfware version 1.0.2.2alpha ((fig.1b)

- PTW Octavius 4D rotational phantom with PTW SRS1000 liquid ionisation chamber array (fig. 2a). 2.5 mm detector resolution.

=> Analysis with PTW Verisoft version 7.0 (fig. 2b)

- Varian Eclipse 13.7 treatment planning system (0.125 cm calculation grid).

EPID measurements

EPID image is converted into dose at 5 cm depth in water and compared with EPIbeam dose calculation computed from Eclipse RT plan.

Octavius 4D measurements

Dose measured by chamber array in rotational phantom is converted into 3D dose distribution and compared with Eclipse phantom dose calculation.

Clinical plans

- 10 patients treated by strereotactic radiotherapy for hepatic lesions.
- Representative of our clinical activity in terms of dose and beam size.
- Treatment plans are made of a 180 to 200° conformal dynamic arc.
- Dose prescription on 80% isodose.

Error detection

- Introduced errors: leaf position (leaf bank opening, B30 central leaf shift and blockage), collimator rotation and isocentre dose.
- Applied to the smallest and largest lesions in clinical plans. (patients 7 and 2).
- Dose at the isocentre set to 11 Gy in Octavius in order to avoid dose bias in comparison (only lesion size varies between the two patients)
- Assessment of error effect clinical impact on dose distribution in Eclipse with Verisoft software.

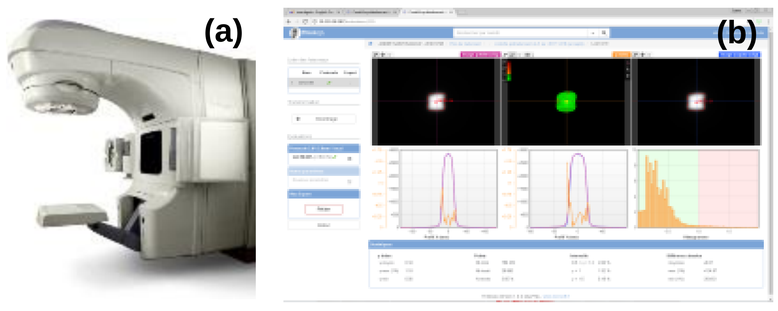

Figure 1: (a) Truebeam with As1000 EPID
(b) EPIbeam software Interface

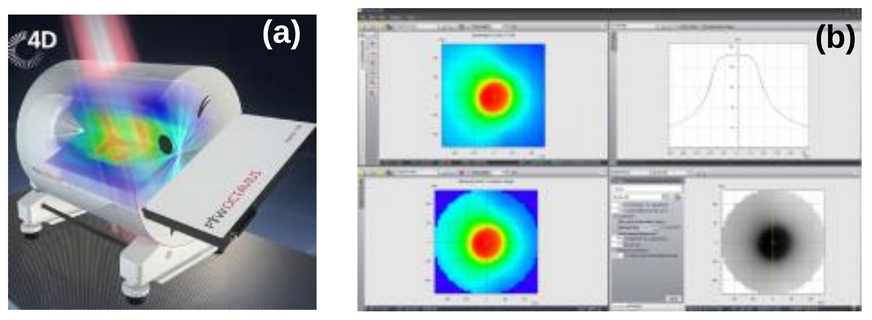

Figure 2: (a) Octavius 4D
(b) Verisoft software interface

Results

Clinical plans

Clinical plans (table 1) covered a wide range of PTV size (average = 129.5 cm³, minimum = 9.8 cm³, maximum = 327.5 cm³) and dose prescription (average = 11.8 Gy, minimum = 6 Gy, maximum =18 Gy) resulting in 1866 MU on average (minimum = 806 MU, maximum = 3072).

Patient	PTV volume (cm3)	Dose/fraction	fraction number	MU	OCTA. 4D	EPIBEAM
1	23,6	18	3	3072	100	98,08
2	327,53	10	5	1616	97,6*	99,5
3	73,3	9	5	1757	98,3	98,57
4	83,76	11	5	1817	100	98,89
5	120,51	18	3	2818	100	99,61
6	27,29	6	5	968	99,9	98,37
7	9,76	11	5	1462	100	99,48
8	218,8	6	5	806	100	99,58
9	251,6	18	3	2697	99,7	99,09
10	159,24	11	5	1649	100	99,27

Table 1: clinical plan results (* field not entirely covered by array)

Chamber array and portal imager QA process gave both gamma values higher than 97% for 2%-2 mm criteria (10% threshold).

Error detection

Results for plans with errors are summarized in table 2 with 2%-2 mm gamma index criteria (10% threshold).

For the largest volume (patient 2), Octavius was more sensitive to collimator rotation and dose errors. Nevertheless, plan comparison in Eclipse shows that EPID control results are closer to those on dose distribution.

The smallest volume (patient 7) is more sensitive to leaf position errors and less on collimator rotation (due to the rounded shape of the lesion). With Octavius, as the lesion is small, the number of tested points is small and gamma index values decreases quickly when errors are present. Both detectors gave similar results to Eclipse calculation, except for the 1 mm leaf opening in both direction that was not seen by EPIbeam.

Patient	Error type	Eclipse/Eclipse	Eclipse/Oct4D	Eclipse/Epibeam
7	None	100	99,3	99,5
2		100	100*	99,5
7	+1mm X1	99,1	91,9	99
2		100	100*	99,5
7	+2mm X1	76,3	67,6	87,4
2		100	97.1*	99,5
7	+1mm X1X2	79,5	69,2	98,5
2		100	99.5*	99,5
7	Dose+2%	100	97	99,2
2		100	83.6*	99,6
7	Dose+3%	99	91,7	94,5
2		86,2	70.2*	81,4
7	-10mm B30	83,5	85,3	88,5
2		96,3	99*	97,9
7	Blocage B30	79,1	83,7	82,8
2		88,3	91.3*	92,3
7	Colli +5°	100	98,9	99,5
2		89,9	93.2*	89,9

Table 2: Error detection results (* field not entirely covered by array)

A 97% gamma index acceptance criteria can be used for both detectors with 2%-2 mm criteria and 10% threshold.

Conclusion

EPI QA process for FFF beams is achievable. It is much faster than chamber array process as there is no need for a phantom setup and it provides similar results. Nevertheless regular QA on collimator and gantry position should be performed on the machine as an error on these parameters is not always if not at all detected with EPID. A similar study will have to be performed on 6 MV FFF beams before using EPID images for routine stereotactic plan QA in our institution.