Epiqa: a tool for RapidArc™ Quality Assurance. A multicenter experience

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Introduction

The clinical usage of Epiqa software is presented as a joint experience of two centres, the Istituti Clinici Humanitas (ICH) and the Oncology Institute of Southern Switzerland (IOSI).

Materials and Methods

The Epiqa software*, based on the GLAaS algorithm (Nicolini et al [1]) for converting amorphous silicon detector images into absorbed dose, has been used for all RapidArc pre-treatment Quality Assurance in two centres, ICH and IOSI.
For each patient, once the RapidArc™ plan was accepted for treatment, the here described QA procedure was followed:

- Calculation of the "verification plan" of the original plan with gantry fixed to 0 degree. The full RapidArc calculation is performed for this plan with the same dose grid size as the original plan of 2.5mm. Dose calculation algorithm is the Anisotropic Analytical Algorithm (AAA).
- Acquisition with the PortalVision™ aS1000 of the original RapidArc plan, with NO additional phantom.
- In Epiqa: comparison between calculated and measured dose matrices (conversion from raw PV images to dose is automatic in Epiqa).

All patients were treated with 6 MV (except one case with 18 MV at ICH), and measurements acquired with PortalVision aS1000.
The patient statistics is presented in the tables on the right, where a difference between the two centres in terms of pathologies and especially in dose/fraction is shown.

The Epiqa software has been used at IOSI also to test linac functionalities through pre-defined "RapidArc commissioning tests", repeated every month.

* EPIdos, www.epidos.eu

ICH statistics	Patients	Dose/fraction Gy	Total Dose Gy
Head & Neck	19	2.12	70.0
Abdominal Lymph nodes	9	7.5	45.0
Epatic mets	4	16.67	50.0
Vertebrae	4	1.8 – 3.0	30.6 – 50.0
Lung	2	2.5	20.0
Brain	2	2.5 – 3.0	30.0 – 45.0
Others (pelvic)	3	1.8 – 2.65	53.2 – 74.2
TOTAL	43		

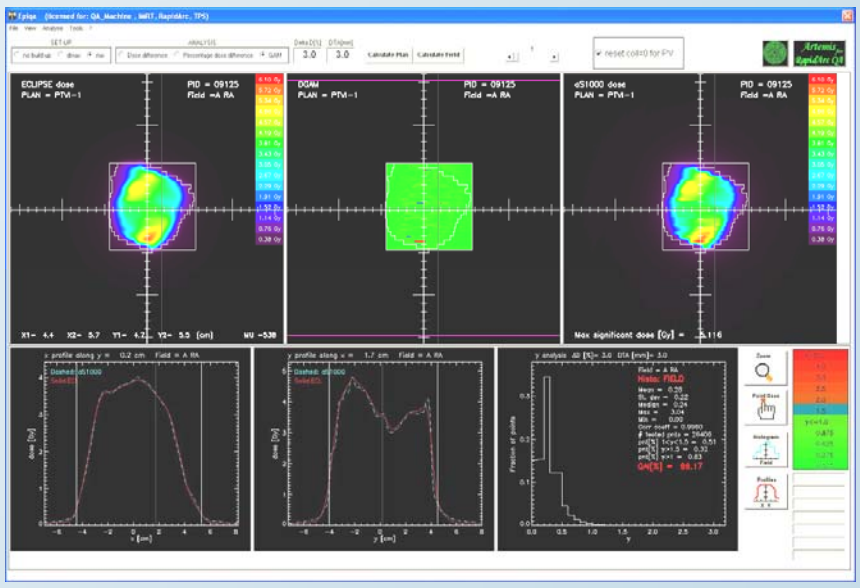
IOSI statistics	Patients	Dose/fraction Gy	Total Dose Gy
Prostate	51	1.8 – 2.0	20.0 – 78.0
Anal Canal or Rectum	19	1.8 – 5.0	5.4 – 59.4
Cervix Uteri	6	1.8	45.0 – 50.4
Other pelvis	7	1.8 – 2.5	35.0 – 50.4
Brain	4	2.5 – 5.0	30.0 – 45.0
Breast bilateral	3	2.5	62.5
Chordoma	2	1.8	63.0 – 64.8
Pancreas	2	1.8 – 2.4	36 – 50.4
Seminoma	2	2.0 – 2.5	25.0 – 32.0
Hodgkin Lymphoma	3	2.0	30.0
Paediatric Hodgkin L.	1	1.8	19.8
Medulloblastoma (CSI)	1	1.8	36.0
TOTAL	101		

Results

RapidArc pre-treatment QA with Epiqa

In figure 1 an example of the Epiqa analysis is shown. The following tables summarise the main results in terms of some plan parameters and in particular of the Gamma Agreement Index, GAI. GAI represents the percentage of the field area (defined by the jaws) passing the gamma criteria of Distance To Agreement 3mm and Dose Difference 3%, relative to the significant maximum dose in the field (arc).

	ICH		IOSI	
	Mean±SD	Range	Mean±SD	Range
Plans checked	43		120	
Arcs/plan	1.81±0.45	[1, 3]	1.07±0.26	[1, 2]
Dose/fraction [Gy]	4.65±4.46	[1.8, 16.7]	2.04±0.43	[1.8, 5.0]
MU total	1008±882	[337,4035]	418±131	[210,1038]
MU/Gy	234±71	[145, 546]	204±59	[26, 415]
Degree/arc	340±37	[210, 358]	356±9	[256,358]
Beam on time [min]	2.54±1.25	[0.82, 7.26]	1.32±0.32	[1.07, 2.50]
GAI (3mm, 3%) [mm]	**97.76±1.60**	**[94.15, 99.98]**	**97.65±1.23**	**[94.23, 99.89]**

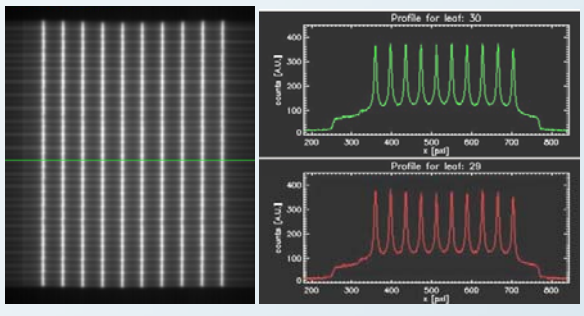


Although the difference in treatment types, especially in terms of dose/fraction, there is NO difference the pre-treatment QA results as GAI between the two centres.
Moreover, being the GAI values in average higher than 97.5%, it was not possible to see if the largest differences could be ascribed to a certain type of treatment.

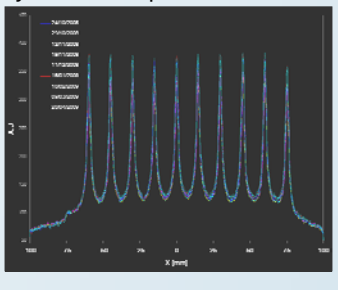
RapidArc commissioning QA with Epiqa

Three tests (recommended by Ling et al [2] and adopted by Varian) were performed during the commissioning phase, and then repeated at least once a month for a total of 9 acquisitions. Analysis was performed with Epiqa. Results presented a very good stability of RapidArc delivery as dose rate variation, gantry speed and leaf speed.

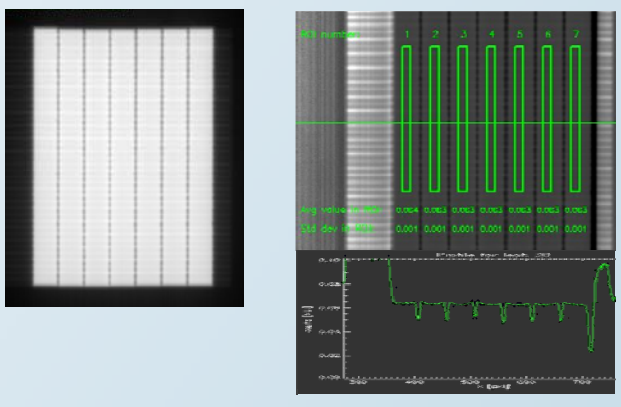
T1: Picket Fence Test during RapidArc



Summary of one leaf profile for the 9 tests.



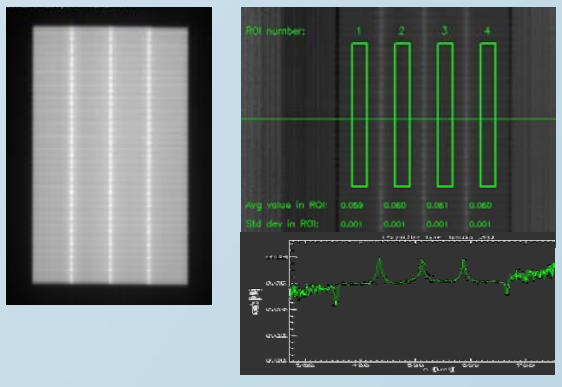
T2: Control of Dose Rate and Gantry Speed during RapidArc



Summary (9 tests) of the *differences from ref. value* (tolerance 2%)

	Mean ± SD [%]	Range [%]	Dose Rate [MU/min]
ROI number 1	1.5 ± 0.1	[1.3, 1.7]	105
ROI number 2	0.3 ± 0.1	[0.2, 0.4]	210
ROI number 3	-0.3 ± 0.1	[-0.6, -0.2]	314
ROI number 4	-0.5 ± 0.1	[-0.7, -0.4]	417
ROI number 5	-0.6 ± 0.1	[-0.8, -0.5]	524
ROI number 6	-0.5 ± 0.1	[-0.6, -0.3]	591
ROI number 7	0.2 ± 0.1	[-0.1, 0.3]	600

T3: Control of Leaf Speed during RapidArc



Summary (9 tests) of the *differences from ref. value* (tolerance 2%)

	Mean ± SD [%]	Range [%]	Leaf speed [cm/s]
ROI number 1	-1.3 ± 0.1	[-1.4,-1.2]	1.6
ROI number 2	-0.3 ± 0.1	[-0.5, -0.1]	0.8
ROI number 3	1.2 ± 0.1	[1.0, 1.4]	0.4
ROI number 4	0.4 ± 0.1	[0.2, 0.6]	2.4

Conclusion

Epiqa proved to be a very reliable and flexible tool for RapidArc pre-treatment Quality Assurance. It was primarily found to be a very reliable and easy to use tool for pre-treatment QA, allowing a fast growth of the number of treated patients, grace to its fast usage. The result is enforced by the fact that data were coming from two different centres with very different RapidArc patient statistics in terms of pathology and fractionation strategies.

References:
[1] Nicolini G et al. The GLAaS algorithm for portal dosimetry and quality assurance of RapidArc, an intensity modulated rotational therapy. Radiat Oncol 2008, 3:24
[2] Ling CC et al. Commissioning and Quality Assurance of RapidArc™ Radiotherapy Delivery System. Int J Radiat Oncol Biol Phys 2003, 72: 575–581

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