SPIROMETRIC GATED VMAT : QA OF POTENTIAL BREATH HOLD INTERRUPTIONS.

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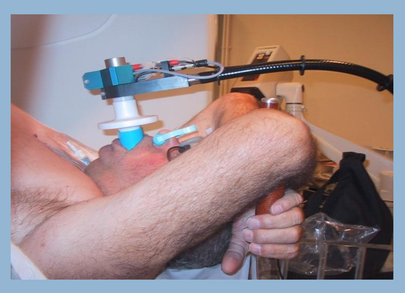
BARCELONA 2015 3rd ESTRO FORUM

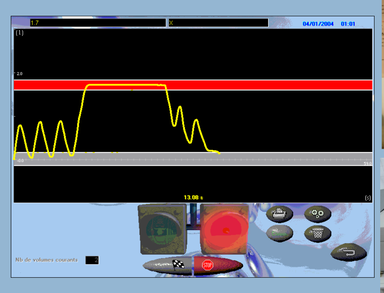
Purpose/Objective :

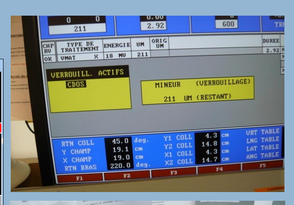
Thoracic and abdominal radiotherapy needs to include breathing controls. Among various possibilities, the breath hold provides a simple process. Planning, delivery and all imaging protocols are easily managed once the internal anatomy remains immobile. However, to obtain the benefit of a modulated irradiation with the VMAT option, we need to secure potential breath hold interruptions during the irradiation.

Materials and Methods

The SDX™ /Dyn'R Breath Hold spirometric system used daily for some patient treatments is connected to the Varian accelerator with an Automatic Gating Module™ (AGM).



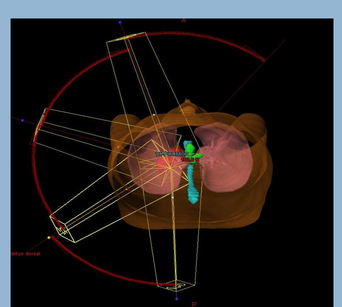


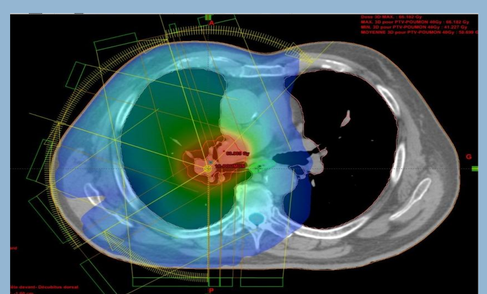


A phantom plan, two QA plans and two patient plans were used to voluntary test interruptions during the irradiations. To evaluate the potential impact of breath hold interruptions, we used the Delta4™/Scandidos system and MLC Dynalog files records.

The % of gamma index passing the criteria (3% - 3mm) were collected. The Log Files were analyzed with the FractionCheck™ /Mobius Medical System module. We collected the 95th percentile and the maximum leaf Root Mean Square (RMS) error.
We compared measurements and records with and without interruptions during the irradiation.

The QA plans are provided by Varian Inc to test gantry rotation, MLC leaves and Dose-rate variations. The Phantom and patients plans were based on four successive arcs which favor the correlation between the patient breath hold ability and the arc irradiation duration. During each arc, two **breath hold interruptions** were obtained with the use of the QA syringe placed in the control room.

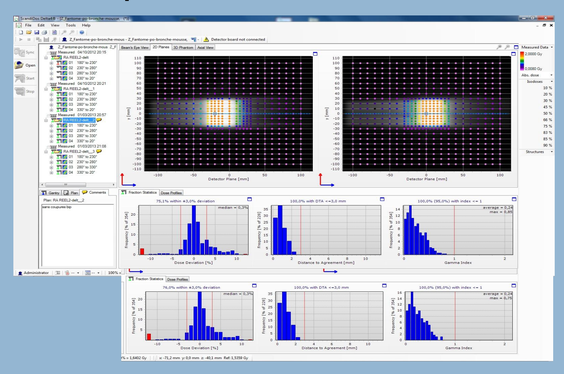




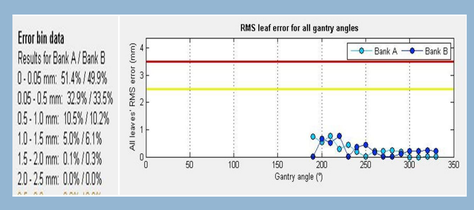
Results

The dosimetric plans selected cover the domain of modulation used for the patient treatments.

The maximum difference of % gamma index, with and without interruption , was only 0,71%. This result indicates that there is no significant differences which could alert on a dosimetric effect of breath hold interruptions.



The table contains the % of gamma index passing the criteria, for all the plans, with and without interruptions.



	Arc number	%γ≤ 1 (γ mean - γ max)	
		Without interruption	With interruptions
Phantom	1	98,6 (0,37 – 1,09)	97,9 (0,38 – 1,1)
	2	99,6 (0,25 – 1,32)	99,6 (0,25 – 1,36)
	3	100 (0,23 – 0,94)	100 (0,22 – 0,89)
	4	98,4 (0,45 – 1,35)	98,4 (0,44 – 1,34)
Patient 1	1	100 (0,36 – 0,78)	100 (0,37 – 0,8)
	2	99,6 (0,26 – 1,2)	99,6 (0,27 – 1,2)
	3	99,8 (0,17 – 1,03)	99,8 (0,22 – 1,1)
	4	98,9 (0,3 – 1,49)	98,9 (0,32 – 1,65)
Patient 2	1	99,5 (0,36 – 1,06)	99,8 (0,34 – 1,03)
	2	99,5 (0,26 – 1,64)	99,5 (0,27 – 1,62)
	3	99,5 (0,32 – 1,31	99,5 (0,31 – 1,27)
	4	98,7 (0,32 – 1,32)	98,1 (0,34 – 1,44)
QA Plan 1	Leaves speed	100(0,64 -0,73)	100(0,36 – 0,4)
QA Plan 2	Gantry - DoseRate	98,5(0,41 - 1,03)	98,4(0,84 – 1,04)
max dose / max spatial deviation criteria = 3%/3mm			

The Log Files analyze do not contain any dose comparison but gives a vision of the delivery process. The mean and maximum 95th percentile difference, with and without interruptions, were 0,04mm and 0,29 mm respectively. The mean and maximum leaf RMS difference with and without interruptions were -0,02 mm and 0,29 mm. The log files stored data are consistent with the Delta4 dosimetric analyze.

Conclusion

The combination of a VMAT irradiation and the breath hold method provides an optimal process. Even if planned with multiple successive arcs, a breath hold interruption has to be anticipated. The connectivity between the SDX™ system and the accelerator, obtained by the use of the AGM™, were validated jointly by both companies. However, we needed to analyze and secure the process through a dosimetric evaluation of potential irradiation interruptions. The results show that no discrepancies could compromise the irradiation quality of such treatments.