

Does classical 2nd monitor unit calculation still have a future?

Validation of a comprehensive QA software

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OBJECTIVES

Quality control of radiotherapy treatment plans includes secondary independent calculation of monitor units. However, with the development of new technology, this single point calculation is getting less relevant and does not always permit an informed decision.

The aim of this study is to investigate the ability of a commercial software (Mobius 3D, FX, version 4.1, Mobius Medical Systems, Houston, TX) to propose an integrated solution from calculation to delivery while decreasing control time on treatment units.

METHODS

Our department uses several TPS with different algorithms (Isogray v4.2, Eclipse v10, Tomotherapy v5). Various treatment technics (Tomotherapy, VMAT, dynamic IMRT, classical 3D conformal for Clinac) are available. Mobius V4.1 was used with golden data provided by vendors to test our beam modeling.

The algorithm used is collapsed cone convolution superposition with 144 isotropically-spaced cones, a step size always inferior to a voxel and high resolution kernels. It provides independent monitor unit calculation, 3D isodoses statistics and dosimetric benchmark.

For Varian treatments, uploading dynalog files in this software permits calculation of the difference between the calculated and delivered leaf positions and its impact on 3D dose calculation.

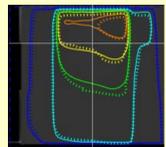
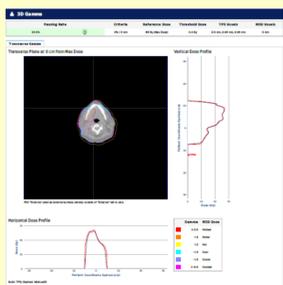


Figure 1 : comparison of Dosisoft isodoses for a wedge on an homogeneous phantom versus Mobius 3D (dashed)

Figure 2 : Comparison of gamma index for a RapidArc Head and neck case versus Mobius 3D



Beam Information	
Number of Fractions Planned	35
Delivery Machine Name	CAPI2
Beam	ARC1 ARC2
Date Transfer	Plan Plan
Energy (MeV)	6 6
MU	274 240
Segments	1453 1473
X1 X2 Jaw (cm)	5.0 5.4
	5.4 5.8
Y1 Y2 Jaw (cm)	5.4 5.4 to 5.5
	5.5 5.5
Wedge	None None
MLC	VMAT VMAT
Relation	VMAT VMAT
Gantry	17.5 18.5
	205.3 205.1
Collimator	10° 345.0 to 345.0
	205.0 205.0
Chock	0° 0°
Delivery Time	1 min 14 sec 1 min 14 sec
Beam On	99.3% 99.7%

Figure 3 : Beam information for a RapidArc Head and neck case versus Mobius 3D

Figure 4 : root mean square analysis of leaf positioning for a Head and neck RapidArc treatment

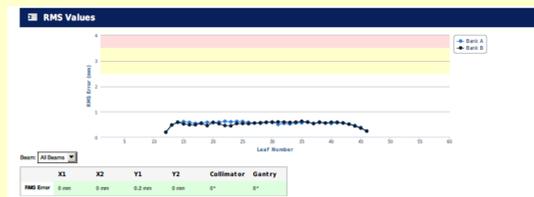


Figure 5 : HDV comparison for an head and Neck case for Tomotherapy

TPS Name	Volume	3D Gamma (3%, 3 mm)	TPS	M3D	% Diff
ATND	2.28 cc	100%	14.212 Gy	14.759 Gy	0.4%
ATND	2.7 cc	100%	6.872 Gy	6.891 Gy	0.4%
COUP FROULE	60.7 cc	100%	13.047 Gy	13.148 Gy	0.4%
COULEE D	6.36 cc	100%	6.877 Gy	6.832 Gy	-0.1%
COULEE D	5.78 cc	100%	3.212 Gy	3.128 Gy	-0.1%
CTV 54.45 cc	59.2 cc	99.8%	55.251 Gy	55.454 Gy	0.4%
CTV 54.45 cc	1.81 cc	100%	58.122 Gy	58.207 Gy	-0.2%
CTV 54.45 cc	33.2 cc	99.2%	65.87 Gy	65.733 Gy	-0.2%
DETS	18.8 cc	99.9%	23.315 Gy	23.241 Gy	-0.1%
ESCAL	2.056 cc	99.1%	4.31 Gy	4.168 Gy	-0.2%
GLANDE DE MAXILLAIRE D	4.48 cc	100%	6.768 Gy	6.881 Gy	0.4%
LARYNX	28.7 cc	100%	29.367 Gy	29.87 Gy	0.7%
MIDDLE	18.7 cc	100%	8.537 Gy	8.552 Gy	0%
MOLLETS	87.4 cc	100%	6.789 Gy	6.84 Gy	0.1%
MUSCLE CONSTRUCTEUR PHARYNX	10.2 cc	100%	24.894 Gy	25.855 Gy	0.9%
NOSE	820 cc	99.9%	16.278 Gy	16.189 Gy	-0.2%
OSSEPHARYNX	13 cc	100%	1.813 Gy	1.847 Gy	0.1%
PAROTIDE D	48.4 cc	100%	28.148 Gy	28.369 Gy	0.2%
PAROTIDE DPTV	43.7 cc	100%	24.631 Gy	24.78 Gy	0.2%
PAROTIDE G	35.4 cc	100%	6.858 Gy	6.787 Gy	-0.2%
PTOXAIS	193 cc	97.1%	54.43 Gy	54.858 Gy	0.2%
PTOXAIS	74.1 cc	99.7%	65.277 Gy	65.188 Gy	-0.0%
TOT	64.8 cc	100%	7.848 Gy	7.9 Gy	0.1%
TRONC CENTRAL	28.3 cc	100%	6.429 Gy	6.432 Gy	0%

RESULTS

We have validated the commercial software by increasing difficulties from unmodulated to modulated field, on a cubic homogeneous phantom (Figure 1 with a wedge) then on a round heterogeneous one. Difference between TPS and Mobius were inferior to 0.5% for UM calculation for 3D conformal treatment and up to 0.6% differences on mean doses. Gamma passing rate (3%-3mm) was up to 100%.

For rapid arc patient, differences for mean doses were between 0.9 and 2%; up to 2.3% UM difference (Figure 2 and 3). Gamma passing rate was 99.7% for (3%-3mm). Dynalog files were uploaded after treatment session and Mobius FX highlights a difference of 0,2mm (RMS error) between planned and delivered position of bank Y2 leaves (Figure 4).

For Tomotherapy treatment, calculated dose distribution shows mean gamma passing rate of 99.6%+/-1.15% (Figure 5).

CONCLUSIONS

To have a multi-brand environment complicates the legal independent monitor unit calculation; a complete solution in one software accessible from every institutional PC facilitates the workflow. Tools as risk of collision, templates of dosimetric alert thresholds positions the software in a global context of quality treatment plans preparation, planning, treatment (taking into account the actual position of the leaves). As far as we know, this is the only software doing a second calculation of dose distribution for Tomotherapy.

Is this change in the quality evaluation of treatment plans another step towards safety? Preliminary results show this solution permits to analyze every step of the process in an efficient way. The web based solution is flexible, easy to use.

Next step will be to analyze the possibility to replace the treatment plans measurements by automatic analysis post treatment. FX plan delivery verification via DVH and 3D dose comparison using machine delivery log file based dose reconstruction would permit to diminish our patient control.

This commercial DICOM-RT based plan verification system is, according to us, the future of independent calculation.

References

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