Monitor Unit Comparison Between a Treatment Planning System and an Independent Monitor Unit Calculation Software

CENTRO HOSPITALAR LISBOA NORTE, EPE
HOSPITAL DE SANTA MARIA
Hospital Pulido Valente

Carreira, P.(1)(2)*; Ribeiro, T. (1)**; Madureira, L.(1)(2); Mota, M.(1)(2); Pontes, M. (1)(2); Prudêncio, L.(1); Teixeira, N. (3); Monteiro Grilo, I.(1)

(1) - Hospital de Santa Maria, Lisboa; (2) - Medicalconsult; (3) – FCM-UNL

Contactos: *pedro.carreira@medicalconsult.pt,**tiagoramosribeiro@gmail.com

Background

In external beam radiotherapy, Monitor Unit (MU) calculation is a key process to achieve the correct dose distribution according to the treatment clinical prescription. The complexity on calculation algorithms, together with heterogeneity corrections applied on treatment planning systems (TPS), lead to the need of a specific dedicated quality assurance software.

An independent MU calculation system allows accuracy verification of calculations from a TPS. The *American Association of Physicists in Medicine* (*Task Group 40 and Task Group 114*) recommends the use of a independent MU calculation system as a mandatory tool for quality assurance on a radiotherapy treatment.

The main goal of this work was to compare the MU and dose calculations between the TPS *XiO®4.60 (CMS)* and the independent MU calculation system *RadCalc® 6.0* (*LifeLine Software, Inc.*), which was a task included in the validation process of the second system in our department.

Materials and Methods

The commissioning data from the *Elekta Synergy®* Linac, for three photon energies (6 MV, 10 MV and 15 MV), was introduced on *RadCalc® 6.0* database. All the data selected was the same used for modeling the *XiO*.

For comparison purpose between the two systems, different fields were simulated in an homogeneous environment (solid water phantom). The field configuration parameters changed were the energy, dimension, gantry, collimator and wedge angles, normalization point and source surface distance (SSD). More complex fields were also simulated changing more than one of these parameters simultaneously.

Each field simulated on *XiO* had 100 MU and consequent dose distribution was calculated with *Superposition* algorithm. For most of the fields the normalization point was placed at isocenter. In *RadCalc* software, MU were calculated for the dose values transferred from *XiO*, as well as the dose values were calculated from the *XiO* MU.

Dose measurements with ionization chamber (PTW model 31010, 0.125 cm^3) in a solid water phantom were made using the TRS 398 protocol for dose correction. The dose measurement values were compared with the dose calculated by both systems.

Tests in heterogeneous medium were made with two CIRS phantoms, a pelvic one and another with a bone insert and an air cavity. Such phantoms were irradiated with fields with different characterization parameters. *XiO* and *RadCalc* MU and dose calculations were analyzed.

Related to the fact that the *Elekta Synergy* Linac has a fixed wedge of 60º, wedged fields with less then 60º were simulated. The evaluation of *RadCalc* calculations for this type of fields was thus made separately with an open and wedged component.

Results

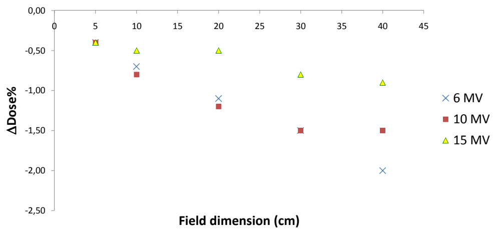
This section gives an overview of the results obtain both from the homogeneous and heterogeneous media tests. The discussion of the results is made in the last section.

- Homogeneous Medium

Table 1 - Greatest differences as function of the analyzed parameter.

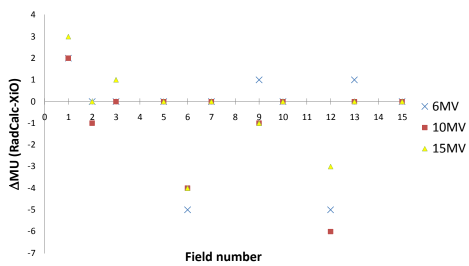
Parameter	Max Dif. *RadCalc-XiO*	
	ΔDose (%)	ΔMU
Energy	- 0.8	1
Dimension	- 2.0	2
Wedge angle	1.9	- 2
Gantry angle	- 0.8	1
Collimator angle	- 0.8	1
SSD	- 0.8	1
Depth	- 1.1	1
Lateral offset	1.6	- 2
Different combinations	- 1.6	2

Graphic 1 – Dose difference (*RadCalc–XiO*) *vs.* field dimension



- Heterogeneous Medium

Graphic 2 – MU difference (open irradiation)



Graphic 3 – MU difference (wedged irradiation)

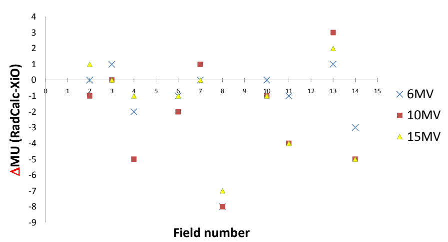
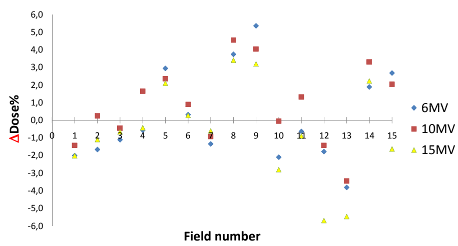


Table 2 - Cirs Phantoms Fields Numbers.

	Field Number	Field Dimension(cm)		Wedge	Gantry	Collimator
		X	Y			
Pelve Cirs	1	3	3	0º	90º	90º
	2	5	5	45º	45º	45º
	3	5	5	20º	0º	0º
	4	10	10	60º	315º	315º
	5	10	10	0º	270º	270º
	6	15	15	45º	315º	315º
	7	20	20	20º	0º	0º
	8	25	25	60º	45º	45º
	9	30	30	0º	90º	90º
Air/Bone Cirs	10	5	5	45º	45	45º
	11	10	10	60º	35º	315º
	12	10	10	0º	0º	270º
	13	20	20	20º	0º	0º
	14	25	25	60º	45	45º
	15	30	30	0º	90	90º

Graphic 4 – Dose difference (*RadCalc–XiO*)



Conclusions

In the homogeneous medium tests, the maximum dose difference was 2%, which is reflected in a 2 MU difference (table1). The greatest discrepancy between systems came with field dimension variations, this is most noticed for 6 MV photons, as seen in graphic 1.

The other field parameters analysed, as wedge angle or normalization point position, had also an important aspect on MU calculation results. For all fields, dose values calculated on *XiO* were closer to the values measured with ionization chamber (variation < 1.5%), dose values calculated on *RadCalc* had a greater discrepancy (< 2.5%). This fact was expected because *XiO* calculation algorithm is more accurate, however the *RadCalc* results allows to credit it has an accurate independent calculation system.

For the heterogeneous medium the maximum variation between systems is 8 MU, regardless of field dimension or energy. The difference between dose values, calculated with the two systems, was less then 6%, and its maximum value came with larger wedged fields.

Taking into account the fact that in *RadCalc* any heterogeneity calculation corrections can be applied, the values obtain acknowledge the necessity for more studies on this topic.

The main goal of this independent MU calculation system is to validate the TPS calculations. For further analyses, fields from patient treatment plans, calculated on patient CT will be used.

In general, the data extracted from this work confirms the efficiency of this independent MU calculation system for a TPS quality assurance procedure.