Impact of Pinnacle model calculation on the dynamic arc-therapy dose delivered by a linac, and the need to cross-check control tools

Authors

G. Rucka (1), S. Valdenaire (2), P. Budillon (1), J.C. Mouttet (1), N.Asquier (1)

1 Croix-Rouge Française/Toulon/France

2 Institut Paoli Calmette/Marseille/France

Introduction:

Volumetric modulated arc-therapy (VMAT) is a fast treatment technique allowing the delivery of good quality radiotherapy. TPS are used for treatment planning and need to perform precise calculations. It is thus important to affine and validate the models created before starting treatments. Our study demonstrates the need to do quality assurance adapted to the model. It is necessary to cross-check the measurements from at least two detectors before proceeding to pre-treatment controls.

Materials and methods:

Photon beams of 6MV, delivered by an Elekta Synergy linac equipped with an Agility multi-leaf collimator, were modeled in Pinnacle TPS V9.8. Two models were created and compared: M1 and M2. M1 focuses on border and out-of-field parameters while M2 focuses on output factors agreement between models and measurements. Both models were evaluated using several tests found in the literature used as quality assurance. On the other hand, 20 treatment cases were controlled with the ArcCHECK device, the PTW TM31010 ionization chamber as well as EBT3 gafchromic films.

Results:

M1 exhibits good agreement with measurements when performing tests from the literature, while M2 performs poorly in the "strip pattern" test. However, M1 calculation/measurement ratio goes up to 4.0% when comparing the dose in atypical fields, while M2 ratio stays below 1.3%. ArcCHECK gamma-test pass rates are similar between both models with 98.2% and 97.6% for M1 and M2, respectively (3%, 3 mm, local). Single point calculations differences with ionization chamber measurements are 2.5% and 1.0% in average, and reach a maximum of 3.6% and 2.0% for the M1 and M2 models, respectively. Gafchromic films analysis confirm the significant differences found with the ionization chamber for the M1 model and exhibit much better agreement for the M2 model.

Conclusion:

The results demonstrate the importance to cross-check control tools. The significant gaps found with the M1 model were neither detected with quality assurance tests, neither with ArcCHECK measurements. It was necessary to implement home-made ionization chamber and gafchromic films test. This defect is preponderant with respect to the dose delivered on the target volume but is not prevalent in the zones of low doses where the diodes of the ArcCHECK are located.