Dosimetric study of the AAA algorithm for VMAT technique using an anthropomorphic phantom

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Purpose/Objective: Be able to know the real dosimetry inside the patients is very important to know the accuracy provided by the Treatment Planning Systems (TPS) and at the same time it is very difficult to realize. To evaluate the dosimetry in a realistic manner without resorting to a real patient, anthropomorphic phantoms can be used. . In this work, we have evaluated the calculations provided by the TPS Eclipse V10 with AAA algorithm in the pelvic area of a RANDO Man© anthropomorphic phantom for prostate treatments, assessing the measures through the use of termoluminiscent detectors (TLDs) with the data provided by the planner in PTVs as well as in various organs of risk.
Materials and Methods: 4 prostate treatments, 2 low risk cases (PTV-T to 7000cGy in 30 fractions) and 2 high risk cases with nodal chain irradiation (PTV-T to 7000cGy and PTV-N to 5040 in 30 fraction)) were planned using a Eclipse V10 with AAA algorithm and irradiated in a VARIAN 2300 iX linear accelerator, equipped with Millenium 120 MLC. PTVs and OARs were delineated in the previously scanned phantom. All treatment plans consisted of a single VMAT field, 6 MV X-rays, full rotation and 30º of collimator rotation. Dose was prescribed to the median PTV dose, requiring that more than 98% of the PTV volume should receive at least 95% of the prescribed dose, and no more than 2% of the PTV volume should exceed 107% of the prescribed dose. Organs at risk fulfilled the departments' constraints. A set of 100 TLDs (Harshaw XD-100 extremity (EXT-RAD) model) was used in order to calibrate, background measures, and PTVs and Organs At Risk (OARs) measurements.
Results: The results of the TLDs dose measurements are summarized in the Table 1.And the absolute desviations for all the measurements is presented in Figure 1.Regarding with the high dose low gradient region, the average dose difference was -1.5% ± 4.6% (1 SD) for the PTV-T and -0.3% ± 4.5% for the PTV-N. The average OARs dose difference is below 2.5% for all of them. The standard deviation of the OARs is significantly higher than the corresponding to the PTVs. A plausible explanation is that the TLD have a size of about 3 mm, and are located in regions of high dose gradients. Also must be taken into account that small variations of the TLD position have a great impact on its dose measurement or calculation. Although the analysis done in this work was focused on the prostate, it is equally applicable to the rest of pathologies involved in the pelvis or abdominal area, because the type of heterogeneities is quite similar.

Table 1: Number of measurements for each location and mean result in %

Location	Number of measurements	Mean result ($D_{calculated}$ - D_{read})/D_{read}
Rectum	10	-0.22% ± 9.7%
Bladder	4	2.35% ± 3.6%
Femoral Heads	16	-2.02% ± 6.4%
Intestinal package	2	0.99% ± 8.7%
PTV-T	11	-1.50% ± 4.6%
PTV-N	6	-0.27% ± 4.5%

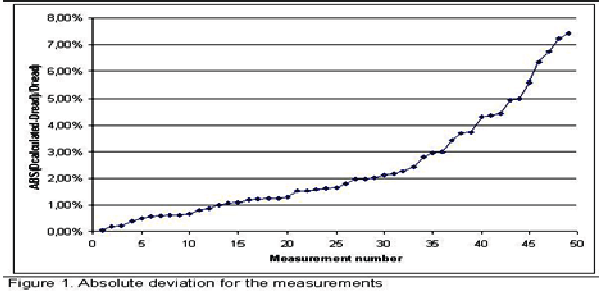

Figure 1. Absolute deviation for the measurements

Conclusions: The use of TLD in conjunction with anthropomorphic phantoms is a useful tool to verify the accuracy of the dose calculation algorithm implemented in the TPS in realistic anatomical cases. We conclude that the AAA algorithm provides reliable dose calculation for the treatment with VMAT in the anatomy of the pelvis.

EP-1195

Validation of Eclipse eMC algorithm for use in boost dose breast cancer

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Purpose/Objective: Step 1 : To validate relative and absolute dose calculations of electron Monte Carlo algorithm (Eclipse, eMC 10.0.28, Varian) in simple geometry conditions for a set of inserts (rectangle, square) used in the clinical routine in a water phantom: profiles, percentage depth dose (pdd) and monitor units (MU) calculations. Step 2 : To study some dosimetric parameters of eMC calculations for boost dose in breast cancer: 1) validation of relative dose and MU calculations with obliquities in a water phantom and 2) comparison of MU calculated in Step 1 with 13 patient case studies ; first, with mass densities of the patients ; second, by assigning 0 UH to the 'body' not to take into account internal heterogeneities.
Materials and Methods: Varian eMC modelling procedure was carried out for 7 energies (6MeV, 9MeV, 12MeV, 15MeV,16MeV, 18 MeV and 20MeV) and 5 applicators (6x6cm^2, 10x10cm^2, 15x15cm^2, 20x20cm^2 and 25x25cm^2). Cylindrical and flat ionisation chambers (CC13, PPC40, NACP – IBA Dosimetry) were used for relative and absolute dose measurements in water. MU were calculated for delivering 1 Gy at the maximum depth dose on the beam axis. eMC calculations grid size and accuracy were 2 mm and 1%. In step 1, the gantry was perpendicular to the water phantom and the surface skin distances were 100cm, 105cm and 110cm.
Results: Step 1 : Relative dose measurements including profiles in the lateral constriction of 80% isodose curve gave good agreements with eMC calculations. The largest differences in pdd at 50% of the maximum dose were found at 6 MeV, up to 2.1 mm for a 5x10cm^2 rectangular inlay. Profiles fitted well with differences < 1% of the inlay size at 50% of the profile. The largest differences were found after the flat floor of the profile on the rounded part (between 98% and 90%). We achieved good agreement between MU eMC calculations and measurements, resulting in a maximum absolute deviation of 3.8%, 2.2% and 1.9% respectively for energies of 6MeV, 9MeV and 12MeV. Step 2 : Differences between MU eMC calculations in patients and MU calculated in water in step 1 were slightly higher, resulting respectively to 9.2%, 3.5% and 23.3% in mean, minimum and maximum deviations. These deviations remained similar when assigning 0 UH to the 'body' of the patients, resulting respectively to 8.1%, 3.5%, and 21.6%.
Conclusions: Step 1 : Relative and absolute dose measurements were found to be accurate enough for a clinical use of eMC. Step 2: significant differences were identified between UM measurements in water (step 1) and eMC calculations in patients both with mass densities of the patients or by assigning 0 UH to the 'body'. Beam obliquity relative to the patient surface was found to be one of the main parameter that could explain this deviation (as far as prescription point was at the maximum pdd in a soft tissue).

EP-1196

Evaluation of an independent monitor unit calculation software based on AAPM task group 114 report

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Purpose/Objective: Independent verification of the monitor unit (MU) calculation for radiotherapy is important to ensure the accuracy of the dose calculation in the treatment planning system (TPS). In2011, task group 114 (TG-114) of the American Association of Physicists in Medicine published a report for use as a guideline for verifying the MU calculation. We consider the clinical use of an independent MU calculation software (EqualDose v 4.0) that was developed by a project of the European Society for Radiotherapy and Oncology. We have evaluated the accuracy of dose calculation by this MU calculation software on the basis of the TG-114 report.
Materials and Methods: Verification plans in a homogeneous phantom were modeled in the TPS (Xio, Elakta Oncology Systems and Eclipse,Varian Medical Systems), including open, physical wedge, dynamic wedge, and multi-leaf collimator fields. We selected an evaluation point within the phantom at the isocenter and off-axis point. Superposition (SP), Convolution (CO), Clarkson (CL), Analytical Anisotropic Algorithm (AAA), and Pencil Beam Convolution (PBC)