Material and Methods: The Agility multileaf collimator (Elekta AB, Stockholm, Sweden) has 160 leaves of projected width 0.5 cm at the isocenter, with maximum leaf speed 3.5 cm/s and dynamical leaf guides. Ten patients with different carcinoma sites previously treated were selected for this study: head and neck, lung, prostate, anal and cervix carcinoma. Selection was made in order to cover common tumor sites and also to have broad spectrum of complexity. VMAT plans were optimized using the new Photon Optimizer algorithm (PO 13.5.35) implemented in the Eclipse TPS V13.5. The plan quality was evaluated by homogeneity, conformity and target coverage. All plans are re-calculated for Octavius phantom with 729xdr Detector (PTW, Freiburg) and irradiated. Comparison of measured and calculated dose distributions was done in VeriSoft 6.0 Software (PTW, Freiburg) using 2D Gamma-index and "Difference in percent of normalization value of reference matrix"-method.

Results: All VMAT plans met clinical objectives, providing high conformal dose distributions. The comparison of the 3D dose distribution measured by PTW Octavius 729 2D-Array passed both used criteria. 2D Gamma-Value (3% local dose, 3mm distance to agreement) analysis for all plans gave results gamma index=1, with 100% passing points. The other comparison method, resulted in more of 95% passing points for all investigated plans.

Conclusion: This study showed excellent dosimetric validation of VMAT plans made for Elekta Agility using newest Eclipse 13.5 version of the Varian planning system. It is also shown that MLC of Elekta Agility allows treating most complex target volumes in VMAT technique.

EP-1550

Dosimetric comparison of the two dose reporting modes of Acuros XB and AAA for lung SBRT

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Purpose or Objective: The purpose of this study is to measure the difference in dose-volumetric data between the analytical anisotropic algorithms (AAA) and the two dose reporting modes of the Acuros XB, namely, the dose to water (AXB_Dw) and dose to medium (AXB_Dm).

Material and Methods: Dose volumetric data for 37 lung lesions treated with Stereotactic Body Radiation Therapy (SBRT) were generated using the AXB_Dm in Eclipse Treatment Planning System (TPS) for Varian Clinac iX or TrueBeam and then recalculated with the AXB_Dw and AAA using the same monitor units and identical beam setup. The internal target volume (ITV) was delineated using the averaged image from the 4DCT and the PTV was obtained by adding 5mm margin to the ITV. A dose of 50Gy in 4 fractions was prescribed to the IC and the D95%. The following dose-volumetric parameters were evaluated; D2%, D50%, D95% and D98% for the ITV and the PTV. Two-sided, paired Student's t tests were used to test for statistical significance ($p<0.05$).

Results: Table I summarized the dose-volumetric data results under the IC and the D95 prescription for all the 37 lesions. Under the IC prescription, the maximum mean difference, observed in the ITVD50% between the AXB_Dm and the AAA was only 1.7 points, although statistically significant ($p<0.05$). The difference in the PTV D98% was not statistically significant between the three algorithms. With the D95 prescription. The maximum mean difference, observed in the ITVD50% between the AXB_Dm and the AAA was 3.3 points, ($p<0.05$). The difference in the PTV D98% and D2% was not statistically significant between the AXB_Dm and AXB_Dw. The PTV D95% didn't differ between the three algorithms.

Table I. Dose volumetric data calculated with AXB_Dm, AXB_Dw and AAA. Data are shown as means ± standard deviation.

	IC			D95		
	AXB_Dm	AXB_Dw	AAA	AXB_Dm	AXB_Dw	AAA
PTV						
D2[c]	101.7±2.2	101.0±2.1	100.6±1.7	133.4±7.7	133.1±7.6	131±6.5
D50[a]	95.4±4	94.8±3.5	93.9±3.2	120.4±4.3	120.3±4.3	118±4.3
D95[d]	86.9±6.2	86.5±6	86.2±5.5	100.1±00	100.1±00	100.1±00
D98[c]	84.6±7	84.2±6.8	84.2±6.5	93.8±2.4	93.8±2.4	94.2±2.6
ITV						
D2[b]	102.1±1.9	101.1±1.6	101±1.3	134.3±8.2	133.9±8.2	132.1±7.1
D50[a]	98.6±2.2	97.7±1.8	96.9±1.9	128.3±7.4	127.6±7.3	125±6.4
D95[a]	94.0±3.4	93.3±3.3	92.4±3.2	118.5±12.5	118.2±12.5	115.9±12.1
D98[a]	92.7±5	92±5	91.2±4.8	116±15	115.8±14.9	113.6±14.8

Abbreviations: AXB_Dm= Acuros XB dose-to-medium reporting mode; AXB_Dw= Acuros XB dose-to-water reporting mode; AAA= Analytical anisotropic algorithm; PTV= Planning target volume; ITV= Internal target volume; IC= Isocenter prescription dose; D95= Prescription covering 95% of the target volume.

[a]A significant difference was found between AXB_Dm and AAA, AXB_Dm and AXB_Dw and AAA and AXB_DW

[b]A significant difference was found between AXB_Dm and AAA, AXB_Dm and AXB_Dw and AAA and AXB_Dw only under the D95 prescription.

[c]A significant difference was found between AXB_Dm and AAA and AAA and AXB_Dw under the D95 prescription.

[d]A significant difference was found between AXB_Dm and AAA, AXB_Dm and AXB_Dw under the IC prescription

[e]A significant difference was found between AXB_Dm and AAA, AXB_Dm and AXB_Dw and AAA and AXB_Dw under the IC prescription and AXB_Dw and AAA and AXB_Dw under the D95 prescription.

Conclusion: Although statistically significant, the dosimetric difference between the three algorithms are within acceptable range with the maximum difference being 3.3 points between the AXB-Dm and AXB_Dw.

EP-1551 Benchmarking Monte Carlo for proton radiosurgery

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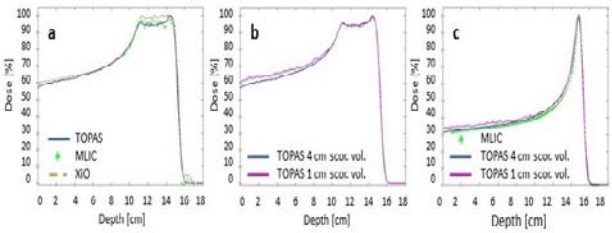
Purpose or Objective: Small proton fields that are used in proton radiosurgery (PSRS) are defined by the loss of electronic and nuclear equilibrium along the central axis as a consequence of electronic and nuclear interactions. The Bragg peak is degraded which can lead to underestimation of range if the treatment planning system (TPS) does not correctly model nuclear and MCS effects. Monte Carlo simulation is the gold standard for dose calculations. The aim of this project was to benchmark Monte Carlo simulation for PSRS against measurements and compare it to the TPS.

Material and Methods: A fixed beamline for passive scattering PSRS was modeled with TOPAS, a platform for Monte Carlo simulations. Depth dose profiles of pristine Bragg peaks with ranges of 6, 10 and 15 cm as well as SOBPs for the same ranges and respective modulations widths of 2 and 4 cm for 6cm, 2.5 and 4.5 cm for 10 cm and 4.5 and 8 cm for 15 cm were calculated with TOPAS. The simulations were compared to annual QA measurements with a multilayer ionization chamber (MLIC) and to the XiO (Electa, Sweden) TPS. The field size in all cases was 6 cm in diameter. Two scoring volumes were used, a 1 cm and a 4 cm radius cylinder with 0.1 cm binning in beam direction.

Results: The measured and calculated Bragg peaks and SOBPs were in good agreement. The absolute difference between measured and calculated ranges and modulation widths were 0.7 mm (0.1 – 1.5 mm) and 0.6 mm (0.3 – 1.1 mm), respectively. The absolute differences between calculated and XiO ranges and modulation widths were 0.7 mm (0.4 – 0.9 mm) and 0.2 mm (0.1 - 0.4 mm), respectively. The differences in the diameter of the scoring volume mainly influenced the build-up area. Figure 1 presents an example of a SOBP (range 15 cm, modulation 4.5 cm) comparing the three methods (a), and calculated with different scoring diameters (b). The pristine Bragg peak for the range of 15 cm is shown in Figure 1c.



Conclusion: Precise characterization of depth dose curves is very important in PSRS when the field size is small and the number of fractions is limited not allowing wash out of any dosimetric uncertainty. The Monte Carlo simulation of PSRS beamline was successfully benchmarked against measurements. This implementation will enable exploration of even smaller volumes and execution of treatment planning studies for PSRS.

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EP-1552

Phantom measurements and simulated dose distributions in pelvic Intra-Operative Radiation Therapy

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Purpose or Objective: Rectal cancer is the second most frequent tumour site treated with intra-operative electron radiation therapy (IOERT) in Europe, after breast cancer [1]. Unlike breast, the pelvic irradiation surface is usually irregular and/or concave, and bevelled applicators are frequently used. A previous study in phantoms has shown that the shape of the irradiation surface can alter the IOERT dose distribution, with possibly important consequences for the interpretation of in vivo measurements [2]. The aim of this work is to study pelvic IOERT dose distributions, by simulating clinical irradiation conditions using phantoms and computational models.

Material and Methods: A phantom was created in-house using a sacral bone model covered with 3mm thick radiotherapy bolus, as shown in Figure 1A. To simulate in vivo measurements, small pieces of Gafchromic EBT3 film (1.5x1.5cm2) were placed on this phantom, and irradiated with a 9MeV electron beam from a Varian 2100 CD conventional linear accelerator (LINAC), adapted for IOERT with a hard docking system of cylindrical applicators. The 7cm applicator with a 45° bevel (7B45) was used to irradiate the phantom. A numerical model of this IOERT system had been previously implemented using BEAMnrc, an EGSnrc based Monte Carlo code, and validated by comparison with water tank measurements. This computational model was used to calculate the IOERT dose distributions resulting from a few irradiation surfaces, with varying curvatures, to compare with the measurements performed with the phantom.

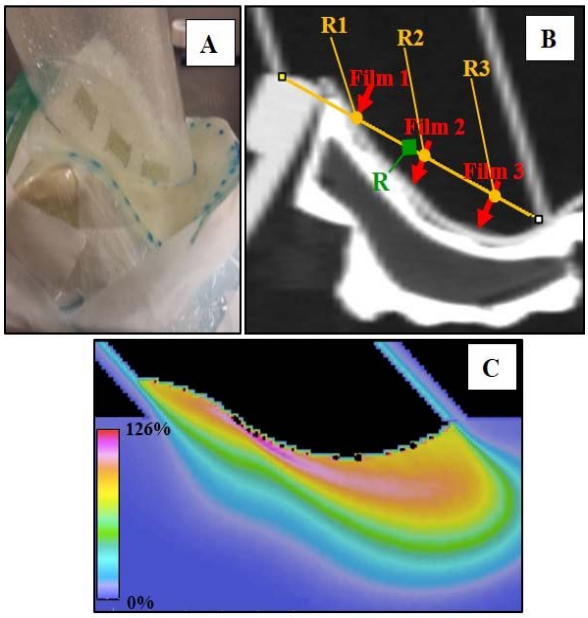

Figure 1 A. Sacral bone model covered with 3mm bolus, 3 film pieces, and the 7B45 IOERT applicator; B. Film locations on the phantom (red arrows) and film positions relative to a flat surface (R1, R2, R3); the green square (R) marks the reference point for surface dose on a flat surface; C. Dose distribution calculated with Monte Carlo simulation model, for irradiation of a curved surface.

Results: The surface doses measured with the films placed on the surface of the phantom (Film 1, 2, 3) were compared with the expected surface dose at the centre of the applicator (location R in Figure 1B) in reference conditions (flat irradiation surface). The percentage differences found are presented in Table 1. The variation introduced by the bevelled applicator along the applicator surface, in reference conditions, is also shown for comparison. The differences between the measured values and those expected for a flat surface (at locations R1, R2, R3 of Figure 1B), are in good agreement with the simulated results of curved surfaces with tissue inside the applicator, where a hotspot appears laterally (see Figure 1C).

	3 irradiations			Location (R1, R2,R3) relative to R	Diff_flat (%)
	Diff (%)	Diff (%)	Diff (%)		
Film 1	+16%	+19%	+18%	-1.3cm	1%
Film 2	+5%	+5%	+5%	+0.5cm	0%
Film 3	-5%	-3%	-4%	+2.7cm	-3%

Table 1. Diff: difference between the dose measured with films and the expected dose, Dexp, at the location R (see figure 1) in reference conditions (flat surface); Diff_flat: expected dose variation in a flat surface (due to the bevelled applicator), for comparison.

Conclusion: The results presented highlight the influence of curved and irregular surfaces on pelvic IOERT dose distributions, and the importance of taking the irradiated surface geometry into consideration when interpreting results of in vivo measurements.

1. Krengli M, Calvo F a, Sedlmayer F, et al. Clinical and technical characteristics of intraoperative radiotherapy. Analysis of the ISIORT-Europe database. Strahlentherapie und Onkol. 2013;189(9):729-37.