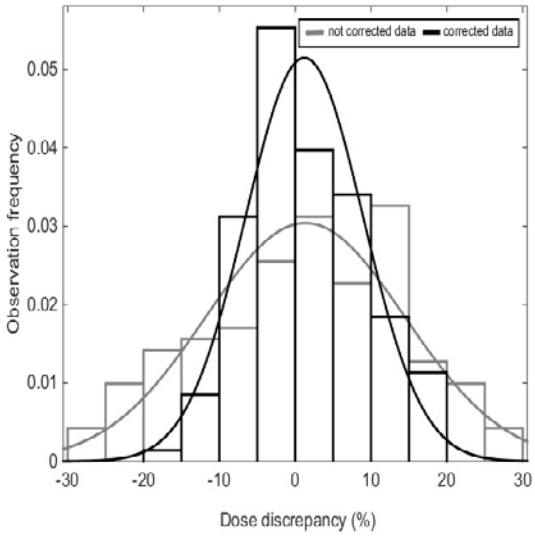
October 2015 and retrospectively analysed, providing 141 dose measurements for all the MOSkins. Measured and calculated contributions by each single catheter were quantified separately. Discrepancies were plotted depending on weighted average polar angles and distances between MOSkins and source, and a linearly fitting CF was calculated.

Results: A correction function CF linearly depending on the weighted average distance and polar angle of the catheter from the dosimeter was obtained (R=0.35, showing a significant correlation). The results showed an increase in sensitivity of MOSkins at higher distances (i.e., due to radiation softening) and at wider polar angles (i.e., due to increased radiation contamination by the presence of the TRUS probe). The percentage dose discrepancy between calculated and measured dose contribution from each single catheter with and without the application of obtained CF resulted in 1.3±13.1% and 1.2±7.7% (k=1), respectively (figure 1).



Conclusion: The use of the CF significantly reduces percentage discrepancy between planned and measured dose per single catheter. Implementation of the CF to correct MOSkin readings online is a further step towards accurate and reliable real time IVD in prostate BT performed with the DPP. Based on the real time measured dose discrepancy, the next step will be defining an action protocol to use the acquired information online.

OC-0256

Column generation-based Monte Carlo treatment planning for rotating shield brachytherapy

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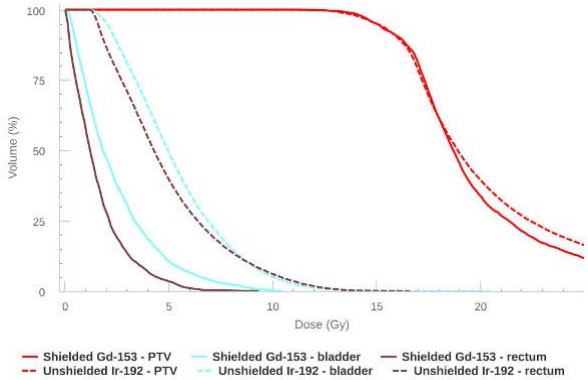
Purpose or Objective: Rotating shield brachytherapy (RSBT) is an intensity modulated high dose rate (HDR) BT treatment technique, where radiation sources are surrounded by catheters containing rotating shields that direct radiation towards the tumour and away from healthy tissues. RSBT for HDR requires sources with lower energies than Ir-192, such as Gd-153 and Se-75, due to shield thickness constraints. The distinct features of shield angle, catheter material and source isotope require the development of a specific Monte Carlo (MC)-based treatment planning and optimization system.

Material and Methods: An MC based dose calculation engine for RSBT has been developed and coupled with a column-generation optimizer. At every iteration of the optimization loop, the column-generation process solves a pricing problem to determine the best dwell position and shield angle combination to add to the treatment plan, resulting in the best possible plan with the shortest treatment time.
As a source model, the microSelectron-v2 source geometry was selected and placed inside a cylindrical platinum shield with a diameter of 1.8 mm and 3.0 mm for interstitial and intracavitary cases, respectively. An emission window coinciding with the active core of the source was created by removing half (180º) of the wall of the shield.
For an interstitial prostate case, RSBT plans were generated only using Gd-153 as a source due to the extreme limitations on shield size in interstitial catheters. For the intracavitary GYN case, both Gd-153 and Se-75 plans were generated. All RSBT plans were compared with conventional HDR BT. Only the original dwell positions used in conventional BT were sampled to create the RSBT plans.

Results: RSBT plans resulted in a considerable reduction in both rectum and bladder doses without sacrificing target coverage for the prostate case. With 95% of the PTV volume receiving over 15 Gy, only 40% of the rectum volume received more than 2 Gy for the Gd-153 RSBT case,as opposed to 85% for the unshielded Ir-192 conventional plan.



For the GYN patient, the median rectum dose was 2.4 Gy, 3.2 Gy and 3.45 Gy for Gd-153 RSBT, Se-75 RSBT and unshielded Ir-192, respectively, with an identical target coverage. The Gd-153 case was also able to reduce the dose to the bladder by 41%.

Conclusion: The development of the first MC-based TPS devoted to RSBT has been successfully accomplished. For the prostate case, a significant dosimetric improvement was achieved over conventional BT using Gd-153 with optimized shield angles. For the GYN case, the improvement was diminished by the central position of the conventional BT dwell positions within the target volume. RSBT allows the placement of dwell positions much closer to normal tissue, which will yield superior dose distributions when properly optimized. RSBT will decrease normal tissue toxicity and allow for tailoring treatments to each individual patient by treating all parts of the tumour without over-irradiation of large regions of normal tissues.

Proffered Papers: Physics 6: Radiobiological modelling

OC-0257

A Bayesian network model for acute dysphagia prediction in the clinic for NSCLC patients

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Purpose or Objective: Acute dysphagia is a frequently observed toxicity during concurrent chemo-radiation (CRT) or high-dose radiotherapy (RT) for lung cancer. This toxicity can lead to hospitalizations, treatment interruptions and

consequently reduce chances of survival. Models to predict acute dysphagia are available. However, these models were based on limited amounts of data and the performance of these models needs improvements before implementation into routine practice. Furthermore, Bayesian network models are shown to perform better than conventional modeling techniques on datasets with missing values, which is a common problem in routine clinical care. In this work, we train a Bayesian network model on a large clinical datasets, originating predominantly from routine clinical care, to accurately predict acute dysphagia in NSCLC patients during and shortly after (C)RT.

Material and Methods: Clinical data from 1250 inoperable NSCLC patients, treated with radical CRT, sequential chemo-radiation or RT alone were collected. The esophagus was delineated using the external esophageal contour from the cricoid cartilage to the GE junction. A Bayesian network model was developed to predict severe acute dysphagia (Grade 3 according to the CTCAEv3.0 or v4.0). The model utilized age, mean esophageal dose, timing of chemotherapy and N-stage to make predictions. Variable selection and structure learning was done using the PC-algorithm. The model was trained on data from 1250 patients. The model's performance was assessed internally and on an external validation set (N=218) from the United Kingdom. Model discriminative performance was expressed as the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC). ROCs were compared using the method proposed by DeLong and colleagues. Model performance was also assessed in terms of calibration. Calibration refers to the agreement between the observed frequencies and the predicted probabilities and is expressed as the coefficient of determination (r2).

Results: One-hundred forty patients (11,2%) developed acute dysphagia (≥ Grade 3 according to the CTCAEv3.0 or v4.0). The model was first validated internally, by validating on the training cohort (N=1250, AUC = 0.77, 95% CI: 0.7325-0.8086, r2 = 0.99). Subsequently, the model was externally validated on a UK dataset (N = 218, AUC = 0.81, 95% CI: 0.74-0.88, r2 = 0.64). The ROC curves were not significantly different (p = 0.28).

Conclusion: The Bayesian network model can make accurate predictions of acute dysphagia (AUC = 0.77, 0.81 in the internal and external validation respectively), making it a powerful tool for clinical decision support.

OC-0258

Linear-quadratic modeling of acute rectum toxicity in a prostate hypo-fractionation trial

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Purpose or Objective: In the Dutch prostate hypo-fractionation trial (19x3.4Gy versus 39x2Gy) a higher incidence of acute gastro-intestinal toxicity was observed in the experimental arm. We performed model estimations using various alpha/beta ratios to determine whether this difference can be explained according to the linear-quadratic model.

Material and Methods: Patients with localized prostate cancer were randomized between standard fractionation (SF=5x2Gy per week, N=293) and hypo-fractionation (HF=3x3.4Gy per week, N=285). Proctitis (grade 2+) was defined as moderate to severe mucous or blood loss, or mild mucous or blood loss combined with at least 2 other complaints: diarrhea, incontinence, tenesmus, cramps, pain. Peak incidences over treatment weeks 4 and 6 were available from prospectively collected patient reports. Normalized Total Dose (NTD, 2Gy equivalent) was accumulated per week for alpha/beta ratios of 3, 5, 10, and∞ (=physical dose), and used to derive relative Dose-Surface Histograms (DSHs) of the delineated anorectum for each patient. Maximum likelihood logistic regressions were performed using a DSH point as variable. Univariate (UV) models and multivariate (MV) models with fractionation schedule as factor were constructed.

Results: Acute proctitis incidences were highest for hypo-fractionation (SF: n=67; 22.9%, HF: n=98; 34.3%, p<0.01). The 7Gy/week DSH point correlated well with proctitis, and was used for subsequent modeling. Figure 1 illustrates the models for the various alpha/beta ratios, and incidences for five (roughly) equal size patient bins. Note that the NTD correction decreases the surface areas that receive <2Gy per day, and increases surfaces receiving >2Gy. The central NTD values of the patient bins therefore lie at higher values for HF than for SF. The MV models have higher likelihood than the UV models, but likelihood for different alpha/beta ratios is similar. All MV models have odds ratios >1.5 (p<0.05) for HF versus SF, i.e. fractionation remains a factor.

Conclusion: Linear-quadratic dose correction cannot explain the observed acute rectum toxicity difference between hypo-fractionated and standard treatment in patients with prostate cancer. Subsequent modeling will concentrate on alternative mechanisms.

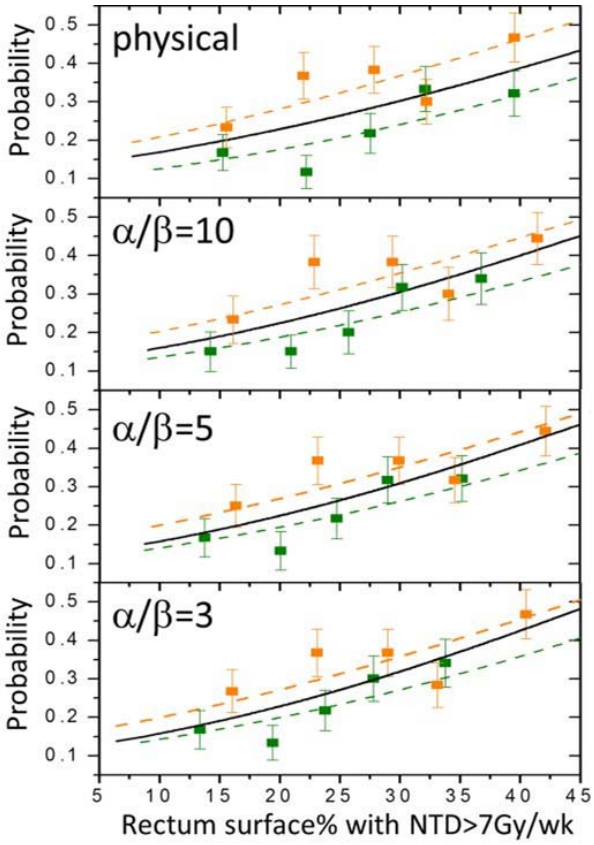

Figure 1 Acute proctitis models (UV solid, MV dashed) for standard (green) and hypo-fractionation (orange)

OC-0259

Spatial rectal dose-response for patient-reported leakage, obstruction, and urgency in prostate RT

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