

Purpose/Objective: To implement a time effective solution to enable radiotherapy centres across the UK to remotely access and register a database of CT/CBCT images. The purpose was to facilitate the IGRT training and assessment of RTTs throughout the UK in order to provide QA for those clinical trials requiring IGRT.

Materials and Methods: The process was initially implemented for the HYPofractionated Bladder Radiotherapy with or without Image guided adaptive planning (HYBRID) Trial (CRUK/12/055), requiring CBCT analysis for plan of the day selection. The anonymised treatment datasets from 5 patients, each containing 6 CT/CBCT images registered to the acquisition position, were imported into two vendor systems. Three patient cases (18 CBCT images) and the consensus plan of the day selection, consistent with the HYBRID Trial RT guidelines, were provided for training. 2 patient cases (12 CBCT images) were provided for assessment. Detailed instructions and support were provided for participating centres in remotely accessing their vendor appropriate database.

Individual centres were asked to complete an internet survey to obtain feedback on the process regarding image quality, usability, and general experience.

Results: Remote training has been accessed by 10 Radiotherapy centres across the UK recruiting patients into the HYBRID Trial. One centre completed the training as a group, while others accessed individually. The assessment required individuals to perform a bladder registration of CT and CBCT, and select the correct treatment plan from a library of 3 plans. This has been completed by 67 Individuals. 54 individuals successfully completed the assessment cases with a pass mark of 83% (10/12 cases) or above on a first attempt; the remaining 13 achieved the pass mark on a second attempt following verbal feedback on the QA process. A pre-requisite of the adaptive trial was that centres had previous experience in CBCT soft tissue analysis for bladder cancer. The majority of centres (70%) reported individuals taking less than 1 hour to complete the training cases and 86% of the respondents reported that the image quality across the systems was sufficient for them to effectively carry out the assessment.

All centres responded that the training and assessment cases provided were sufficient to familiarise them with the trial protocol, and that the training and assessment had prepared them for plan selection within the trial.

Conclusions: It is feasible and practical to use remote systems to train and assess IGRT competency for multi-centre clinical trials. This solution will be extended to UK clinical trials involving IGRT for other anatomical sites.

OC-0565

Identification of a rectal sub-region at risks of toxicity in prostate cancer radiotherapy

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Purpose/Objective: In case of prostatic irradiation, dose constraints are designed for the whole rectum. A rectal sub-region (RSR) may be especially involved in the risk of toxicity and may be highly predictive of toxicity. The goal of this work was to characterize this RSR.

Materials and Methods: A total of 118 patients (pts) having received a total dose of 80Gy in prostate by IMRT with IGRT were included in this study. Rectal bleeding (RB) at three

years was analyzed (\geq grade 1). A total of 31pts suffered from RB. Following a leave-one-out cross validation scheme, each patient was chosen as anatomical template of reference (ATR) towards which the anatomies of the 117 remaining patients were non-rigidly registered. The planned dose distributions of each patient were then propagated into the space of the ATR. A voxel-wise comparison (Mann-Whitney) was performed between the registered dose distributions of the two groups of pts (i.e. pts with or without RB). This enabled the segmentation of a RSR where the difference of dose between the two groups was significant ($p < 0.05$). This RSR was then spatially characterized and its predictive performances were quantified by the area under the curve (AUC) resulting from logistic regression at each bin of its DVH.

Results: The average volume of the identified RSRs was 2.8cm³ (3.4% of the absolute rectal volume). The RSRs were mostly located in the anterior rectal wall (90% of the volume located at less than 16mm from the prostate) and in the inferior part of the rectum. In these RSRs, pts with RB received in average 3.8Gy more than the pts without RB. The AUC in the RSR was 71% whereas the AUC was 63% at the maximum in the other evaluated full rectum or rectal sub-regions (anterior rectal wall only...).



Conclusions: The identified RSR, likely involved in the risk of toxicity, is located in the anterior rectal wall, in the inferior part of the rectum. The RSR could be subject to specific dose constraints at the inverse planning step of IMRT to reduce the risk of toxicity, and be used to predict the risk of rectal bleeding.

Proffered Papers: Innovation in physics and technique of IORT

OC-0567

In vivo dosimetry in Intra-Operative Partial Breast Irradiations

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Purpose/Objective: A general principle in patient radiation protection is to give the smallest effective dose in diagnostic or in therapy procedures. Patients benefiting from Breast Conservative Treatment (BCT) will all require adjuvant radiotherapy. This radiotherapy is usually performed with external beam radiation but can be, in selected cases, also delivered intra-operatively in a single session. The purpose of

this study is to report the measured body exposures treated with single dose intra-operative electron radiation therapy (IOERT) in a large cohort of patients and to analyze which beam parameters impact the body exposure.

Materials and Methods: During an almost 5-year period, more than 500 Partial Breast Irradiation (PBI) procedures have been performed with IOERT in our institution for pT1N0 unicentric ductal breast carcinoma. A dose of 21 Gy was prescribed at the 90% isodose depth. Beam delivery was achieved with a Mobetron 1000 (Intraop, Sunnyvale, Ca). This mobile accelerator produces 4, 6, 9 and 12 MeV electron Beams with a 10Gy/min dose rate. Although the Mobetron is self-shielded device, a small component of straight X-rays radiation is always present during treatment delivery. In order to measure their body exposure coming from this straight radiation, three LiF Thermo-Luminescent Dosimeters (TLD) were positioned on each patient, respectively on the thyroid, on the contralateral breast and at the gonads level. The TLD were placed in an Aluminum container thick enough to provide electronic equilibrium and to stop any scattered electrons. TLDs were directly read just after PBI in a manual Harshaw reader under Nitrogen flow.

As a comparison, the body exposure in a series of 30 BCT patients treated with 6 MV external beams was measured in the same way.

Results: Mean doses for PBI treatments on the thyroid, contralateral breast and gonads were 0.82, 0.41 and 0.14 cGy respectively. Higher energy beam gives significant higher body exposure. The field size, ranging from 35 mm to 65 mm does not influence the body exposure. On the other hand, the treated quadrant has an impact on measured doses. Patients treated with external radiation received much higher body doses, from 25 times to more than 100 times higher for the contralateral breast.

Conclusions: As radiation protection is concerned, IOERT is a safe procedure and gives very small body doses, unlikely to increase the carcinogenic risk significantly, especially in the contralateral breast. Pregnant women might, in certain circumstances and with additional safety measures, be treated with the IOERT approach with an acceptable fetal dose.

OC-0568

Necessity of using an image modality to improve IORT dosimetry

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Purpose/Objective: To evaluate the necessity of using an image modality in order to improve and adapt the IORT dosimetry based on Monte Carlo simulations.

Materials and Methods: A model of the IntraBeam™ system has been previously developed with the GATE platform taking into account the different parts of the device. This study was performed on 25 patients. A preoperative CT acquisition of the patient breast was performed and included in the simulation allowing accurate dose calculation (Figure 1).

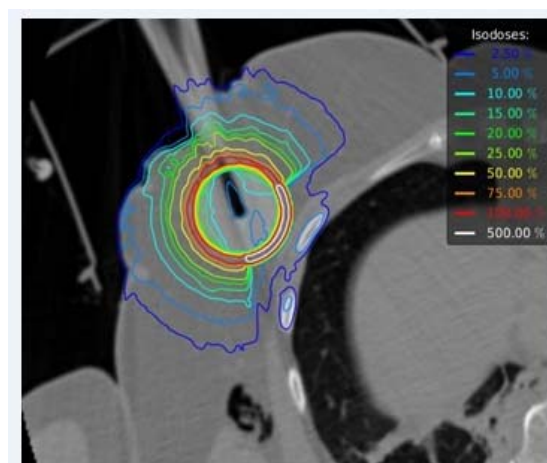


Figure 1: Dose distribution simulated on MC accounting for patient tissues heterogeneities.

During IORT, in vivo dosimetry was performed on 15 patients using thermoluminescent dosimeters (TLD) placed on the skin at 1 and 3 cm around the spherical applicator. First, comparison between simulation results on GATE and TLD measurements have been performed to confirm the dose prediction at the TLD locations. The dose simulated was recorded at the same initial position of the TLD. The depth dose curves between MC simulations and software computed doses have been compared. Then, the dosimetric influence of the applicator's position was simulated: the applicator has been moved from 5 mm to 10 mm around its initial position. Finally, in addition to pre-operative CT acquisition, an intraoperative CT has been acquired on three patients in order to validate the overall dosimetric evaluation protocol. **Results:** Patient results showed a good agreement between clinical experiments and simulations. Indeed the relative mean deviation between TLD and GATE dose measurements was $0.1\% \pm 0.11\%$ with a maximum of 0.33%. The simulation uncertainty was less than 1% (from 0.41% to 0.95%). Breast densities significantly changed the depth dose curves compared to the one given by the IntraBeam software which consider the breast as homogeneous. Considering the applicator displacement, the mean percentage deviation of the dose was $6.3\% \pm 44.9\%$, $8.8\% \pm 89\%$ at 5 mm and 10 mm respectively. These results indicated that the dosimetry was greatly influenced when moving the applicator position due to the high dose fall-off of the low energy x-ray source. **Conclusions:** We proposed the use of an accurate model of the IntraBeam system on the GATE platform accounting for the tissues heterogeneities. Using a pre-surgery image modality could greatly optimize the dosimetry by determining a better applicator position. The dosimetric evaluation of the proposed platform with patient datasets supports its use for patient specific dosimetry planning. By this way we should be able to adapt a personalized dosimetry and not also prescribe the same dose to all the patients.

OC-0569

Optimized Monte-Carlo intra-operative radiotherapy dose prediction for flat and surface applicators

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