simulated errors had gamma values greater than 1, and fail the criteria. In addition to dwell positions and times analysis, the system was capable of determining the transit time between dwell positions and its effect on the estimated dose delivered when compared against the treatment plan.

Figure 1 - The position-time gamma analysis of the modified plan.

Conclusions: Our application of the developed quality assurance system ‘magic phantom’, to HDR brachytherapy has demonstrated ability to perform the verification of all HDR treatment plans. This device has shown potential to be the comprehensive QA solution for the entire treatment delivery, with further development of this system focused on real time in vivo source tracking.

OC-0273
Commissioning of a model-based dose calculation algorithm for brachytherapy according to the TG-186 report
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Purpose/Objective: One of the important proceedings of brachytherapy during the last years was the clinical implementation of modern planning algorithms. To provide guidelines to the medical physicist the AAPM TG-186 published a report that describes procedures for commissioning new treatment planning algorithms (TPSs) in brachytherapy. To evaluate the guidance of this report from the end-users perspective we describe in this work the commissioning process of a commercial model-based dose calculation algorithm (MBDCA) for an HDR afterloading device in our clinic according to TG-186. We furthermore study complemental dose measurements.

Materials and Methods: The TPS BrachyVision v11.0.47 utilizing the dose calculation algorithm Acuros v1.5.0 for an Ir-192 HDR GammaMedplus afterloader (Varian Medical System, Palo Alto, CA) was used for this study. In the first step the commissioning process, as recommended by the TG-186 report, was followed for level 1. Dose comparisons between TG-43 formalism and Acuros were carried out in water medium for a single source scenario of 40700 U. Moreover hand calculations were performed for several points of interest using along away table for the relevant TG-43 consensus data. Measurements in a water tank (40x40x40 cm³) using a Semiflex chamber, type 31010, (PTW Freiburg, Germany) were conducted. Dose measurements are in particular of interest to validate the impact of heterogeneities in the Acuros module. They were carried out at various points of interest, laterally and distally positioned from the source. Therefor the source was either positioned in an implant needle made of steel or in a shielded 90° vaginal cylinder of 3.5 cm diameter. This shielded cylinder is also virtually available for dose calculation as template in the applicator library of the BrachyVision/Acuros system.

Results: Results of computations and measurements in water are summarized in Table 1. Hand and TG-43 based calculations are close to results of the Acuros computations (better than 2% for all points). As expected, dose measurements close to the source show deviations (about 30% at 1,14 cm), but reached reasonable accuracy at longer distances (e.g. 5% at 7,11 cm).

Dose values behind the shielding of the vaginal applicator are shown in Figure 1. Good agreement was reached between measurements and the results of the MBDCA. TG-43 formalism takes heterogeneities not in to account, so the computed doses are not accurate behind the shielding.

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Table 1: Overview on calculated and measured dose points for lateral distances r from the HDR GammaMedplus source. Hand calculated values from the along away (1°) tables indicated with *(1°)* are extrapolated.

Conclusions: Commissioning of a MBDCA is well feasible when following the TG-186 report, level 1. In addition dose measurements in water can complete the procedure to check the impact of heterogeneities in the medium.

Proffered Papers: Brachytherapy 7: Gynaecology

OC-0274
Development of rectal dose surface maps combining cervical external beam and brachytherapy doses
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Purpose/Objective: Dose surface maps (DSM) provide spatial features of the rectal wall dose distribution which has been shown to correlate with tissue toxicity in different ways (Buettner et al 2009). This study aims to develop the methodology and assess feasibility of using DSM to accumulate rectal wall dose from both external beam radiotherapy (EBRT) and brachytherapy (BT) in cervical cancer patients. This was previously not possible using conventional dose volume histogram due to lack of spatial information and challenges with anatomical difference between the two therapeutic modalities.
Materials and Methods: 20 cervical cancer patients who underwent treatment at Royal Marsden Hospital were identified retrospectively. Both EBRT and BT plans were retrieved from radiotherapy archive. The plans were anonymised and transferred to VODCA-RT (MSS GmbH,Hagendorf,CH) which is a dosimetric analysis software. The rectum was recontoured using standardised anatomical definition of 2.5cm from anal canal to the rectosigmoid junction. Posteriorly cut DSM were generated using VODCA-RT for both EBRT and BT. The raw data was then organised using in-house R script before being normalised to 21x21 pixels using MATLAB (Mathworks, Natick, MA). Assuming an α/β ratio of the linear quadratic model of 3Gy for the rectum, equivalent BED dose in 2Gy conversion was made using the equation shown below.

\[
DSM = \text{new dose} = \frac{\text{dose per EBRT fraction}}{\alpha \times \beta} \times \text{BED per BT fraction} \times \text{new number of BT fractions} \times \text{dose per BT fraction}
\]

Dose values of corresponding pixels were then summed to derive the respective DSM. Maximum rectal toxicity such as bleeding and proctitis within 6 months of treatment were also recorded using CTCAE v4.0. Statistical analysis was performed using MedCalc software v14.10.2.

Results: Combined rectal DSM were successfully generated for all 20 patients using our methodology. An example of a combined DSM is illustrated in figure 1. As expected, there was significant variation between the mean rectal volume during EBRT and BT (67.71cc and 53.99cc respectively, p=0.0189) due to presence of brachytherapy applicator and rectal retractor. There was also a mean difference of 0.93cm between EBRT and BT rectal cranio-caudal length (p=0.049). Normalisation to 21x21 pixels was therefore felt to be a good compromise to account for these anatomical differences whilst maintaining relatively accurate spatial dose distribution following dose summation. Consistent with previously published study by Buettner et al, ROC analysis on our data also demonstrated that lateral extent (rectal circumference) receiving >60Gy is a good predictor of risk of G1-3 proctitis (AUC=0.879, p<0.0001).

Conclusions: Rectal dose summation using DSM for cervical EBRT and BT is feasible. This method retains valuable spatial information which is closely correlated to toxicity. We propose a follow-up study with a bigger cohort incorporating organ motion for further validation of DSM as alternative easessment of rectal constraints in cervical cancer patients.

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Reference:

OC-0275
Critical evaluation and comparison of CT vs MR based HR-CTV and OAR contouring during IGT for cervical cancer
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Purpose/Objective: Radical radiation therapy comprising of external beam radiation therapy(EBRT) and intracavitary brachytherapy with concurrent chemotherapy,is the gold standard for management of locally advanced cervical cancers. Brachytherapy forms the mainstay of treatment for local control rates and toxicities.Recent reports indicate that image-guided BT (IGBT) improves local control and late morbidity. MR imaging is the gold standard for IGBT practice which have been well described in GEC-ESTRO I-IV recommendations.However, various survey reports suggest the limited availability of MR and logistics with radiotherapy units.On the other hand,CT Imaging is available in the radiotherapy units. There has been an increased interest in the use of CT during IGBT in Cervical Cancers. With an aim to validate CT based IGBT in terms of OAR and HR-CTV contouring we undertook this sub-study as a part of ongoing prospective EMBRACE study.

Materials and Methods: Patients who were recruited for the EMBRACE study ,after completion of EBRT,underwent CT application with MR/CT compatible applicators. A planning CT with I.V contrast and appropriate bladder filling protocol followed by T2w-MR Imaging for BT planning was performed. HR-CTV and OARs were contoured on CT images based on pre-Rx MR, clinical findings at diagnosis and at BT.First the contouring was done on CT images followed by on T2w-MR Images.HR-CTV and OAR volumes and HR-CTV dimensions (height, width and thickness) were analyzed and compared.

Results: So far, 27 patients (Mean Age:47±8.4 years) with histologically proven cervical cancer,with FIGO (2009) Stage IB to IIIB (IB2-1,IIB-13, IIIB-12, IVA-1) who underwent CT and MR during IGBT process were analyzed.The mean ± SD volumes of rectum, bladder and sigmoid on CT was 40 ± 20.0 cc, 79 ± 30.6 cc and 40.4 ± 26.7 cc as compared to 33 ± 11.6 cc, 84.7 ± 29.6 cc, 35.6 ± 19.7 cc on MR respectively.The mean ± SD HR-CTV on CT was 41 ± 23.6 cc while it was 42 ± 23.6 cc on MRI with a Pearson's correlation co-efficient of 0.921 (p<0.001). The mean ± SD maximum height, width and thickness on CT was 44.4 ± 10.5mm, 47.6 ± 6mm and 33.5 ± 5.3mm while it was 44.8 ± 10.5mm, 46 ± 7.2mm and 34.8 ± 7.5mm on MR. The correlation coefficients were 0.73 (p = 0.00) for height,0.61 (p<0.00) for width and 0.76 (p<0.00) for thickness.Since the correlation for width was least, we divided the patients into 3 groups:no parametrial invasion,medial parametrial invasion and lateral parametrial invasion at the time of BT. The correlation coefficient were 0.76 (p <0.00), 0.77 (p <0.00) and 0.54 ( p <0.53 ) for the three groups respectively. To estimate the differences further, the mean ± SD difference between CT and MR for various dimensions were as follows: 0.37 ± 7.6mm for height, -1.5 ± 4.8 mm for width and 1.3 ± 5.9 mm or thickness respectively.

Conclusions: As compared to MR Based contouring, the OAR and HR-CTV volumes are comparable.On evaluation of HRCTV maximum dimensions, the correlation was highest for...