of rotation is exhaustively searched on a grid of 9 different points separated by 1 cm from the center of the insertion area (Figure 1b). For the needle angulation, the method by Poulin (2013) for parallel needle positioning was adapted as follows: a heuristic is determined by projecting the planning target volume (PTV) from the center of rotation into a transverse plane and k-means clustering on the indices of the latter surface is applied (Figure 1c). The dwell time is determined by the resolution of linear equations following a similar method described by Goldman (2009) for external beam radiotherapy, called Fast Inverse Dose Optimization (FIDO). To test this optimizer, a planning study for focal prostate brachytherapy was performed. The optimal parameters were determined to obtain the desired coverage (PTV D95 of 19 Gy) without exceeding the constraints of the organs at risk (D10% urethra of 21 Gy, D1 cc bladder and rectum of 12 Gy). The dose distribution was calculated on 10 patients (PTV volumes ranged from 8.5 cc to 23.3 cc with a median of 16.1 cc) for 2, 4, 6, 8, 10, 12 and 14 needles by using the earlier mentioned constraints as input.

Results: The average coverage (D95 of PTV) and the dose on the organs at risk (D10% urethra, D1 cc of bladder and rectum) for all 10 patients are depicted in Figure 1d. The quality of the dose plan increases with the number of needle insertions. On average, a clinical acceptable plan is already reached by using four needle insertions. The complete optimization workflow took less than 20 minutes on a PC with a 3.10 GHz Intel® Core™ i5-2400 processor and 8 GB RAM using MATLAB R2013a.

Conclusions: The efficacy of the automated optimization tool was demonstrated for focal HDR prostate brachytherapy with divergent needles. On average, clinically acceptable plans were achieved using 4 needles or more.

PD-0180
Use of 3D-ultrasound for cervical cancer brachytherapy: an imaging technique to improve contouring
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Purpose/Objective: To determine whether a real-time 3D-ultrasound (3DUS) imaging improves brachytherapy structure delineations for cervical cancer.

Materials and Methods: MRI, CT, 3DUS (Clarity AutoScan, Elekta, Montreal) and CT-3DUS fusion were all used for imaging the structures of interest (HR-CTV, cervix, uterus and rectum/sigmoid) for cervical cancer brachytherapy treatments of 8 consecutive patients. MRI images were acquired prior to brachytherapy following EBRT. 3DUS was performed simultaneously to the CT planning in the treatment room. Fusion between 3DUS and CT was performed on the Clarity workstation and the contours were traced using the OncentraBrachy planning system (Elekta). Contouring was done by 3 physicians: 2 radiation oncologists (RO1 and RO2) and 1 diagnostic radiologist (DR) specialised in gynaecology. MRI contours traced by the DR were used as the reference set even though the applicators were not yet in place. The cervix and the HR-CTV were contoured three times by the DR to validate the stability of the reference. The absolute volumes and the transverse and longitudinal dimensions of the HR-CTV were compared with the reference for each imaging modality and physician.

Results: As expected the CT volumes are larger than MRI (Table 1). The MRI contours of the DR and the ROs are significantly larger than the intra-observer variability. The difference comes from the fact that ROs include treatment considerations, which is not the case with the DR. The 3DUS volumes are closer to the MRI volumes for each physician, but standard deviations are the largest (32% to 42%). CT-3DUS fusions keep the benefit of 3DUS alone for volume definition while reducing significantly the variability for each physician. The variation in longitudinal dimension of the contours was found to have the largest impact on both inter-observers and inter-modalities differences in volumes.

Conclusions: Generally, 3DUS allows for contours closer to MRI, but offers little information on the OARs. The CT-3DUS helps to get that extra information and offers, in axial slices, contours closer to MRI in all cases for the ROs compared to the CT alone. The learning curve of 3DUS could also explain the large standard deviation seen. This technology is promising and requires further investigation to determine its usefulness in treatment planning.

PD-0181
Image-guided adaptive brachytherapy for cervix cancer: higher target dose by increasing planning aim
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Purpose/Objective: Image-guided adaptive brachytherapy (IGABT) is increasingly implemented as a treatment modality for patients with cervical cancers. The use of intercavitary (IC) and interstitial (IS) implants enables higher conformance of target dose and sparing of organs at risk (OAR). Until August 2014 our planning aim for HR-CTV D90 was 81 Gy\(_{a/b=10}\). Data from the EMBRACE study suggests that the planning aim should be above 85 Gy\(_{a/b=10}\) and in September 2014 this was implemented in our clinic. In this retrospective analysis data from 19 patients subjected to the new planning aim were compared with data from patients treated before September 2014.

Materials and Methods: Since September 2014 19 patients have been treated with conformal external beam radiotherapy (EBRT) to 50.4 Gy in 28 fractions in combination with IGABT, using 5 or 4 fractions with a planning aim of 5.5 Gy or 6.5 Gy, respectively. For each brachytherapy fraction 3D image-guided treatment planning was performed to optimize the dose to the target volumes while keeping the dose to the OARs as low as possible. Dose-volume-histogram parameters for the target volumes and the OARs were recorded for each fraction and EQD2 total doses were calculated. The dose-volume-histogram parameters for this patient cohort were compared with a patient cohort of 147 patients treated prior to September 2014. The latter cohort were treated with EBRT to a total dose of 50 Gy in 25 fractions in combination with IGABT, using 5 fractions with a planning aim of 5 Gy per fraction.

Results: Figure 1 shows the percentage of patients that received HR-CTV D90 >81, >85, >87, >90 Gy\(_{a/b=10}\), with and without needles when the HR-CTV planning aim was 81 Gy\(_{a/b=10}\) and 85 Gy\(_{a/b=10}\). For the lower planning aim the fraction of the patients treated with HR-CTV D90 >81 Gy\(_{a/b=10}\), D90 >85 Gy\(_{a/b=10}\), D90 >87 Gy\(_{a/b=10}\) and D90 >90 Gy\(_{a/b=10}\) was 86%, 61%, 46% and 34%, respectively. For the higher planning aim these figures increased to 95%, 90%, 68% and 36%. The largest improvement was seen for the percentage of patients receiving D90 >85 Gy\(_{a/b=10}\). For the patients treated without needles, we were able to achieve D90 >85 Gy\(_{a/b=10}\) for 83% of the patients, compared to 69% when we used the lower planning aim. For patients treated with needles, we were able to achieve D90 >85 Gy\(_{a/b=10}\) for 45% when we used the lower planning aim. Table 1 shows that the dose to the OARs are unchanged for both planning aims, which proves that we were able to increase the target dose without increasing the dose to the OARs. Needles were used in at least one fraction for 36% of the patients when the planning aim was 81 Gy\(_{a/b=10}\) compared to 63%, when the planning aim was 85 Gy\(_{a/b=10}\).

Conclusions: When the planning aim was increased, we were able to increase the target dose while keeping the doses to the OARs unchanged. Increasing the planning aim improved the quality of the dose distribution. This was either achieved by improving the dose optimization, by implanting more patients with needles or by using a higher number of needles per implant.

PD-0182 Prediction of needle placement in the first fraction of cervix brachytherapy: pre-MRI plan versus expert opinion

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Purpose/Objective: The Utrecht applicator (Elekta, Veenendaal, the Netherlands) used in the brachytherapy (BT) treatment of cervix carcinoma has the possibility to include up to 10 interstitial needles along with the intra-uterine and ovoid channels. The choice of needles and their insertion depth in the first fraction is based on discussion amongst radiation oncologists, medical physicists and RTTs, the so-called ‘expert opinion’, making use of the MRI scan (without applicator in place) recorded in week 3 or 4 of external beam radiotherapy (EBRT) (pre-MRI). The purpose of this study is to investigate whether a pre-MRI simulation can predict more accurately which needles are best suited for use in the first BT fraction.

Materials and Methods: For 5 patients the high risk CTV (HR-CTV) was delineated on the pre-MRI. Using the ‘applicator modeling’ functionality the applicator was simulated on the MRI, the so-called ‘pre-plan’. The applicator model was correctly placed virtually, and the needles which obviously entered the HR-CTV were reconstructed. Needles were then discarded based on a few criteria. Only needles with more than one active source position well within the HR-CTV were included. Furthermore, needle positions always avoided in