Material and Methods: Five patients, treated using a SIB-IMRT technique, were included in this retrospective study. For all patients, a new planning CT (CT2) had been performed after observing anatomical changes between the initial planning CT (CT1) and CBCT images. For this study, CT1 was registered with CBCT by using a DIR algorithm (SmartAdapt v13.5, Varian Medical Systems). We obtained a new CT (CTdef) by applying the deformation field both on CT1 and on contoured structures. We copied and recalculated the initial plan to CTCdef. To assess whether replan was really needed at that time, we proposed a two-step algorithm (figure):

Impact of changes on targets coverage. This evaluation was twofold. On one hand, we assessed the dosimetric coverage and homogeneity of CTVCTdef by comparing D98% and D2% to initial ones. On the other hand, we defined a geometric overlapping index (OI) as the percentage of CTVCTdef volume inside PTVCT1.

Impact of changes on OARs coverage. We focus on two dose-volume indices, V30Gy of parotid glands and D2% of spinal cord on CTCdef. The tolerance limits were set as the range of variability of those indices by shifting the isocenter of the original plan on CT1 up to 3mm (the CTV to PTV margin) in each direction.

Results: Table 1a shows the dosimetric differences when recalculating the original plan on CTdef. Only patient #2 (highlighted data) should have been replanned.

The differences between using a new CT or the CTdef for dose planning are shown in Table 1b. CT2 and CTdef are equivalent since plans on CT2 can be transferred to CTdef with equivalent dosimetric results. Patient #3 was excluded because, additionally to anatomical equivalent since plans on CT2 can be transferred to CTdef.

Conclusion: The proposed algorithm is a useful tool to decide whether is necessary to replan a treatment, thus avoiding unnecessary ART for a significant number of patients. We showed that CTdef provides a valid new planning CT for those patients which must be replanned, thus avoiding unnecessary scans.

EP-1821
Adaptive external radiation therapy of cervical cancer with different uterine fundus positions
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Purpose or Objective: Adaptive strategies for external radiation therapy of cervical cancer may counteract that parts of the target volume may receive too low radiation doses due to interfractional uterus movement. This has become more important when using advanced radiation delivery techniques (IMRT/VMAT) with highly conformal dose distribution to the target volume. We have retrospectively tested a simple adaptive strategy with different PTV shapes covering possible movement of the fundus of the uterus.

Material and Methods: For 5 cervical cancer patients treated with external radiation, the planning CT and CT scans taken throughout the treatment course were used as a basis for the study. For each patient the uterus was delineated as CTV in the planning CT with an uniform CTV to PTV margin of 1 cm. Two additional PTVs were delineated to account for a +/- 0.5 cm shift in the position of fundus uterus in the anterior-posterior direction. The PTV of the affected lymph node areas was added to the 3 PTVs to make up a final PTV for treatment planning, and corresponding WMAT plans were made for each case. The conventional treatment plan was based on the uterus position in the planning CT, and the two other plans were used as possible adaptive “plan of the day” for each treatment fraction. 8 - 19 CT scans were taken throughout the treatment course for each patient, and the volume of the part of uterus receiving less than 95% of the prescribed dose for each fraction was calculated for both conventional and adaptive strategies.

Results: For the conventional treatment, parts of uterus receiving less than 95% of the prescribed dose was found in 4 of the 5 patients recorded, corresponding to 29 of the overall 52 CT scans taken throughout the treatments. The mean volume of the under dosed part of the uterus was 18.4 cm3. The adaptive approach improved the dose coverage for all the under dosed fractions; 4 fractions in 3 of the patients received adequate doses to the whole uterine volume, and for the other fractions the mean volume of the under dosed part of uterus was reduced by 30 - 67 % for the actual patients.

Conclusion: For external radiation of cervix cancer, the proposed simple adaptive technique, based on only one planning CT, increased the volume of the uterus receiving > 95 % of the prescribed dose for all the fractions tested. However the approach did not give adequate dose distribution to the whole uterus for all fractions for the adaptive PTVs used in this study.

EP-1822
Limits and potentialities of the use of CBCT for dose calculation in adaptive radiotherapy
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Purpose or Objective: To evaluate the feasibility of using CBCT images for dose calculation and to identify the most convenient calculation approach for replanning in Adaptive Radiotherapy (ART). For large cone beam geometry, scattered radiation and beam hardening cause uncertainties in the estimation of tissue electron densities (pel). Different strategies have been adopted over the last decade to face this problem but there is no agreement on the results obtained with each technique.
Material and Methods: By using a CIRS 062 phantom, conversion curves (Hounsfield Unit, HU, to ρel) for two different Varian CBCT models and for head and pelvis protocol were measured. Diffusing material was added to the phantom to simulate the typical dimensions of the anatomical districts. A dosimetric analysis was then performed for CIRS phantoms and patients treated for H&N and prostate cancers, by comparing dose distributions calculated on the same CBCT using different HU-pel conversion curves. For each case, the plan-CT and CBCT images were registered rigidly. A VMAT plan was generated on the plan-CT and transferred to the CBCT. The dose was calculated on the CBCT without heterogeneity corrections, using the plan-CT conversion table and using the CBCT site-specific conversion tables. The distributions were compared to the reference distribution (Dref) with 3D gamma analysis, Dref being the dose calculated on the plan-CT using its proper conversion curve. For each comparison the net disagreement was calculated, i.e. the percentage of points that exceeded gamma criteria without taking into account discrepancies due to registration errors (DTA = 2mm for phantoms, 3 mm for patients).

Results: For the CIRS phantoms, the CBCT conversion curves gave good results for dose calculation: mean net disagreement for gamma criteria D0-1% was lower than 1%. For the pelvic region, the best results were obtained without applying heterogeneity corrections to the calculation. The dosimetric discrepancies with respect to Dref were few and mostly below 2% of the local dose. For H&N patients, calculations with the CBCT site-specific conversion curves showed the smallest discrepancies with Dref. On average, 0.4% of the points showed discrepancies larger than 1%.

Conclusion: The differences between the results found for phantoms, pelvis and H&N patients highlighted the importance of careful evaluations for each anatomical region. The error introduced by calculating the dose on a CBCT is acceptable for ART. CBCT dose calculation could be used to monitor the entity of anatomical variations in the patients. An important limitation on the use of CBCT for treatment planning is the FOV dimension, often not sufficient to include the whole PTV or patient shoulders in case of H&N treatment. This affects dose calculation due to the lack of scattered radiation causing underdosages in cranial and caudal slices.

EP-1823
Characterization of KV- and MV-CBCT for personalized adaptive treatment therapy on RayStation TPS
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Purpose or Objective: Modern treatment therapy, with the combination of intensity modulated fields, dose escalation and small margins, is unthinkable without equipment that facilitates IGRT. Hence, the latest generations of linacs are equipped with modern KV and MV detectors, with enhanced image quality and precision. RayStation TPS exploits this development further, making it possible to use these image series to execute personalized adaptive treatment planning, by using the acquired CBCT during treatment. Our goal with this project is to characterize the geometrical and dosimetric (in terms of HU) accuracy of different CBCT types from different machines (Elekta XVI, Varian TrueBeam OBI and Siemens Artiste kView).

Material and Methods: Using CatPhan phantom, planning CT with a Philips BigBoard Brilliance, Head&Neck protocol were acquired and exported to RayStation TPS. The advantage of using CatPhan is, that it has both geometrically known and accurate measures, and inserts with known CT numbers. CBCT series were acquired by using Head&Neck protocols. The captured image series were then imported to RayStation, to execute personalized adaptive treatment planning. To test the feasibility of dose tracking approach in Head-and-neck (HN) cancer, two deformable image registration (DIR) strategies have been implemented and compared.

Material and Methods: Planning (pCT) and weekly (w-CT) acquired computed tomography (CT) scans of a cohort of 15 Head-and-neck (HN) cancer patients already prospectively enrolled in our Institute for a study on adaptive approach have been imported in RayStation TPS version 4.6.102.4 (RaySearch Laboratories AB, Stockholm, Sweden). The recently available hybrid algorithm was used including body contour as focus ROI and with/without manually contoured ROIs as controlling ROIs indicated as RH/H, respectively. DICE index was used to assess the goodness of propagation of contours generated by both DIR approaches. Doses/volumes statistics and radiobiological data were calculated and compared according DIR strategy.