Purpose/Objective: Adaptive radiotherapy aims to adjust the treatment plan during the treatment course to ensure correct target coverage and to avoid normal tissue complications.
The goal of this study was to investigate the effectiveness of an adaptive planning procedure incorporating offline dose feed-back to manage the entire treatment planning. To this purpose a retrospective analysis was performed on fifteen patients with prostatic tumor treated with IGRT-IMRT.
Materials and Methods: A Siemens Artiste™ was used for IGRT-IMRT treatments of the fifteen patients included in the study. Pinnacle3 Treatment Planning System (TPS) was used for the clinical practice while a beta version of Raysearch TPS was used retrospectively for the adaptive analysis. Quantec dose volume constraints were used for IMRT planning while for the PTV coverage $V_{98\%}$> 98%. The theoretical plan delivered to the patient, was re-calculated with Raysearch Station on the reference CT images. This plan was taken as the baseline of the treatment. The real dose delivered to the patient was calculated on the daily acquired CBCT and compared with the theoretical baseline. To track every treatment, the most significant cut off point for the rectum and for the bladder was identified for each patient, while for the PTV coverage $V_{98\%}$ was considered. All the treatments were analyzed performing a track with the most representative CBCT of the weekly treatments; a total of 8/7 CBCT were included in the recalculation.
Results: The PTV coverage of the delivered treatment recalculated on the daily CBCT not always satisfy the expected goal ($V_{98\%}$> 98%): 6 patients over 15 did not maintain at the end of the delivered treatment this desired percentage. The DVH cut off points for the bladder and the rectum resulting from the clinical optimization differ from those obtained with the real treatment delivered: one patient only over 15 failed for the bladder, while for the rectum all the patients respected the criteria at the end of the delivered treatment.
Conclusions: The offline dose compensation technique in image guide radiation therapy can effectively consider the residual uncertainties which cannot be corrected online. The comparison of the cumulative dose with the approved treatment planning dose, resulted in a deviation of the accepted initial conditions of PTV coverage and OARs constraints in six over fifteen patients. For these patients a well-timed re-planning during the treatment would have avoided these discrepancies. This retrospective analysis suggests the need of correction strategies to improve the final treatment.

EP-1514

Soft tissue vs. bony anatomy registration in an adaptive plan selection protocol for bladder cancer

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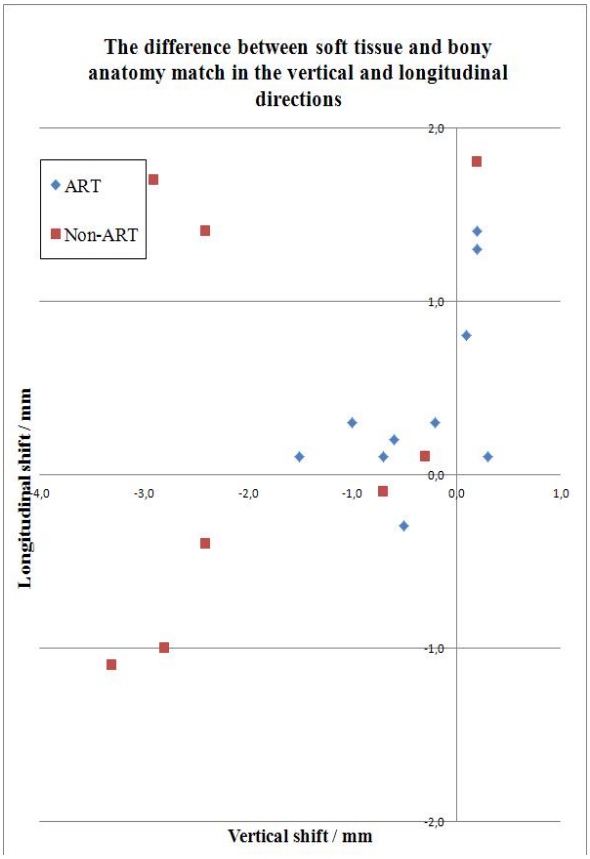
Purpose/Objective: In radiotherapy (RT) of urinary bladder cancer, variations in the shape, size and position of the bladder is a major challenge. Our institutions are therefore running a clinical ART daily plan selection trial for bladder cancer where the bladder every day is treated with the smallest possible PTV. Since the trial also includes patients who will receive elective lymph node irradiation, we are treating patients based on bony anatomy registration although set-up based on soft tissue (i.e. bladder) registration might be favourable. Still the increased patient awareness of the importance of having an empty bladder at each treatment session might reduce the difference between soft tissue vs. bony anatomy based registrations. In this study we are therefore comparing the difference between these two registration strategies for patients treated within vs. outside the adaptive protocol.
Materials and Methods: This study included both the first ten patients from our institution included in the bladder ART trial (treated from December 2013) as well as the nine last patients treated before enrolling patients in the trial. The difference between bony anatomy vs soft tissue registration was compared between these two groups using weekly CBCTs for all patients. For the bony anatomy registration, the patients were aligned on the whole pelvic bones excluding the moveable part of the femoral heads. The soft tissue match on the bladder the registration volume was narrowed to approximately 1 cm from the bladder-CTV. The difference between the registration strategies was assessed by calculating the vector length of the difference from Cartesian coordinates.
Results: Patients treated within the ART trial have a much stronger association between soft tissue and bony anatomy registration. Of the 10 patients treated with ART none had a vector length of the difference between the strategies larger than 2 mm. Conversely, for the 9 patients treated without ART only one patient had a vector length below 2 mm. The standard deviations of the vector length for all ART patients were around 1 mm while it ranged between 1 mm and 3 mm for the non-ART patients. The mean vector length of the difference was 1.5 mm for the ART patients and 3.8 mm for the non-ART patients the difference in the vector is statistical significant with a p-value of 0.0006. The vertical difference were statistical significant with a p-value of 0.0044 while the longitudinal and lateral differences had a p-value of 0.4128 respectively 0.9105
Conclusions: For patients treated with ART the difference between a bony anatomy and a soft tissue registration is in the order of 2 mm compared to 4 mm for bladder patients treated before enrolment in the ART protocol. This difference is possibly due to the increased patient-awareness to the bladder emptying instruction. This awareness also minimize the changes of the bladder during treatment leading to a smaller volume irradiated.



EP-1515

Evaluation of organ motion and uterine dose summation for IMRT in locally advanced cervical cancer

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Purpose/Objective: Interfractional changes in target and organ position and shape during external beam radiotherapy (EBRT) of cervical cancer patients may be of significant magnitude (Figure 1). To compensate for motion, application of relatively large CTV-PTV margins is often applied, which can reduce the clinical advantages of e.g. IMRT. The study aimed to evaluate the patterns of target and organ motion during EBRT and to evaluate the impact on dose delivery with specific focus on dose to the uterine body.

Materials and Methods: Ten patients with locally advanced cervical cancer treated with chemoradiation and brachytherapy were analysed. EBRT was delivered as 45-50 Gy in 25-30 fractions using daily online cone beam computed tomography (CBCT) for patient set up. Treatment was in supine position, and a drinking protocol was applied to obtain a full bladder. The clinical target volume (CTV) encompassed the gross tumour volume (GTV), cervix, parametrium, uterus, upper vagina and the nodal CTV. Cervix/uterus as well as bladder and rectum were delineated on each CBCT, and transferred to the planning CT. The impact of a reduced margin strategy of 0.5 cm CTV-PTV for the uninvolved uterus was compared to our standard of 1.5 cm. Uterus DVH parameters were extracted for each fraction and D98 was summed for both scenarios with evaluation of the percentage of fractions where D98 was less than 95% and 90% of prescribed dose. Bladder volume was assessed for each fraction to analyse for time trends and to evaluate a correlation between uterine coverage and bladder volume.

Results: In 6/10 patients the uterus D98 was at least 95% of prescribed dose in at least 92% of all fractions for the reduced margin strategy. In the remaining 4 patients the D98 was less than 95% in at least 5 fractions for the reduced margin strategy. In 2/4 patients the lack of coverage was correlated with the bladder filling which was significantly different from the bladder volume in the treatment planning scan (p=0.001, p=0.02). In 2/4 patients there was no correlation between bladder volume and lack of coverage (p=0.33, p=0.19). For all patients and for both margin strategies, the fractional dose summation for uterus D98 was >90% which corresponded to at least 40.5 Gy (table 1).

	Standard margin			Reduced margin		
Patient	90%*	95%*	Sum.dose**	90%*	95%*	Sum. dose**
1	70	70	92.4	67	47	90.3
2	100	96	97.2	100	92	96.7
3	100	100	97.5	100	100	97.2
4	100	93	97.1	100	66	95.4
5	100	100	94.4	100	100	94.5
6	100	100	96.7	100	96	97.3
7	100	96	97.0	100	25	94.2
8	89	79	95.2	79	61	94.2
9	100	100	97.7	100	100	96.6
10	100	100	97.2	100	100	97.5

* % of fractions covering at least 98% of the uterine volume with at least 90% and 95% of prescribed dose respectively.
** Fractional dose summation for D98≥95%.

Conclusions: Treatment plans with standard margin and reduced margin were robust to organ motion in terms of fractional dose summation. The uterus D98 was at least 90% of prescribed dose for all patients. Taking into account that brachytherapy delivers additional 5-10 Gy to the uninvolved uterine body, the summed uterine dose will be well above 45Gy, which is often considered appropriate for targeting tissue at risk of microscopic spread. Dose coverage was partly but not consistently correlated to variation in bladder volume. This may indicate that an adaptive radiotherapy approach based on a library plan selection strategy should include evaluation of bladder volume and location of uterine body.