Conclusion
These findings suggest that the strategies used to keep bladder and rectum volumes constant in these cohort of patients were useless to prevent GTV movement, sometimes beyond the PTV. This conclusion could be translated to the CTV. We highly recommended complementing these strategies with daily image guided IMRT. Our results support the notion of having plan libraries for preoperative rectal IMRT to adapt anatomic variations.

PO-1120 Deformable-image-registration-based Adaptive Radiotherapy on Halcyon's MV CBCT system
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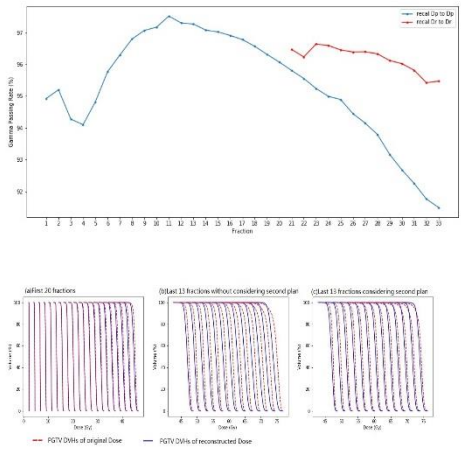
Purpose or Objective
Imaging dose integration as enabled by the MV CBCT system of Varian's new Linac Halcyon can avoid extra dose in image guidance as encountered by routine adaptive therapy(ART). To investigate benefits of ART on the new system, this work performed deformable image registration algorithm to reconstruct daily dose, validated the dosimetric accuracy and indicated appropriate time of replanning.
Material and Methods
A historical Nasopharyngeal Cancer patient treated by 33 fractions of one full-arc VMAT on Halcyon was studied. CT rescanning and replanning was conducted after 18th fraction due to macroscopic tumor shrinkage. Planning CT(pCT) and replanning CT(rCT) along with pre-treatment MV CBCT images were retrieved from Varian's ARIA system. Reconstructed dose of second plan (Ddir) based on pCT deformed to MV CBCT at 21st fraction was compared with original dose of second plan(Dgold) through a 3mm/3%/10%threshold global gamma analysis. With the DIR algorithm provided by Velocity AI, pCT was registered to MV CBCT at each fraction and produced a series of reconstructed dose of initial plan (rDp), which were further accumulated and compared with original dose of initial plan (Dp) scaled with fraction number. Taking replanning into account, reconstructed dose(rDr) of second plan based on rCT deformed to MV CBCT was used in place of rDp in the last 13 fractions and further accumulated with rDp in the first 20 fractions, which was compared with accumulation of second plan's original dose (Dr) in the last 13 fractions with Dp in the first 20 fractions. The accumulated dose comparison was restricted within the FOV of MV CBCT.
Results
91.01% of the dose grid points fall within 3mm/3% criteria of 10% threshold global gamma analysis with Ddir as evaluation and Dgold as reference, with over half of the dose grid points having a gamma index below 0.2. Using accumulated Dp as reference and accumulated rDp as evaluated dose distribution, gamma passing rates gradually increase from 95% to 97% due to averaging of random dose deviation, but decrease continuously after one third of the course, down to less than 92% in the end, indicating when anatomical variation began to take the major effect (Fig 1). In comparison, using Dr accumulated with Dp as reference and rDr accumulated with rDp as evaluated dose distribution, gamma passing rates maintain steadily above 95% (Fig1). In accordance, planned and recalculated DVHs of PGTV are largely overlapped in the first 20 fractions(Fig2(a)) but the disparity between DVHs gradually increase without replanning in the last 13 fractions (Fig2(b)), while high DVHs similarity is maintained when considering replanning in the last 13 fractions (Fig2(c)).
Conclusion
This study validates the dosimetric feasibility of dose reconstruction based on CT-to-MV CBCT deformable registration as conducted on the MV CBCT imaging modality provided by Halcyon that enforces image guidance at each fraction and takes imaging dose into account, providing guidance on time to replan.



PO-1121 Characterizing Dosimetric Uncertainties to Tumour Volume and Organs at Risk in Rectal Cancer
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Purpose or Objective
Avoiding adverse toxicities in rectal cancer is dependent on a high degree of accuracy and precision in treatment. However, the daily uncertainty with position and volume of the Organs at Risk (OAR) can result in an increased dose to these organs. In this study, we sought to characterize the inter-fractional uncertainties in target volume and OAR, and identify factors that might predict patients most likely to benefit from online plan adaptation.
Material and Methods
10 patients treated with neoadjuvant intensity modulating radiation therapy (IMRT) for locally advanced rectal cancer were retrospectively analysed. All patients received 45 Gy/25 fractions with simultaneous integrated boost (SIB) to GTV of 52 Gy total five times a week. The presence or absence of rectal gas was subjectively assessed in each patient's planning computed tomography (CT) and treatment cone beam CT (CBCT) images. Bladder volumes were re-contoured for all patients and mean bladder dose was calculated. Increased small bowel dose was assessed by a Yes/No criteria: Increased small bowel volume in the greater than 5Gy isodose region than was planned and/or increased dose to the small bowel of greater than 5Gy.
Results
30% of patients had rectal gas changes in greater than 50% of their CBCT images. Rectal gas changes were as common in the first week of treatment as during the remaining treatment course and no clear time trend was seen (36% versus 32.43%). Relative change in bladder volume varied extensively between and within patients. Average planning bladder volume was 399.51 ml (SD ± 273.93) versus 254.95 (SD ± 112.49) for the treatment CBCT bladder volume. No significant difference was seen in bladder volumes over the course of treatment (t statistic: -0.382; DF: 85; *p* value: 0.410), but 74% of treatment volumes were smaller overall for the duration of treatment in comparison to the initial planning bladder volumes. The mean bladder dose was correlated with the relative change in bladder volume (Regression coefficient: -0.68; Pearson coefficient: -0.67; *p* value < 0.0001). 64% of treatment scans met criteria for increased bowel

dose. A relative decrease in bladder volume was predictive of meeting criteria for increased dose to the small bowel (ß estimate: -4.7; Odds Ratio: 0.0091; *p* value < 0.0001).

Conclusion

Volume variability in the bladder suggests that the planned dose is not equivalent to the dose delivered to the OAR for the majority of rectal cancer patients. Early changes in bladder and rectal gas volume do not predict for late changes. Large decreases in bladder volume result in a dose increase to the bladder and small bowel dose metrics, which are in the clinically significant range.

Poster: RTT track: Patient care, side effects and communication

PO-1122 Assessment of bladder volume and urinary symptoms for patients undergoing prostate radiotherapy.

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Purpose or Objective

Patients undergoing prostate radiotherapy have been routinely instructed to obtain a full bladder. However, the achieved bladder volumes during treatment were often sub-optimal due to persistent issues of incontinence, frequency and side effects of treatment. Some of these patients undergoing radiotherapy to the prostate alone would have limited radiation dose to the bowels by default. This study investigated the achieved mean bladder volume in relations to pre-existing urinary functions and side effects after prostate (+/- seminal vesicles) volumetric modulated arc therapy (VMAT).

Material and Methods

20 patients undergoing prostate (+/- seminal vesicles) VMAT (74Gy, 37# over 7.5 weeks) were recruited in a prospective observational study to evaluate the impact of their urinary functions on bladder volume. 736 cone-beam computed tomography (CBCT) scans were used to analyse the overall bladder consistency. All the patients were routinely instructed to obtain a full bladder (150cm^3 as threshold) by voiding, followed by drinking 400-600ml of water and wait 30-60 minutes before CT simulation and daily treatment. No specific rectal preparations were given but all the patients were encouraged to empty their bowels before each procedure. Treatment planning constraints to the bladder (V_{70}, V_{65}, V_{60}) were routinely evaluated based on the Quantitative Analyses of Normal Tissue Effects in the Clinic (QUANTEC) guidelines and approved for treatment. Spearman correlation test was conducted to analyse the mean bladder volume of each patient in relations to their respective urinary functions that were assessed using the Common Terminology Criteria for Adverse Events (CTCAE, version 3) and International Prostate Symptom Score (IPSS) at three timepoints (pre-treatment, mid-treatment and post-treatment). A further Mann-Whitney U test was performed to analyse pre-treatment urinary functions between the patients with mean bladder volume <150cm^3 versus ≥150cm^3.

Results

The mean (range) population bladder volume was 152.2cm^3 (79.6cm^3-336.2cm^3). There was a moderate positive correlation between mean bladder volume with incomplete bladder emptying symptoms during mid-treatment (r_s=0.498, *p*=0.025) and post-treatment urinary straining (r_s= 0.491, *p*=0.028) respectively for the IPSS sub-scores. Patients with pre-treatment incontinence tend to achieve mean bladder volume <150cm^3 (n=11) versus those without ≥150cm^3 (n=9) (*p*=0.023). However, none of the CTCAE-assessed radiation-induced urinary side effects had showed significant correlation with the mean bladder volume.

Conclusion

This study suggests a further review on patient selection to be instructed with full bladder protocol as those with pre-existing urinary incontinence tend to sustain a smaller mean bladder volume during treatment. In addition, patients with larger bladder volumes sustained throughout the treatment may experience post-treatment urinary straining compared to those with smaller bladder volumes.

PO-1123 Could patient-related outcome measures help us in radiotherapy review clinics?

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Purpose or Objective

Common Terminology Criteria for Adverse Events (CTCAE) are widely used in radiotherapy (RT) review clinics to assess severity of acute toxicities. No clinical intervention is generally indicated in those with no toxicity (grade 0) or mild toxicity (grade 1) in contrast to those with higher grades of toxicity.

Toxicity symptom monitoring is an area in which patient self-reporting could be used to inform clinical interventions: If those with no or mild toxicity from RT could be identified through appropriate patient-related outcome measures (PROMs), this cohort could potentially be spared a face-to-face review in a RT clinic whereas those with greater toxicity could be identified for clinical review.

The aim of our retrospective analysis was to ascertain the frequency of different acute toxicity grades for patients on RT for breast and prostate cancer, which represent the highest volume tumour sites in our tertiary centre, to inform the usefulness of PROM collection.

Material and Methods

The trust's RT database was used to identify adjuvant breast RT and radical prostate RT patients between April and May 2018 inclusive. The RT clinic annotations for those patients were analysed and appropriate CTCAE toxicity grades were extracted for appropriate adverse events relevant for tumour site.

Results

116 breast and 91 prostate RT patients were identified. In the breast cohort, 89 patients suffered grade 0/1 toxicity at worst, representing 76.7% of the cohort. In the prostate cohort, 52 patients suffered grade 0/1 toxicity at worst, representing 57.1% of the cohort. No grade 3/4 toxicity was seen in either group. The most common grade 1 toxicity in the breast patients was skin toxicity (44.7%) and in prostate patients was urinary frequency (45.6%). Grade 2 toxicity in the breast cohort was largely skin toxicity (76.7%) and in the prostate group was principally urinary frequency (44.4%). In the prostate cohort, grade 2 toxicity was more commonly seen in those that received nodal RT versus those that did not (76.9% vs.37.2%), reaching statistical significance (p = 0.01); in the breast cohort, grade 2 toxicity was more common in those that received a boost versus no boost (35.3% vs. 21.2%) but not reaching statistical significance (p=0.20). Both the prostate nodal and breast boost RT groups represented a small proportion of their overall tumour-site groups (14.3% and 14.7% respectively).

Conclusion

A large proportion of patients on adjuvant breast and radical prostate RT suffer minimal acute toxicity with potential subgroups more likely to suffer toxicity. If appropriate PROM tools were developed to reliably identify these groups, both those who could safely avoid attending a clinic appointment in person and those who