PO-0982
The impact of plan complexity on the accuracy of VMAT for the treatment of head and neck cancer
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Purpose/Objective: In our department, Volumetric Intensity Modulated Arc Therapy (VMAT) is used to treat a variety of head and neck (H&N) cancers. Presently, the complexity of plans is limited to ensure the accuracy of patient treatment within the range of the departmental experience. The complexity limitation is applied through use of a monitor unit (MU) constraint during plan optimisation. Plans of higher complexity can be obtained by loosening the MU constraint, and setting more stringent optimisation objectives on organs at risk (OAR) and target volumes (PTV). This could potentially yield higher quality treatment plans but may also degrade the accuracy of the TPS calculation or the plan delivery at the treatment machine. The aim of this study is to investigate the level of plan complexity that results in accurate treatment plan calculation and delivery, and quantify the corresponding gain in plan quality.

Materials and Methods: Five previously treated H&N patients were selected for the study. Each patient’s clinical plan was used as the lowest complexity level and labelled C1. Subsequently, a pareto-optimal plan (C3) was created that focused equally on sparing spinal cord, brain stem and parotid gland while maintaining, or improving on, the previously obtained target coverage. Next, a C2 plan was created such that the plan quality was in between C1 and C3. Plan quality of each complexity level was assessed in terms of OAR sparing and PTV coverage. The average leaf pair opening (LPO), critical leaf pair opening (%LPO<1cm) and mean leaf travel were used as plan complexity metrics. The calculation and delivery accuracy of each complexity level using Varian TrueBeam LINAC/Eclipse TPS was verified using time resolved point dose measurements (TRPD), EBT film measurements (Ashland Inc.) and ArcCheck measurements (Sun Nuclear Corp.). A comprehensive uncertainty analysis was carried out including a quantification of the measurement and delivery reproducibility.

Results: Increasing plan complexity from C1 to C3 reduced the Spinal Cord Dmax, Brain Stem Dmax and Parotid Gland Dmax up to 12.9 Gy, 11.1 Gy and 7.4 Gy, respectively. In addition, C3 plans improved the target coverage compared to C1 plans, with the PTV66 and PTV54 D98 increasing up to 1.0 Gy and 0.6 Gy, respectively. The verification measurements showed that the plan calculation and delivery for all complexity levels was well within clinical acceptance levels (Table 1). TRPD showed that VMAT dose delivery itself was reproducible within 0.1% (1 S.D.) over 10 consecutive deliveries for both C1 and C3 complexity levels.

Conclusions: This study has shown that increasing the plan complexity can provide significant dosimetric advantages for the treatment of H&N cancer. Verification measurement results indicated that this did not noticeably degrade the calculation and delivery accuracy of VMAT using a Varian TrueBeam LINAC and our Eclipse TPS beam model.

Table 1: TRPD EBT film and ArcCheck results, %dosage was performed using ±2% ±2mm criterion

<table>
<thead>
<tr>
<th>Complexity Level</th>
<th>Mean point dose deviation ±1.5 S.D.</th>
<th>Mean EBT film % dosage ±1.5 S.D.</th>
<th>Mean ArcCheck % dosage ±1.5 S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>0.1%±0.4%</td>
<td>96%±3%</td>
<td>94%±4%</td>
</tr>
<tr>
<td>C2</td>
<td>0.1%±0.2%</td>
<td>97%±2%</td>
<td>96%±3%</td>
</tr>
<tr>
<td>C3</td>
<td>0.4%±0.1%</td>
<td>97%±2%</td>
<td>94%±3%</td>
</tr>
</tbody>
</table>

PO-0983
Accuracy of a 4D-PET system in determining the position of a mobile phantom
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Purpose/Objective: Positron Emission Tomography (PET) offers the opportunity of using biological and functional information when defining the Gross Tumour Volume (GTV) in the radiotherapy process. Respiratory motion causes blurring of the PET tumour image and misalignment between PET and CT. As a result, inaccurate tumour contouring can happen. A way to improve tumour definition is using a 4D PET, where PET images are acquired together with the breathing cycle. PET images are then rebinned into phases according to the respiratory curve. The purpose of this work is to estimate the error between the tumour location as detected by PET and the corresponding location of the respiratory curve.

Materials and Methods: A 1 ml-syringe half-filled with 0.3 mCi of 18F was attached to a respiratory phantom (AZ-733V, ANZAI MEDICAL Co). This phantom moves in cranio-caudal direction with nominal amplitude of 20 mm. The shape of the cycle can be set to sinusoidal or respiratory with a frequency of 10 or 15 rpm, leading to 4 types of movements. The phantom is synchronized with the PET, and also records the amplitude and time. A Siemens Biograph64 mCT was used to acquire 4D-PET images of the syringe in the 4 operating modes of the phantom. Lung gated protocol was used with matrix size of 200x200, leading to a pixel size of 1.02 mm. Plane spacing was set to 2 mm, and images were rebinned into 8 respiratory phases. Syringe was contoured in PET images for every phase in the software MultiModality WorkStation VE52A (MAMS, Siemens), using the 20% SUVmax as threshold. Images and contours were exported to the treatment planning system Eclipse v11 (Varian), where the centre of mass of the syringe was identified for every phase. The cranio-caudal position of the 4D-PET images at a particular phase was then compared to the ANZAI position at the same phase. The difference between these two coordinates is an estimate of the PET accuracy when determining the position of the phantom in each phase.

Results: The maximum (mean) differences for the sinusoidal waves were -2.24 (-0.68) mm and 1.11 (0.21) mm for 10 and 15 rpm respectively; for the respiratory shaped cycle these differences were less than 2.04 (-0.39) mm and -2.00 (-0.55) mm. As an example, the position of the syringe and the recorded ANZAI motion were plotted below for sinusoidal wave and 15 rpm.
Conclusions: Results exhibited a good synchronization between 4D-PET and the system used to register the respiratory wave, accurate enough to use it for clinical purpose. For the 4 types of movement, the cranio-caudal displacement between the syringe from the 4D-PET and ANZAI were less than 2.30 mm. Moreover, mean difference showed that in most of the cases, curves were out of phase. This might lead to a systematic error in the tumour position. It could be interesting to run more measurements for different cycles and 4D-PET acquisitions if we want to modify the margins for the GTV due to the use of 4D-PET for tumor contouring.

PO-0984
Treatement plan intercomparison for SBRT in a national context: final results from 53 centers
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Purpose/Objective: The purpose of this work is to investigate whether a particular technology can provide superior SBRT treatment plans in a real context, characterized by different radiation technologies (linac and treatment planning systems), and different modality for planning (optimization strategies and team experience).

Materials and Methods: Three inter-comparison studies have been designed for prostate, liver, and lung lesions. Five contoured CT sets, the dose objective to target and a list of constraints for organs at risk for each anatomical region, were sent to the participants. A total of 53 centers across Italy joint the studies: 14 for liver metastases, 14 for prostate lesions, 25 for lung nodules. Table 1 summarizes the irradiation techniques of each center.

Results: For the prostate and lung studies, all participants were able to achieve the objective of dose to target and to respect the constraints on organs at risk. For the liver study, 5 participants did not comply with the constraint to the healthy liver, and 1 center did not achieve the objective of dose to the target in one of the five cases. A large difference between centers emerges in the three studies, due to the differences in the maximum dose and homogeneity accepted; no significant correlation between the irradiation techniques and dose volume histogram was found.

Conclusions: Despite the large difference in the irradiation technique used, the principal goal of a SBRT approach was achieved by all institutions in almost all patients, for both dose coverage to target and dose sparing to organs at risk in all three regions considered. In our analysis, the optimization strategy decided by the planner plays a predominant role respect to the technology utilized. Inter-comparison of DVH could be a useful tool to standardize treatment planning of stereotactic treatments, in particular before starting a clinical multi-institution trial.

PO-0985
How accurate is lung IMRT and VMAT delivery? A multi-centre audit as part of the Isotoxic IMRT trial
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