treatment. Image matching was performed initially using the auto match feature on the TomoTherapy platform and positioning was then refined by the treating radiographers. In addition to the initial radiographer who performed matching at time of treatment, a further two radiographers repeated the image matching process in order to provide information about inter-observer variability.

Results: The results of intra-fraction motion include components both of positional change and also residual error in inter-observer image matching. The inter-observer variation had a standard deviation of 0.6mm left-right (LR), 0.3mm anterior-posterior (AP) and 0.9mm cranio-caudal (CC). Intra-fraction motion had a mean positional change approximately 0 in LR and AP and 0.6mm CC. The standard deviations were 0.7, 0.6 and 1.0mm in LR, AP and CC directions. Using the standard van Herk PTV margin recipe[1], the margin required to allow for these two components of uncertainty is 2.3mm LR, 1.7mm AP and 3.4 mm CC.

Conclusions: The PTV margin component attributable to intra-fraction motion and inter-observer matching is bigger than expected, and bigger than used. When using high dose single fraction radiosurgery, the standard PTV margin recipe may be unnecessarily generous. Work is on-going to resolve the difference between the 'ideal' PTV margin and the 'clinically practical' margin currently in use.

References:
1. Van Herk et al. The probability of correct target dosage: dose-population histograms for deriving treatment margins in radiotherapy IJROBP 47: 1121-1135, 2000.

EP-1306

SBRT of bone metastases in oligometastatic patients: predictive factors of oncological outcomes

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Purpose/Objective: To evaluate the safety of Stereotactic Body Radiotherapy (SBRT) of bone metastases in oligometastatic disease and to investigate possible predictive factors of local control (LC), progression disease free survival (PDFS) and overall survival (OS).

Materials and Methods: Main eligibility criteria were number of metastatic sites ≤5, controlled primary tumor with no evidence of progression under systemic therapies, exclusion of surgery and no previous radiotherapy of the lesion of interest. Patients were classified into two categories: only bone (BOD) and outside bone oligometastatic disease (OBOD). SBRT was delivered only to bone lesions using two different schedules: 24Gy/1fraction or 27Gy/3 fractions.

Results: Between January 2010 and December 2013, 40 patients were enrolled in our study. The most frequent primary tumors were prostate (40%), breast (17,5%) and lung cancer (15%). Two patients experienced severe late toxicity (fracture of the treated site). LC was longer among 'Responders' than 'Not responders' lesions (94,2% and 91,2% versus 50% and 16,6% at 1 and 2 years, respectively) (p=0,004). The multivariate analysis of PDFS showed a significant correlation with PTV volume (p=0,003) and Oligometastatic Status (p=0,002). The multivariate analysis of OS, confirmed a statistical significant value of the Oligometastatic Status (p=0,002) whereas no correlation was proved for PTV volume (p=0,065).

Conclusions: SBRT of bone metastases is safe with a low incidence of severe toxicity. PET response has proven to be a strong predictive factor of LC whereas the BOD status and the small size of bone metastases might identify a subset of oligometastatic patients at better prognosis.

EP-1307

Innovative QA methodology for true patient-specific Dose Volume Histograms (DVHs) measurements

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Purpose/Objective: The aim of this study is to present an innovative QA methodology for patient-specific plan verification through true measurements of DVHs and comparisons with the corresponding TPS-calculated DVHs.

Materials and Methods: 3D-printing technology and polymer gel dosimetry were combined in a unique way in order to construct a patient-specific QA phantom (patient-specific dosimetry phantom - PSDP). The selected patient planning-CT scans were used for the construction of a patient-specific 3D-printed model (external surface and bone structures). The 3D-printed model was subsequently filled with Vinyl-Pyrrolidone (VIPAR) polymer gel. The constructed PSDP was then treated as if it the real patient, i.e. 'immobilization', set-up, image guidance (e.g. CBCT) and irradiation were implemented on the phantom. The irradiated PSDP was then MRI-scanned (derivation of T2-maps). The T2-maps of the PSDP contain dosimetric information that was extracted by analyzing the polymer gel dosimetry data. These PSDP T2-maps that contain dosimetric information, were subsequently imported to the TPS and were registered/fused to the real patient planning-CT scans and RStructure dicom-RT data. This way, the PSDP measured dose pattern was spatially correlated with the real patient RStructure information, allowing the measurements of DVHs.

Results: True patient-specific DVHs measurements were implemented following the proposed methodology. DVHs measurements were directly compared with the corresponding TPS-calculated DVHs. The QA and evaluation of the validity of overall treatment chain, of the treatment outcome and patient safety was feasible.

Conclusions: True patient-specific DVHs can be measured for the first time and compared against the TPS-calculated corresponding DVHs, following the proposed methodology. Patient-specific treatment outcome and patient safety could

be enhanced with an introduction of such QA tool in the clinic.

EP-1308

Normal tissue dose reduction by in-body electron modulation, using local magnetic field

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Purpose/Objective: Energy of gamma ray radiotherapy is transferred by electrons in both target tumors and surrounding normal tissues. If electrons, generated in body tissues, could be specifically removed in critical normal tissues, these normal tissues will be spared without compromising the target tumor dose. The purpose of this study was to present a new method of in-body electron modulation, using a magnetic field, to reduce dose of normal tissues near a target tumor.

Materials and Methods: Two tissue equivalent phantoms which composed with normal tissue area (NTA) and target tumor area (TTA) were developed; 1) single beam model (SBM) phantom to analyze a longitudinal percentage depth dose curve, and 2) multi-beam model (MBM) phantom to analyze a cross sectional dose of both NTA and TTA dose. Distance of a gap between NTA and TTA were 5mm. The phantoms were irradiated using 3x3cm sized field of 6MeV photon beam with or without 0.3T local magnetic field through beam path to remove forward electrons. Absorbed dose were measured in each NTA and TTA.

Results: With magnetic field applied, bending effect of the electron beam path was visualized in longitudinal film data. The percentage depth dose curve of SBM phantom showed about 40% dose reduction in NTA and almost no dose difference in TTA with magnetic field. Re-build up phenomenon were observed in the gap between NTA and TTA. In MBM phantom experiment, dose of the NTA were 300 cGy and 190 cGy, without and with magnetic field, respectively (36.7 % dose reduction). And dose of the TTA were 600 cGy and 580 cGy, without and with magnetic field, respectively (3.3% dose difference).

Conclusions: Applying local magnetic field could reduce dose of normal tissues near a target by removing forward electrons without compromising target dose in gamma ray radiotherapy. Further in vivo studies are needed to confirm biologic significance of this phantom experiment.

EP-1309

Are daily dose recalculations really necessary in head and neck helical tomotherapy?

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Purpose/Objective: Head and neck cancer patients often undergo important soft tissue changes during radiotherapy. To assess the actual delivered dose recalculated on the daily IGRT images is often time consuming and mostly not routinely feasible. The aim of this study was to assess whether daily dose recalculations are necessary and and to develop a recommendataion for daily practice.

Materials and Methods: Six head and neck cancer patients treated in our department with helical tomotherapy were analyzed for this work in progress. Total fraction number was 32 to 34 per patient. All patients underwent daily IGRT by MVCT at the TomoTherapy Unit. For each patient, we retrospectively performed daily dose recalculations on the MVCTs to assess the influence of soft tissue changes on dose distributions. We evaluated several summation doses: daily dose summations (DayDo), dose recalculations/sumations every second day (2Do), once a week (1WeDo) and once every two weeks (2WeDo). For the days when the dose recalculation on the MVCT was not performed, the day(s) before were summed up. In order to avoid dose recalculation errors due to recalculation on MVCTS, we compared the summation doses with the doses recalculated on the first MVCT (MVCT1Do) (expected to be very similar to the planning CT) times the total number of fractions.

We analyzed the mean dose (Dmean), the maximum dose (Dmax), the Dmax in 1 cm^3 (D1cc) and the minimum dose (Dmin). For the PTV: Dmax, Dmin and Dmean; for the spinal cord (SC): Dmax, D1cc, for the SC+5mm: Dmax, D1cc; for the parotid glands (PG): Dmean; for the mandible (Mnd): Dmean, Dmax.

Results: Overall, for all OAR the median changes as compared to MVCT1Do was 3.3Gy (range: +8Gy (for SC+5mm) to -8.73Gy (Mnd)). The median PTV Dmax change as compared to MVCT1Do was -0.71Gy (+0.13Gy to -3.01Gy), the Dmin +4.24Gy (+5.39Gy to -1.59Gy) and the Dmean change was -0.07 (0.09Gy to -0.26Gy). The differences between the scenarios (DayDo as compared to 2Do , 1WeDo and 2WeDo) were small and mostly not statistically significant. The only statistically significant differences between the scenarios were for the PTV Dmean and the SC Dmax and D1cc. The overall median differences in Gy (range) between the DayDo and the 2Do, 1WeDo and 2WeDo are presented in the table.

Structure	Analyzed dose	2Do	1WeDo	2WeDo
		(median differences in Gy to the daily dose recalculations/summations over the whole treatment course)		
PTV	Dmax	-0,04 (0,12 to -0,11)	0,03 (0,20 to -0,43)	-0,05 (0,23 to -0,38)
	Dmin	-0,06 (0,08 to -1,52)	-0,56 (0,32 to -3,37)	-0,14 (1,04 to -2,33)
	Dmean	-0,13 (0,04 to -0,98)	-0,33 (0,13 to -2,09)	-0,28 (0,09 to -1,00)
spinal cord	Dmax	-0,41 (0,12 to -2,29)	-0,62 (0,08 to -3,72)	-0,56 (0,49 to -2,29)
	D1cc	-0,25 (0,18 to -1,23)	-0,43 (-0,02 to -2,56)	-0,97 (0,26 to -3,72)
right parotid gland	Dmean	-0,02 (0,03 to -0,67)	-0,17 (0,03 to -1,49)	-0,34 (0,04 to -0,71)
left parotid gland	Dmean	0,05 (0,17 to -1,06)	0,11 (0,26 to -2,37)	0,03 (0,25 to -1,20)
mandible	Dmean	-0,04 (0,04 to -1,09)	-0,18 (0,08 to -2,43)	-0,15 (0,12 to -1,21)
	Dmax	-0,03 (0,10 to -0,97)	0,09 (0,22 to-2,17)	0,31 (0,40 to -1,07)

Conclusions: Significant changes can be observed during treatment. Daily dose recalculations remain a 'gold' standard. Nonetheless less time consuming scenarios can be used for some structures to assess the actual delivered doses during treatment with an implication on adaptive replanning.