bony structure fusion without any translational or rotational limitations was done. Secondly, the treatment isocenter position was reproduced with only a translation registration. In the first technique, target volume deformation and translation relative to the best bony anatomy match enabled the evaluation of the IM. With the second technique, direct evaluation of the complete PTV (combined IM and SM) margin is possible. For both, we tested symmetric and asymmetric margins around the nodal CTV ranging from 0 to 10 mm. For each patient, the tested margins were applied on all CTs and CBCTs data sets forming either an ITV or a PTV. This way, different virtual planning and treatment sequences were simulated. For each sequences, statistics of the relative volume of nodal CTV not overlapping the planned PTV or ITV was measured. Margin recipes were compared based on their maximum relative Non Overlapping CTV Volume (NOV) for 95% of treatment fractions, 90% of possible planning and 90% of patients. Delineation error was evaluated by repeating contouring of the same images.

Results: The symmetric expansion analysis showed that with a NOV threshold of 3%, the obtained margins are 4 mm and 5 mm for ITV and PTV respectively. For asymmetric ITV, with same NOV threshold, the margins are 3 mm in all directions except anteriorly and internally which are 5 mm. With one observer, the measured delineation error was 1 mm. This value might increase with multiple observers.

Conclusion: In the future, we will validate this geometric margin analysis with a dosimetric approach involving 3 different methods of adaptive radiation therapy where PLN are treated with a bony anatomy match while simultaneously treating the prostate located by implanted gold markers. These techniques may further reduce both prostate and PLN margins.

2060 POSTER

Flattening Filter-free Beams for Extreme Hypofractionated Radiotherapy of Localized Prostate Cancer

D.R. Zwahlen[1], S. Lang[1], S. Kloeck[1], Y. Najafi[1], G. Studer[1], K. Zaugg[1], U.M. Luetolf[1]. [1]*Universitätsspital Zürich, Radiation Oncology, Zürich, Switzerland*

Background: Short hypofractionated schedules for localized prostate cancer are investigated with high-dose-rate brachytherapy or Cyberknife® stereotactic body radiotherapy (SBRT). We tested the ability to deliver the dose of 38 Gy in 4 fractions and distributions of flattening filter-free (FFF) photon beams with TrueBeam® linear accelerator SBRT plans.

Material and Methods: Treatment planning study was performed on CT scans of 7 patients with localized carcinoma of prostate using 10 MV FFF photon beams (X10FFF) of TrueBeam® linear accelerator (Varian Medical Systems). Planning target volume (PTV) included the prostate and base of seminal vesicles defined by MRI and CT imaging, plus a 2 mm volume expansion in all directions, except posterior, where the prostate abutted the rectum and expansion was reduced to zero. Urethra and rectum were identified on MRI and CT imaging and delineated on CT slices where PTV contour was present. Volumetric intensity modulated arc therapy (VMAT) plans were prepared in Eclipse® treatment planning system (PRO 8.9, AAA 8.9). The prescribed dose (PD) was 4 x 9.5 Gy = 38 Gy. PTV coverage was 95% of PD, allowing maximum dose of 200% of PD. Maximum dose (Dmax) for organs at risk (OAR) including rectum and rectal mucosa was 100% and 75%, for urethra and bladder 120% of PD, respectively. Two 360º arcs with maximum dose rate of 2400 monitor units (MU)/min were used. Plans were normalized to Dmax. Number of MU, treatment delivery time, dose parameter for PTV coverage and dose to OAR were recorded.

Results: Prescription isodose was 74.8–81.0%. PTV coverage, urethra, rectum and bladder statistics are shown in the table.

	Mean ± 1 Standard Deviation
PTV V100 (%)	97.72±0.16
PTV D90 (Gy)	39.15±0.13
Urethra Dmax (Gy)	41.42±1.07
D10 Urethra (Gy)	40.47±0.81
D50 Urethra (Gy)	39.71±0.78
Rectum solid	9.04±1.50
Rectal mucosa Dmax (Gy)	28.95±1.07
Rectal mucosa D1 (Gy)	27.47±0.98
Rectal mucosa D10 (Gy)	21.99±1.15
Rectal mucosa D25 (Gy)	14.77±2.31
Bladder solid	3.34±1.51
Bladder Dmax (Gy)	35.92±2.39

On average 3677 MU ± 542 were used and maximum dose rate was 1462–2400 MU/min. Average dose rate was 1961 MU/min ±468. Treatment delivery time for all patients was 2 min.

Conclusion: Non-invasive FFF SBRT is feasible and dose constraints for PTV coverage and OAR are met similar to high-dose-rate brachytherapy or Cyberknife®. Homogeneous target coverage is achieved while sparing urethra and rectum. FFF SBRT for localized prostate cancer allows fast and safe delivery of extreme hypofractionated radiotherapy and may help to reduce the impact of organ motion.

2061 POSTER

Clinical Evaluation of 6 Degree-of-freedom X-ray Image-guidance Fusion Algorithm and Robotic Positioning System for Frameless Cranial Radiosurgery

M. Graveline[1], D. Marti[1], V. Thakur[2], R. Ruo[2], E.T. Soisson[2], H. Patrocinio[2], D. Roberge[1]. [1]*McGill University Health Centre, Radiation Oncology (D5–400), Montréal, Canada;* [2]*McGill University Health Centre, Medical Physics, Montréal, Canada*

Purpose: (1) To use stereoscopic x-rays paired with infrared (IR) tracking (ExacTrac®) to determine patient positioning error in frameless cranial radiosurgery, and (2) to evaluate the effects of region-of-interest (ROI) exclusion on 6D fusion results.

Methods and Materials: (1) Positioning errors were quantified through restrospective analysis of ExacTrac images taken for 17 patients (23 targets). All images (196) were sorted into 2 categories: initial and verification. Initial images are acquired after patient setup using an IR camera system and fiducial array. Verification refers to subsequent images used to check patient position. Corrections greater than the tolerance of 0.7 mm/1º were required in 49/173 image sets requiring patient repositioning, no corrections were made in the remaining 124 sets.

(2) ROIs including (i) air external to the skull, (ii) mandible, and (iii) neck are often manually excluded from 6D fusion. The effect of various ROI exclusion on the 6D fusion was assessed by repeating fusions using varying ROIs for 12 patients.

Results: See the table.

Displacement	Study					
	(1) Deviation detected in:			(2) Difference in fusion: no blocking vs. blocking of ROI:		
	Initial	Verification		(i)	(ii)	(iii)
		Correction	No correction			
Translation (mm)						
Lat	0.3±1.2	0.3±0.9	0.0±0.3	0.05±0.07	0.03±0.04	0.07±0.07
Lng	−0.2±1.9	0.5±1.1	0.1±0.3	0.06±0.04	0.16±0.28	0.09±0.10
Vrt	−1.1±0.9	−0.6±1.2	−0.1±0.3	0.05±0.04	0.19±0.40	0.06±0.06
Rotation (degrees)						
Lat	0.0±0.9	0.0±0.9	0.0±0.3	0.08±0.09	0.21±0.25	0.12±0.09
Lng	0.2±1.0	0.0±0.0	−0.1±0.3	0.06±0.03	0.19±0.35	0.20±0.21
Vrt	0.0±0.6	0.5±0.9	0.0±0.3	0.11±0.25	0.22±0.46	0.12±0.19

Mean±SD (SD = Std. Dev.)

(1) The largest shifts were detected upon initial positioning in the mask using the IR array only. SD of applied corrections was up to 1.2 mm/0.9º. In 71% of image sets, detected shifts were below the pre-determined tolerance (SD 0.3 mm/0.3º in all directions).

(2) ROI exclusion effects 6D fusion. Minimal differences were seen when excluding air only but deviations up to 1.4 mm/1.6º were seen when bony anatomy (lower jaw & neck) were excluded from 6D fusion.

Conclusion: Large initial positioning errors (>1 mm) were detected with ExcaTrac when using the mask, fiducial array and camera only for patient setup. Intrafraction motion greater than 0.7 mm/1º were observed in 29% of images. Residual shifts detected by ExacTrac are on the order of 0.3 mm (95% CI < 0.7 mm). Excluding bony anatomy that is not rigid with respect to intracranial target (lower jaw and neck) will effect the magnitude of shifts detected using 6D fusion.

2062 POSTER

Comparative Study Between Coplanar and Non-coplanar Techniques in Radiotherapy of Abdominal Tumours

L. Diaz[1], A. Ureña[2], I. Castro[2], V. Díaz[1], I. Villanego[1], E. Gonzalez[1], J. Lupiani[1], M.D. De las Peñas[1], M. Iborra[2], E. Alonso[1]. [1]*Hospital Puerta Del Mar, Radiation Oncology, Cadiz, Spain;* [2]*Hospital Puerta Del Mar, Radiophysics, Cadiz, Spain*

Background: Radiotherapy treatment using 3D techniques for abdominal tumours is usually extremely difficult if we focus on gastric or pancreatic cancers, due to the irregularity of the PTV's and the proximity of many organs at risk. Of these, the most critical are often the kidneys due to its constraints that are hard to achieve. To overcome this, in our center are using non-coplanar treatment techniques, and the comparison with previously used techniques is the aim of our study.