recombination correction factors appear depending on the orientation of the chamber which is also consistent with other observations in the literature and with the theory of Jaffé.

PO-0833

CHO cell depth-survival distributions after different configurations of contralateral carbon beams

L. Grzanka[1], M.P.R. Waligórski[1,2], M. Korcyl[1], P. Olko[1]
[1]*Institute of Nuclear Physics Polish Academy of Sciences, Cyclotron Centre Bronowice, Kraków, Poland*
[2]*The Marie Sklodowska-Curie Centre of Oncology, Krakow Division, Krakow, Poland*

Purpose/Objective: Contralateral ion beams, both with spread out Bragg peaks (SOBP), will yield a more uniform dose distribution over the target region than that from a single-port SOBP irradiation. We may achieve this either by superposing two contralateral beams, each with a 'flat' SOBP dose distribution (case A), or by applying two 'ramped' SOBP beams (case B). For these two carbon beam configurations we compared the depth distributions of dose, survival, RBE, dose-averaged energy and dose-averaged LET over the target region, against another calculation where we obtained a desired uniform level of survival over the target region directly using our other optimisation algorithm (case C).
Materials and Methods: We applied a numerical algorithm to optimise the entrance spectra of a composition of pristine carbon ion beams which delivers a desired dose-depth profile over a given range by spreading out the Bragg peak. The physical beam transport model was generated using the SHIELD-HIT10A Monte-Carlo code. A multi-dimensional interpolation algorithm was used to calculate at given beam depths the cumulative energy-fluence spectra for primary and secondary ions in the optimised beam composition, as required by the mixed-field calculation of Katz's cellular Track Structure Theory (TST) which then predicts the resulting depth-survival profile. The depth-dose profile is optimised over a given depth range using the L-BFGS-B algorithm, with parallel processing support. Another optimisation algorithm incorporating the formulae of Katz's TST, is able to yield a desired survival-depth profile directly. Our 1-dimensional irradiation geometry consisted of a 4 cm slab of 'target volume' surrounded by 8 cm slabs of 'healthy tissue' both composed of water and of CHO cells represented by Katz's TST cellular parameters (m = 2.31, d0 = 1.691 Gy, sigma0 = 5.967e-11 m^2, kappa = 1692.8). The desired dose over the target volume was 3 Gy and the survival level 20%.
Results: With respect to dose-depth distributions, we found that the '2 flat dose' (case A) gave the best sparing of healthy tissue, compared with '2 ramp dose' (case B) and 'flat survival' (case C). However, case A gave a highly non-uniform survival distribution over the target region ('underkill' in the central region and 'overkill' at its borders), unlike cases B and C (uniform survival distribution over the target region). The '2 flat dose' (case A) gave the highest non-uniformity of dose-averaged energy and dose-averaged LET distributions over the target region.
Conclusions: Our 1-dimensional kernel of a carbon beam therapy planning system, based on a beam transport model, Katz's Track Structure Theory with in vitro cell survival parameters, and efficient optimisation algorithms, is able to yield quantitative predictions of various beam configurations and irradiation strategies relevant to therapy planning using carbon beams.

Poster: Physics track: Dose measurements

PO-0834

Derivation of a universal dataset for commissioning of an EPID-based dosimetry system

R. Tielenburg[1], I. Olaciregui-Ruiz[1], R. Rozendaal[1], B. Mijnheer[1], M. Van Herk[1]
[1]*Netherlands Cancer Institute Antoni van Leeuwenhoek Hospital, Radiation Oncology, Amsterdam, The Netherlands*

Purpose/Objective: Commissioning an EPID for dosimetry purposes requires a large number of measurements, which is time-consuming and cumbersome. In order to decrease the commissioning time, the use of a universal dataset would be advantageous. In this study the derivation and feasibility of such a universal dataset is described.
Materials and Methods: Measurements were performed on 22 Elekta linac/photon beam energy combinations at 10 different sites in 6 countries, all equipped with aSi iViewGT EPID systems (see table). A single set of equipment, consisting of an electrometer, two types of IC, mini-phantoms and a slab phantom, was sent to each site prior to the measurements.

Table 1. Overview of the Elekta linac/photon beam energy combinations investigated in this study

Site	Energy	Head Type
Denmark: OUH, Odense	18MV	MLCi, Agility
France: Claude Bernard, Metz	6MV	BeamModulator
Netherlands: AMC Almere	6MV, 10MV	MLCi
Netherlands: AMC Amsterdam	6MV, 10MV	Agility
Netherlands: AVL Amsterdam	6MV, 10MV, 6MV FFF, 10MV FFF	MLCi, Agility
Portugal: Champalimaud, Lisbon	6MV, 10MV	MLCi
United Kingdom: St James' Leeds	6MV, 10MV	Agility
United Kingdom: RMH, Sutton	10MV, 15MV	BeamModulator
United Kingdom: Elekta, Crawley	6MV FFF, 6MV FFF	Agility
USA: Univ. Washington, Seattle	6MV, 10MV, 18MV	MLCi, BeamModulator

IC measurements were performed using different combinations of phantom thicknesses and field sizes to obtain the dosimetric characteristics of the linac. Additionally, IC measurements in a mini-phantom were performed at EPID level. EPID images were then acquired for all thickness/field size combinations. For the full commissioning in total, 45 IC measurements and 50 EPID images were required per linac/energy combination, which takes approximately 4 hours.
From this large dataset a universal dataset has to be derived which should then be combined with as few as possible linac specific measurements to complete the modeling. The accuracy of using such a simplified procedure was tested by comparing the 2D dose distribution in a polystyrene phantom, reconstructed from the EPID measurements and the universal

data set approach, with the dose distribution calculated with the treatment planning system used in that centre.
Results: The gathering of IC and EPID datasets on a large variety of Elekta linacs went smoothly. For each linac/energy combination, a universal dataset was derived from similar linacs. This universal dataset was combined with only three measurements for each specific linac/energy combination: one IC measurement at the isocentre of a 20 cm thick phantom, and two EPID images, with and without the phantom in the beam. Preliminary validation results for 5 linac/energy combinations and a set of square fields (3x3 to 23x23 cm^2) using the universal dataset, showed deviations of the dose at the iscocentre varying between -0.5% and +1.5%. Gamma analysis (3%/3mm) yielded values for the mean gamma, near-maximum gamma and gamma pass rate varying between 0.26-0.37, 0.67-1.04 and 96.5%-100.0%, respectively. These results are comparable to data obtained by a reconstruction from EPID measurements based on a full commissioning process in those centres.
Conclusions: A generic set of EPID dosimetry model parameters has been derived for a variety of Elekta linac/energy combinations. Customizing the universal dataset in combination with 3 measurements instead of performing full commissioning decreases the amount of work needed to commission an EPID for dosimetry purposes by about 90% without a noticeable loss of accuracy.

PO-0835

Modelling the dosimetric effects of tumor motion due to respiration

M. Adamczyk[1], T. Piotrowski[1], S. Adamczyk[1]
[1]*Greater Poland Cancer Centre, Medical Physics Department, Poznan, Poland*

Purpose/Objective: The goal of the retrospectively performed dose distribution simulations was to justify the concept of validating conformal versus intensity-modulated approach in the treatment of non-small cell lung cancer (NSCLC) patient. The insight into the difference between the actual (affected by respiratory motion) and planned dose distributions for both clinical target volume (CTV) and organs at risk (OARs) was provided.
Materials and Methods: To test the influence of the respiratory motion on the dose distribution, for 10 patients representative for the spectrum of tumor sizes and locations, treated in free-breathing conditions (our standard institutional technique), 2 plans were prepared: with three-dimensional conformal (3D-CRT) and sliding window intensity-modulated radiation therapy (IMRT) techniques. For each of the field angles considered, the motion kernel (derived from the literature data) was generated to simulate tumor motion trajectories, with the largest amplitude in cranio-caudal direction of 4 mm, 6 mm and 8 mm repsectively. While the robotic platform MotionSim XY/4D with 2D diode array MapCHECK 2 (Sun Nuclear, USA) on it repeatedly cycled through the motion trajectory, radiation was delivered starting at a random point. The measurements' results determined the agreement between the planned and measured doses within CTV and OARs. The evaluation of plan delivery was based on the Gamma Index (γ) with 3-mm criteria of distance to agreement (DTA) and 3% dose difference (ΔD).
Results: No statistically significant differences were found between the motion patterns with the smallest amplitudes for CTV in 3DCRT plans. The differences were found for the 8-mm amplitude when it was compared both to static conditions and 4-mm amplitude. For IMRT the significant differences between 0 mm vs. 6 mm, 0 mm vs. 8 mm and 4 mm vs. 8 mm were found. According to the analysis performed for OARs, the motion impact on delivered vs. planned doses had less effect for esophagus and spinal cord. The only OARs for which the observed differences were comparable was heart.
For maximal amplitudes of breathing trajectory below 4 mm the disagreement between planned and delivered dose distribution could be neglected. Whereas respiratory motion with amplitude above 5 mm, especially for IMRT, led to significant changes in delivered dose distribution.
Conclusions: 3DCRT is safe in a greater range of respiratory movements amplitudes. For patients with large tumor sizes or due to inability of achieving proper 3DCRT dose distribution coming from tumor and OARs close proximity, the IMRT affords possibilities for further optimizing the therapeutic ratio. Statically planned IMRT dose distribution could lead to tumor underdosage due to interplay effect (intra-fractional motion with respect to the movement of MLC). It is therefore important to verify the amplitude of individual patient breathing motion trajectory.

PO-0836

Dose sensitivity in the craniospinal IMRT junction region to positional and dose error

Y.K. Lee[1], A.T. Kim[1], P. Zhao[1], A. Karotki[1]
[1]*Odette Cancer Centre - Sunnybrook Health Science, Medical Physics, Toronto, Canada*

Purpose/Objective: Craniospinal irradiation (CSI) using multiple isocentre intensity modulated radiation therapy (IMRT) allows for homogeneous dose distribution throughout the target and the dose distribution is conformed tightly around the target volume, reducing unnecessary dose to the organs-at-risk. The technique utilizes a combination of complicated field segments and there are sections of the treatment volume (junction) that are treated by fields from multiple isocenters. Small isocenter positional variations and dose changes in the junction regions may be unavoidable throughout the fractionated treatment. Dose sensitivity in the CSI IMRT junction region to positional and dose variations is tested using a diode array.
Materials and Methods: Ten CSI patients were planned with a 3-isocenter (cranial, upper and lower spine) IMRT technique using Pinnacle treatment planning system v9.2. The plans were prescribed to 36 Gy in 20 fractions. All beams were optimized simultaneously with a high weight placed on the target volume with lower weight placed on the other objectives. The isocenters were placed 25-27 cm away from each other. The IMRT plans were then recalculated and measured on a MapCHECK diode array placed in the upper/lower spine overlap region. ≥95% of measured to planned dose to the MapCHECK diodes with a γ-index <1 for 3% dose difference and 3mm distance-to-agreement was deemed clinically acceptable.
To test the sensitivity of junction region to positional and dose variations, the following changes were made to the plan