The simulated carbon-ion beam elements were unidirectional and of rectangular shape, with a Gaussian spatial distribution and a spread in kinetic energy of 1%. Dose distributions were then calculated in a head phantom for different irradiation setups, *i.e.* unidirectional-grid setup, interlaced-crossfiring setup, orthogonal-crossfiring setup and a combination of the interlaced- and orthogonal-crossfiring setups. Thereafter, the beam-element separation was selected based on an optimality criterion.

Realistic treatment simulations were then performed by simulating the dose distributions produced in the human head by carbon-ion grid irradiations, using CT image sets from real patients.

Results

The carbon-ion beam elements, constituting the grid, remained narrow down to the depth of the target volume. Highly conformal dose distributions could be produced. With the unidirectional-grid irradiation, it was not possible to deliver a high minimum dose to the target volume while keeping the valley dose low in the normal tissue located close to the target volume. When interlaced crossfiring was employed, the treatment objectives, *i.e.* a high minimum target dose, combined with low valley doses throughout the normal tissue, could be reached.

Conclusion

In this study we proposed a new carbon-ion grid therapy method. The specific physical interaction properties of carbon-ion beams were found to provide unique opportunities to explore the high tissue tolerance to radiation-grid irradiations to create new forms of radiotherapy. An irradiation setup based on interlaced-crossfiring was in this study found necessary to produce low valley doses throughout the normal tissue irradiated, which is known to be of importance to maintain the toxicity of grid treatments at low levels.

EP-2178 Use of the PTW Starcheck Maxi MR for commissioning a 1.5 Tesla MR Lina

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Purpose or Objective

MR Linacs are becoming commercially available but most conventional dosimetry equipment is not suitable for use in their strong magnetic fields. The purpose of this work was to test the new MR conditional PTW Starcheck Maxi MR array to determine its suitability for use in the Elekta Unity 1.5T MR Linac and to assess how to use it for commissioning the MR Linac.

Material and Methods

Measurements were made with the array both on a conventional linac and the Elekta Unity MR Linac to check for linearity, repeatability, dose rate, consistency between the measurement axes, drift with time and comparisons made with either a conventional array (on the conventional linac) or film (on the MR Linac).

Safety measures were put in place to enable the device to be safely used within the 1.5T MR environment, including the installation of suitable cabling and labelling to specify safe conditions of use.

A QA platform was constructed in-house to allow quick and easy set-up of the array on the MR Linac couch, using the MV imaging panel to verify the position of the device. The Starcheck Maxi MR is now in use for routine QC flatness & symmetry measurements on the MR Linac. Comparisons have also been made between field sizes measured by the array and field sizes measured with film and EPID.

Conventional plotting tanks cannot be used within the MR Linac due to their size and ferromagnetic components. Tests were made to determine whether the Maxi is suitable to test the MR Linac beam model by acquiring fields of 2x2 cm up to 40x22 cm at varying depths and FSDs and comparing with the profiles calculated within the Monaco beam model.

Results

No difference was seen in performance of the array between measurements on the conventional and MR Linacs. Linearity was within 0.5% down to 5MU, repeatability 0.1% and warm-up time was measured as 3 minutes after which measurements stabilised to within 0.5%. Good agreement was found between the Starcheck and arrays/ films on conventional /MR Linac respectively.

The array can be used safely within the bore of the MR Linac but the control box required positioning outside the projectile zone. The in-house QA platform allowed fast set-up of the array repeatably to within 1.5mm. Routine QC measurements show the MR Linac symmetry and flatness to be consistent within +/-0.2% and +/-0.6% respectively.

Good agreement was found between Monaco profiles and Starcheck Maxi profile over the range of field sizes and depths measured, demonstrating that the device is suitable for accepting a beam model.

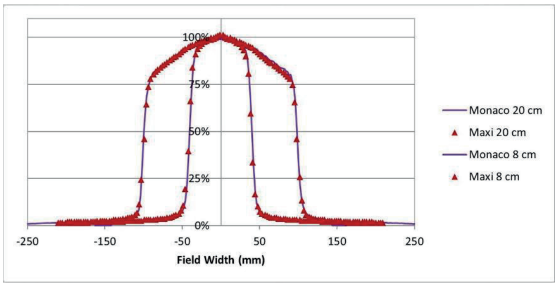

Figure 1: Profiles from a 20x8 cm field measured on the Starcheck Maxi compared to those extracted from Monaco

Conclusion

The PTW Starcheck Maxi MR array is an accurate and suitable device for QC and commissioning of a 1.5T MR Linac.

EP-2179 Assessment of lung position reproducibility of High-Frequency Ventilation (HFV) in radiation therapy

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Purpose or Objective

The use of HFV has been demonstrated to be feasible in RT allowing for reduction of respiratory motion. The system involves the use of a high frequency jet ventilator that delivers small tidal volumes at high frequency combined with a Venturi tube that is able to maintain open the whole respiratory circuit. The present work aimed to present a method to assess inter- and intra-fraction lung reproducibility when HFV is used as breathhold technique for radiation treatments.

Material and Methods

Multi-level thresholding method was used for lung segmentation both in CT ($VLung_{CT}$) and CBCT ($VLung_{CBCT}$) images. CBCT images were taken pre- and post-treatment. Rigid registration based on backbone-weighted mutual information between planning CT and both pre-treatment and post-treatment CBCTs was performed. The Dice's coefficient (DC) was calculated for lung volumes according to the formulae:

$$DC = \frac{2\,(VLungCBCT \cap VLungCT)}{VLungCBCT + VLungCT}$$