Outside-patient air threshold and carbon fibre table in Pinnacle

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Introduction

Modern treatment techniques should not be restricted in terms of the choice of gantry angle, due to limitations imposed by the linear accelerator carbon fibre tabletop. If the tabletop attenuation is not included in the dose calculation, beams passing through the tabletop will be calculated with dose errors of 3-8%. The aim of this work is to evaluate the attenuation for the Reuther tabletop, to implement the linear accelerator tabletop in the Pinnacle TPS and to asses the effect of the "outside-patient air threshold" (OPAT) on the Pinnacle dose calculation.

Material and Methods

A CT scan was taken of the linear accelerator carbon fibre tabletop before the tabletop was installed at linear accelerator and then imported into the TPS. The attenuation through this tabletop was measured in a 6 MV photon beam for gantry angles from 180° to 270° and compared to the reference dose measured at a gantry angle of 0° (where the photon beam does not pass through the tabletop). The same setup was simulated in the treatment planning system and the number of monitor units required for a dose of 10 Gy to the isocentre was calculated for each field and compared to the monitor units for reference field at gantry 0°.

The influence of the outside-patient air threshold (OPAT) used in the treatment planning system was investigated for the dose calculation of a 6 MV photon beam.

Results

The attenuation measured through the tabletop varies from 3-8% depending on the angle of the beam through the tabletop. For the default OPAT value of 0.6 g/cm^3 in Pinnacle TPS, the linear accelerator tabletop has density values below this threshold, so that the effect of attenuation through the tabletop is not accounted for in the dose calculation. For OPAT values of 0.1 - 0.3 g/cm^3, Pinnacle overestimates the attenuation of the tabletop by 0.2 - 1.2% as compared to the measured attenuation. The CT values of the tabletop are such that for OPAT greater than 0.4 g/cm^3, parts of the tabletop are not detected.

Discussion

Not including the treatment table in the TPS dose calculation can lead to dose errors of up to 8%. These discrepancies become evident on carrying out IMRT verifications at certain angles. Thus, a treatment tabletop correction should be included in the TPS. For a simple tabletop correction, the CT table in the Pinnacle planning system could be replaced with a volume overwritten with the appropriate density values in the middle and at the edges depending on the design of the tabletop of the linear accelerator.

The default OPAT value of 0.6 g/cm3 in Pinnacle TPS is not suitable for dose calculations if the tabletop is to be accounted for in the TPS. For OPAT of 0.3 g/cm^3 and less, the dose calculated is within 0.5% of the measured value for gantry angles where the beam passes through the tabletop (130° - 230° depending of the position of the isocentre). However, if the beam passes through the side edges of the table, Pinnacle dose calculations and dose measurements differ by 1.2%. If too small a value of OPAT is used, then noise in the CT image outside the patient outline may cause a false interpretation of the patient outline, leading dose calculation errors. An OPAT value of 0.3 g/cm^3 appears to give the best compromise between for Pinnacle dose calculations through the Reuther treatment tabletop.