AbstractID: 13017 Title: A novel phantom for electron density calibration of linac Cone Beam CT options

Purpose:

For image-guided radiotherapy (IGRT) linear accelerators offer also Cone-Beam-CT (CBCT) functionality. In order to use such a system for dosimetric planning an electron density calibration, known as hounsfield unit (HU) calibration, is compulsory. Studies on available phantoms for CT performance checks/QA have shown that these are not sufficient for an adequate HU calibration.

Therefore we designed a new dedicated phantom and carried out a planning study to determine the usability of such calibrated CBCT data in comparison with diagnostic CT data.

Method and Materials:

Available linac CBCT options acquire in a single rotation a volumetric CT data set with a scan length of typically 15-23 cm and up to 45 cm field-of-view (FOV). In order to 3D-calibrate the system with regard to HU a special phantom has been designed to include the whole imager area. Removable inserts allow flexible positioning of the probes in x-z as well as z-direction. We compared 20 plan setups (10 in the pelvic and 10 in the thoracic region).

Results:

Within the field of view the HU variation is up to 5%. Towards the imager edges hounsfield units show small deviations relative to the imager center (max. 8%). Relative dose distributions in CBCT-based plans show minor differences to plans calculated using a diagnostic CT image dataset ($p=0.002$) and absolute dosage deviations are within 1% ($p=0.001$).

Conclusion:

The newly designed phantom allows real 3D-calibration of linac CBCT. These CBCT data can be used for treatment planning as relative doses distributions and absolute doses are almost equivalent to diagnostic CT data. It is made of water equivalent material and consists of probes with tissue equivalent materials. Probes can be positioned in the phantom in a flexible manner to measure spatial HU dependence. The phantom has additional scatter material to simulate a real patients' situation.