Cyberknife Patient Specific Quality Assurance using 2D Mapcheck Diode Array

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Objective(s): Recent implementation of multileaf collimator (MLC) into CyberKnife (CK) robotic radiosurgery system raises the necessity for CK patient specific quality assurance (QA) procedures. Gafchromic EBT3 film, cylindrical diode array and planar ion chamber were examined for their use of dose verification of CK plans. This study aims to investigate the feasibility of MapCheck planar dose array system as a patient specific QA device for CK plan.

Methods: MapCheck (Sun Nuclear 1175) detector with 445 solid state detectors and specifications: center array spacing: 7.07 mm, active detector area: 0.8 mm x 0.8 mm, total buildup to detector junction: 2.0 ± 0.1 g/cm^2 was used for the dose verification of CK plan. Four fiducial markers were placed according to Accuray recommendations on MapCheck device to enable image-based setup. A pre-treatment plan dose verification was created in Precision (V2.0.0.1) treatment planning system. The central axis of the device was aligned with planning tumor volume center. All beams were rearranged to be in nominal position. The final calculation was made with Ray Tracing calculation algorithm and high resolution.

The verification of the dose for patient plan was done on CK M6 unit. The array calibration of the device was performed with 6 MV energy on linear accelerator Varian IX. The dose calibration was done with CK system. No additional buildup was utilized for either dose calibration or delivery of QA plan to MapCheck. To simplify the setup of dose calibration conditions: field size 10 x 10 cm^2, source to detector distance 800 cm, a plan was previously established in Precision. After absolute dose calibration of the device, the QA plan was delivered on MapCheck using the precise tracking and delivery system of CK. Twelve patients plans (4 intracranial and 8 extracranial lesions) (PTV 15-320 cm^3) were measured with MapCheck.

Results: Absolute dose comparison between measured and calculated planar doses was in a good agreement. For 80% of the cases 100% of pixels passed the dose difference 2%, 2 mm distance and 10% dose difference threshold for 10 patients, and for 20% of the cases 99.7% and 99.3% of pixels passed the 2%/2mm, 10% criterion. The measurement uncertainty was enabled.

Conclusion(s): The feasibility of using MapCheck as a patient specific QA device for CK plans was demonstrated. 2%/2mm (10% threshold) criteria is recommended for MapCheck. A verification of dose delivery of more plans should be conducted to truly recommend the device for the patient specific QAs of CK plans.