Commissioning and Verification of Brainlab Monte Carlo Dose Calculation Algorithm for VMAT SRS planning

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Objectives: We commissioned the Brainlab Monte Carlo Dose calculation Algorithm for VMAT SRS planning and verified it by measurements and comparisons with two other algorithms: Pencil beam and Eclipse Acuros. The commissioning and verification results are reported in this abstract.

Methods: Brainlab's Elements Cranial SRS (v3.0) provides single lesion planning using VMAT optimization, thus allowing dose modulation with MLC leaf positioning, dose rate, and gantry speed. We commissioned and performed quality assurance for the available dose calculation algorithms, which includes the Pencil Beam (PB) algorithm with only reference beam data (RBM PB) and PB with full beam data (Elements PB) and the Monte Carlo (MC) algorithm XVMC. Calculation between the two were compared to each other and to Acuros® XB dose calculation algorithm by Varian. End-to-end verification was performed using gamma analysis to further investigate the SRS photon dose calculation accuracy and robustness of these algorithms.
Open field MLC, static cone, dynamic MLC, and conical cone plans were calculated with each algorithm. IBA CC01 ionization chamber was used for each measurement, and small field correction factors as determined in TRT-483 were applied. End-to-end tests were performed using an anthropomorphic stereotactic end-to-end verification (STEEV) phantom from CIRS and a phantom/diode array, StereoPHAN/SRSMapCHECK from SunNuclear. Each phantom was CT scanned with 0.5 mm slice thickness. Four clinical plans were optimized in Brainlab Elements Treatment Planning System (TPS). Each plan was calculated with the following algorithms: Elements PB, RBM PB, MC, and Acuros® XB with 0.1 cm dose grid size. The delivered dose was measured with a SunNuclear SRSMapCHECK diode array detector. The calculated dose was compared with the measured dose by Gamma analysis with DTA 3%/1mm.

Results: The results of point dose measurements for field size larger than 1x1 cm2 among measured dose, dose calculated by pencil beam algorithms, and dose calculated by Monte Carlo algorithm were in excellent agreement (1.45% ± 0.7%). For the small rectangular field sizes (0.4x1, 0.2x1 cm2), Monte Carlo calculation showed superior accuracy and robustness to pencil beam algorithm when compared with measured dose, with percent dose difference 13% and -2.2%, respectively. Monte Carlo calculation have higher gamma results compared with pencil beam algorithm due more accurate calculations with heterogenous materials. Acuros® XB showed comparable accuracy with MC in terms of gamma passing rate.

Conclusion(s): The SRS MapCHECK measurement agrees dosimetrically with the plans calculated by Pencil Beam algorithm and the Monte Carlo algorithm XVMC by Brainlab, as well as the Acuros® XB dose calculation algorithm by Varian. Point dose calculation for small field dosimetry and gamma analysis using SRS MapCHECK both showed that Monte Carlo algorithm is more robust and is superior in regions of heterogenous materials.