PRESAGE 3D dosimetry accurately measures Gamma Knife out put factors.
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Small-field output factor measurements are traditionally very difficult because of steep dose gradients, loss of lateral electronic equilibrium, and dose volume averaging in finitely sized detectors. Three-dimensional (3D) dosimetry is ideal for measuring small output factors and avoids many of these potential challenges of point and 2D detectors. PRESAGE 3D polymer dosimeters were used to measure the output factors for the 4 mm and 8 mm collimators of the Leksell Perfexion Gamma Knife radiosurgery treatment system. Discrepancies between the planned and measured distance between shot centers were also investigated. A Gamma Knife head frame was mounted onto an anthropomorphic head phantom. Special inserts were machined to hold 60 mm diameter, 70 mm tall cylindrical PRESAGE dosimeters. The phantom was irradiated with one 16 mm shot and either one 4 mm or one 8 mm shot, to a prescribed dose of either 3 Gy or 4 Gy to the 50% isodose line. The two shots were spaced between 30 mm and 60 mm apart and aligned along the central axis of the cylinder. The Presage dosimeters were measured using the DMOS-RPC optical CT scanning system. Five independent 4 mm output factor measurements fell within 2% of the manufacturer's Monte Carlo simulation-derived nominal value, as did two independent 8 mm output factor measurements. The measured distances between shot centers varied by±0.8 mm with respect to the planned shot displacements. On the basis of these results, we conclude that PRESAGE dosimetry is excellently suited to quantify the difficult-to-measure Gamma Knife output factors.

Dosimetric Verification of SBRT with FFF-VMAT Using a 3-D Radiochromic/ Optical-CT Dosimetry System
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With an increasing use of small field size and high dose rate irradiation in the advances of radiotherapy techniques, such as stereotactic body radiotherapy (SBRT) and stereotactic radiosurgery (SRS), an in-depth quality assurance (QA) system is required. The purpose of this study is to investigate a high resolution optical CT-based 3D radiochromic dosimetry system for SBRT with intensity modulated radiotherapy (IMRT) and flattening filter free (FFF) volumetric modulated arc therapy (VMAT).
Methods:

Cylindrical PRESAGE radiochromic dosimeters of 10cm height and 11cm diameter were used to validate SBRT. Four external landmarks were placed on the surface of each dosimeter to define the isocenter of target. SBRT plans were delivered using a Varian TrueBeam™ linear accelerator (LINAC). Three validation plans, SBRT with IMRT (6MV 600MU/min), FFF-VMAT (10MV 2400MU/min), and mixed FFF-VMAT (6MV 1400MU/min, 10MV 2400MU/min), were delivered to the PRESAGE dosimeters. Each irradiated PRESAGE dosimeter was scanned using a single laser beam optical CT scanner and reconstructed with a 1mm × 1mm high spatial resolution. The comparison of measured dose distributions of irradiated PRESAGE dosimeters to those calculated by Pinnacle3 treatment planning system (TPS) were performed with a 10% dose threshold, 3% dose difference (DD), and 3mm distance-to-agreement (DTA) Gamma criteria.

Results:

The average pass rates for the gamma comparisons between PRESAGE and Pinnacle3 in the transverse, sagittal, coronal planes were 94.6%, 95.9%, and 96.4% for SBRT with IMRT, FFF-VMAT, and mixed FFF-VMAT plans, respectively. A good agreement of the isodose distributions of those comparisons were shown at the isodose lines 50%, 70%, 80%, 90% and 98%.

Conclusion:

This study demonstrates the feasibility of the high resolution optical CT-based 3D radiochromic dosimetry system for validation of SBRT with IMRT and FFF-VMAT. This dosimetry system offers higher precision QA with 3D dose information for small beams compared to what is currently available.