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Patient Specific Quality Assurance of Single Isocenter Multiple Targets Radiosurgery Plans using a High-Resolution Digital Detector Array

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Abstract
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Yun Yang [1] , Anna Rusnak [2] , Nicholas Vallone [2] , Eric Klein [3]

1. Radiation Oncology, Rhode Island Hospital, Brown University, Providence, USA 2. Biomedical Engineering, Brown University, Providence, USA 3. Radiation Oncology, Rhode Island Hospital, Providence, USA

Corresponding author: Yun Yang, yun520cn@gmail.com

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Abstract

Objective: Single isocenter multiple target (SIMT) radiosurgery treats several targets in the same plan and thus reduces treatment time significantly compared to single isocenter per target treatment. Besides the complicated treatment planning process, the patient specific quality assurance (QA) is often challenging due to limited detector resolution and active measurement area of the QA devices. In this study, SIMT plans from a new automated treatment planning system (TPS), were measured and analyzed using a novel high-resolution digital detector array.

Methods: Five previously treated SIMT patients with 1 - 6 targets of volume ranging from < 0.1 to 1.2 cc were selected and imported into Elements Multiple Brain Mets SRS V3.0 (Brainlab, Munich, Germany). Treatment planning with Elements V3.0 is automated with the couch, gantry, and collimator angles optimized and determined by the TPS directly. All plans were created with dynamic conformal arcs and 6FFF energy. Based on preset clinical protocols, each plan has 3 - 5 couch angles and collimator rotations limited to ±5° - ±85°. Treatment plans were normalized to 100% prescription dose covering at least 99.5% of all planning target volumes (PTVs). The QA plans were created and calculated on the myQA SRS phantom (IBA Dosimetry, Schwarzenbruck, Germany). Dose were delivered on a TrueBeam sTX with HDMLC (Varian Medical Systems, Palo Alto, CA) and measured using the myQA SRS device with 0.4mm detector resolution and 12cm x 14cm active measurement area. The Gamma Index analysis were then performed with the myQA Patient software.

Results: With automation of Elements V3.0, all plans were optimized and calculated within about 10 minutes. Each plan has 3 - 5 couch angles and 4 - 10 arcs based on plan complexity. All plans achieved target coverage and met dose limit to organs at risk. Gamma Index were performed with global, absolute dose, 10% threshold settings and multiple different distance to agreement (DTA) and dose difference (DD) criteria. With 1mm DTA and 3% DD criteria, the average gamma passing rate of TPS calculations compared to myQA SRS measurements was 98.5%. With 2mm DTA, the average gamma passing between calculated and measured dose were 98.4% and 99.3% for 2% DD and 3% DD respectively.

Conclusion: SIMT plans from the new Elements V3.0 TPS were measured and verified the novel myQA SRS device. The automated plans were created rapidly with consistent quality. The high-resolution of myQA SRS device permits accurate dose measurements for small field, while the large active area acquires dose to multiple targets in one measurement and improves the QA efficiency for SIMT plans.