Evaluation of High-Fidelity Mode for Semi-Automated Multi-Met, Single-Isocenter Stereotactic Radiosurgery Planning Using the Ethos 2.0 Planning System

Udbhav Ram - McMaster University; Joel Pogue, PhD - The University of Alabama at Birmingham; Richard Popple, PhD - University of Alabama at Birmingham; Natalie Viscariello, PhD - The University of Alabama at Birmingham; Dennis Stanley, PhD - The University of Alabama at Birmingham; John Fiveash, MD - University of Alabama at Birmingham; Carlos Cardenas, PhD - The University of Alabama at Birmingham

Objectives: The recently released Ethos 2.0 treatment planning system (TPS) includes updates for the semi-automatic generation of stereotactic plans. In this study, we evaluate the impact of the new 'high-fidelity mode' feature on the quality of CNS stereotactic radiosurgery (SRS) plans. The high-fidelity mode within the Ethos treatment planning system (TPS) employs a high-resolution dose grid (1.25 mm), allows for higher dose concentration within the target, and aims to achieve sharper dose fall-off while minimizing plan complexity. An attractive feature of the Ethos treatment platform is that it can accommodate and treat patients weighing up to 500 lbs, making single-isocenter SRS a viable option for patients with higher body weight who may not be eligible for treatment on other machines due to weight limitations.

Methods: Fifty brain metastasis patients previously treated with linac-based SRS were anonymized and imported into an Ethos 2.0 emulator. Fifteen of these cases were used to optimize Ethos 2.0 planning templates, which were then applied without further adjustment to the remaining 35 patients. All plans were prescribed 30 Gy in 5 fractions, with a 2 mm margin from GTV to PTV.

Planning templates with and without rings were evaluated in high fidelity mode and compared to standard templates with and without rings. Control rings are commonly used in our clinical practice to enhance dose shaping around the target, helping to limit exposure to surrounding healthy tissues by creating sharper dose gradients. Their inclusion or exclusion in the planning process was assessed to determine their impact on plan quality and dose distribution. Key clinical metrics analyzed included per-target PTV coverage (V100%), whole-brain dose outside the PTV (Brain-PTV V24Gy), Paddick Gradient Index (GI), and RTOG Conformity Index (CI). A Wilcoxon paired statistical analysis was performed to quantify differences across the templates.

Results: The tuning and testing cohorts included cases with a range of 1 to 13 and 1 to 17 targets, respectively. Enabling both high-fidelity mode and control rings resulted in superior average metrics: PTV V100% of 99.4%, Brain-PTV V24Gy of 24 cc, CI of 1.17, and GI of 4.0. In contrast, when both high-fidelity mode and control rings were disabled, the average values were 98.2% for PTV V100%, 29.21 cc for Brain-PTV V24Gy, CI of 1.34, and GI of 3.97. Notably, the addition of control rings in combination with high-fidelity mode significantly improved Brain-PTV V24Gy and CI scores ($p < 0.01$).

Conclusion(s): The findings of this study indicate that enabling high-fidelity mode and utilizing control rings on the Ethos 2.0 treatment planning system can improve the quality of single-isocenter, multi-target SRS plans compared to those created without high-fidelity mode. This approach may offer a viable treatment option for patients with higher body weight who may not be eligible for conventional linac-based SRS due to equipment weight limits, thus expanding access to precise stereotactic

treatments. Further studies are warranted to validate these findings and confirm their efficacy and safety in routine clinical practice.