

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

Udbhav S. Ram, Joel A. Pogue, Richard A. Popple, Natalie N. Viscariello, Dennis N. Stanley, John Fiveash, and Carlos E. Cardenas

Introduction

The Ethos 2.0 treatment planning system now supports semi-automatic stereotactic plan generation. Its new high-fidelity mode uses a 1.25 mm dose grid to concentrate the dose within the target, sharpen dose fall-off, and reduce plan complexity. The goal of this study was to evaluate the impact of the new 'high-fidelity mode' feature on the quality of CNS stereotactic radiosurgery (SRS) plans.

Methods

50 brain metastasis patients previously treated with linac-based SRS were anonymized and imported into an Ethos 2.0 emulator. 15 were used for tuning planning templates, which were then applied on the remaining 35 cases with no further modification. Tuning/testing cohorts had a range of 1-13 and 1-17 targets, respectively.

All cases were prescribed to 30Gy in 5 fractions with 2mm GTV-to-PTV margins. Within the Ethos TPS, HF mode uses a high-resolution dose grid (1.25mm), allows higher doses within the target, and promises sharper dose fall-off while decreasing plan complexity. Control rings (CR) with thickness determined by PTV diameter are also investigated, as it is standard practice in our clinic. The four templates were:

- 1) High Fidelity mode On + Control Rings On
- 2) High Fidelity mode On + Control Rings Off
- 3) High Fidelity mode Off + Control Rings On
- 4) High Fidelity mode Off + Control Rings Off

Clinical metrics evaluated: PTV V100% (coverage per-target), Brain-PTV V24Gy (per-plan), Paddick Gradient Index (GI), RTOG Conformity Index (CI).

The two-sided Wilcoxon paired nonparametric test was used for difference testing, with significance values stratified as follows:

- No significance (ns): $p > 0.05$
- *: $0.01 < p \leq 0.05$
- ** : $0.001 < p \leq 0.01$
- ***: $0.0001 < p \leq 0.001$
- ****: $p \leq 0.0001$

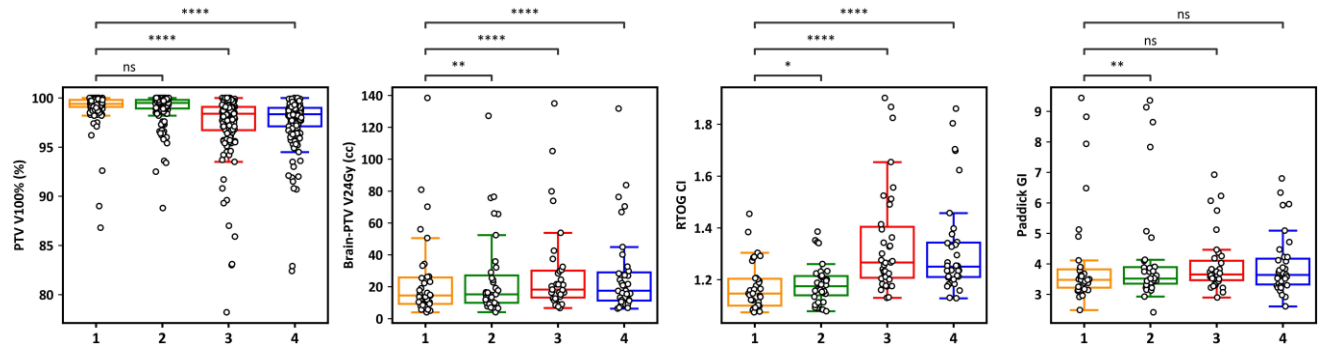


Figure 1: Boxplots showing comparison of clinical metrics across all 4 templates. Template 1: HFon+CRon, Template 2: HFon+CRoff, Template 3: HFoff+CRon, Template 4:HFoff+CRoff

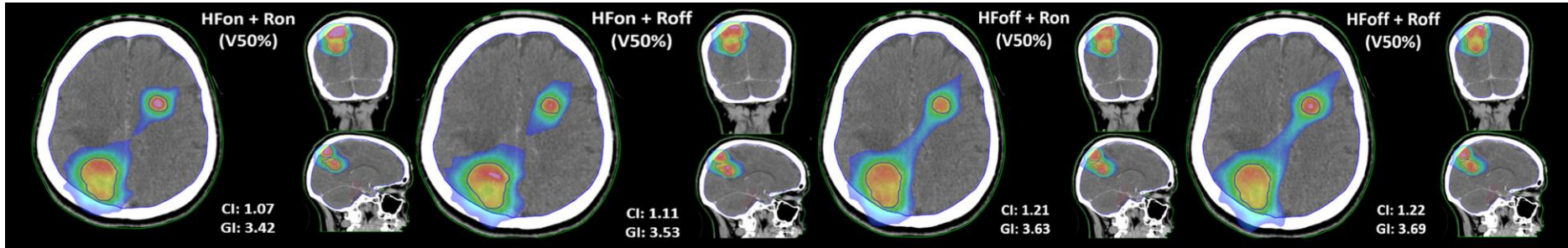


Figure 2: Qualitative plan comparisons across all 4 templates showing increased hotspot intensity and decreased healthy brain dosage with HF mode and CR enabled compared to all other plans

Results

- Enabling both control rings and high-fidelity mode improved all evaluated plan metrics compared to other templates.
- Adding control rings when using HF mode significantly lowered Brain-PTV V24Gy and CI.
- Control rings had minimal effects on target coverage, but using high-fidelity mode itself had the largest impact on clinical metrics.

Conclusion

- Enabling high-fidelity mode and control rings on the Ethos 2.0 TPS can improve the quality of single-isocenter, multi-target SRS plans compared to those without high-fidelity mode.
- This approach may also accommodate heavier patients who exceed standard linac weight limits, expanding access to precise stereotactic treatments.
- Further studies are needed to confirm efficacy and safety in clinical practice.

Contact Info

Udbhav Ram (udbhavram@uabmc.edu) and/or Carlos E. Cardenas (cecardenas@uabmc.edu)