OPTIMIZATION OF SRS PLANS USING PSEUDO-STRUCTURES FOR LOW-DOSE CONTROL IN LEKSELL GAMMA PLAN

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Introduction: In stereotactic radiosurgery (SRS), protecting organs at risk (OARs) is a crucial objective. The Leksell Gamma Plan automatic plan optimizer Lightning effectively limits the maximum dose (Dmax) to OARs, but doesn't allow the user to control the volume receiving lower but clinically relevant doses (e.g., 12 Gy). In this study we present and validate a novel stepwise optimization method designed to reduce these low-dose volumes without compromising key plan quality metrics.

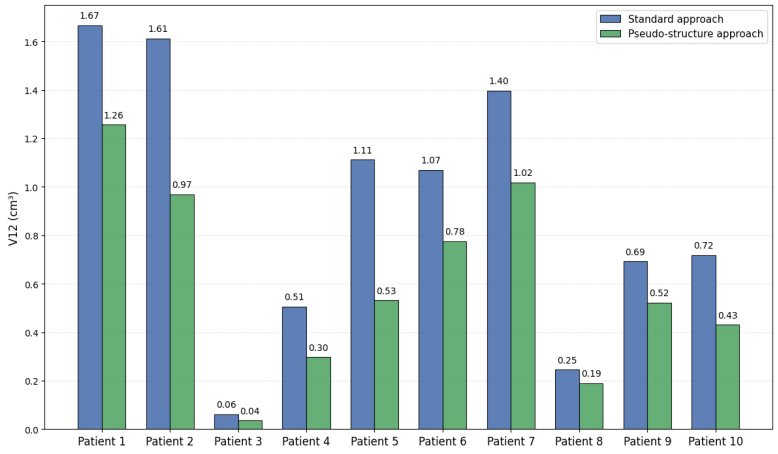

Figure 2. Comparison of V12 Gy (cm³): standard and pseudo-structure optimization (n=10 patients)

Materials and Methods: Ten patient SRS plans (18-30 Gy prescription dose) for various intracranial targets were analyzed. Firstly, standard optimization with Dmax constraints on critical structures (brainstem, optic nerves) was performed. Then the 12 Gy isodose contour within each OAR was used to create a new, interior pseudo-structure. Lastly, the optimizer was used again with additional reduced Dmax constraints (10.5–11.5 Gy) for this pseudo-structure. Plan quality was assessed by comparing the OAR V12Gy, OAR Dmax, Paddick Conformity Index (PCI). Statistical comparison was performed by Wilcoxon signed-rank test.

Results: Application of the method demonstrated a statistically significant reduction in the V12Gy for all critical OARs (W=0, p = 0.002). Crucially, there was no significant deterioration in the primary plan parameters: PCI were maintained (p = 1), and the Dmax to the original OARs did not increase significantly (p = 0.1094).

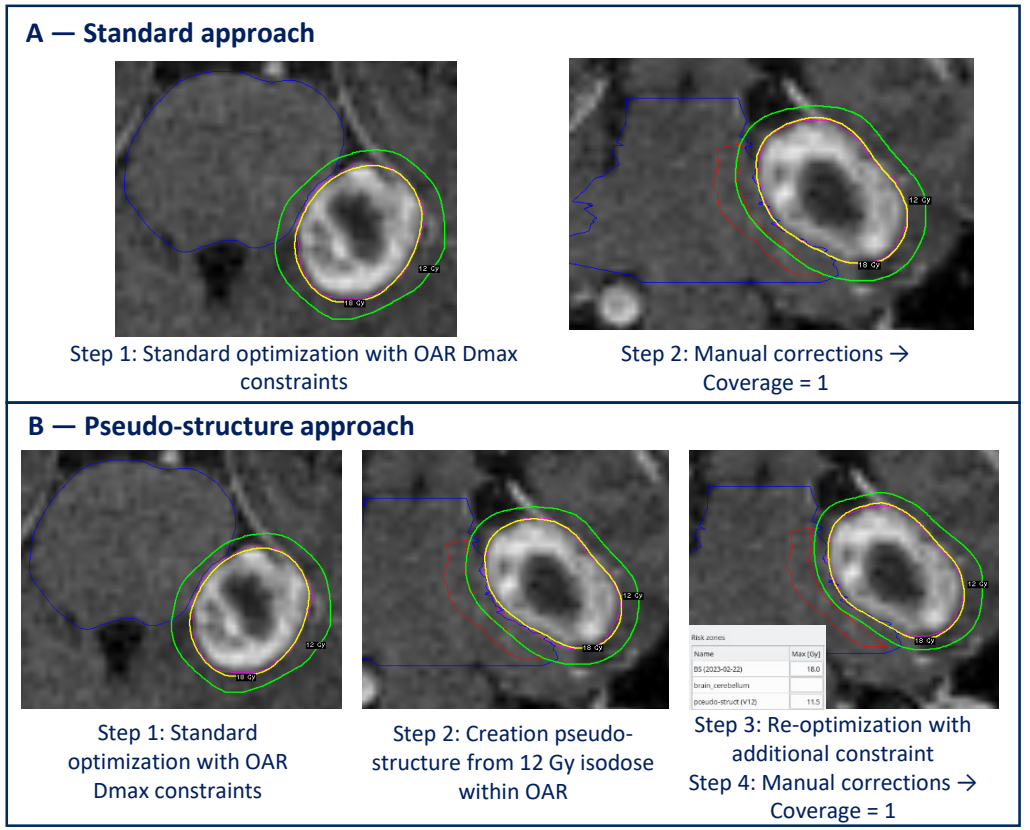

Figure 1. Workflow comparing two optimization strategies for SRS planning

Conclusion: The proposed two-step optimization technique, utilizing dose-defined pseudo-structures, provides precise, user-directed control over low-dose volumes to OARs in Gamma Plan. It directly addresses a key limitation of the standard optimizer. The method enables a reproducible reduction in volumes receiving 12 Gy without degrading target conformity or coverage, potentially reducing the risk of radiation-induced complications and enhancing patient safety. This approach requires no additional software, and is easily integrated into existing clinical workflow.

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