Improving Clinical Efficiency and Consistency with RapidPlan for Single Lesion Brain SRS

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Purpose

The dynamic conformal arc (DCA) planning technique offers low plan complexity and high delivery accuracy,and thus is preferred for linac-based single lesion brain stereotactic radiosurgery (SRS). But it often requires a large amount of planner intervention. Volumetric modulated arc therapy (VMAT) reduces human planning effort by computer-based inverse treatment planning. This work investigates whether Varian Eclipse (Palo Alta, CA) RapidPlan knowledge-based planning and the VMAT photon optimization (PO) algorithm could provide similar plan quality as the DCA planning with a more clinically efficient and consistent solution.

Methods

A RapidPlan model was trained using 80 SRS plans with lesions ranging from 5-69 mm and treated with doses from 12-27 Gy. The model was validated on 26 additional patients with lesions from 14-30 mm and prescriptions between 14-21 Gy. For these 26 lesions, clinical plans were generated in iPlan (v4.5.5) using 3-4 non-coplanar dynamic conformal arcs and recalculated in Eclipse (v15.5.11). Validation plans were created from the RapidPlan model using VMAT with a preset beam arrangement (3 non-coplanar arcs with gantry angle at 185° CW 175°, 179° CCW 10°, 181° CW 350°, collimator angle at 315°, 30°, 80°, and couch angle at 0°, 300°, 65°, respectively). For comparison purpose, each plan was also optimized using VMAT in Eclipse with the same beam arrangement (same gantry, collimator, and couch angles) as the DCA plan. Both the knowledge-based plans generated from the RapidPlan model (KBP) and the directly optimized VMAT plans using the same beam arrangement (VMAT), aim to achieve the same PTV coverage and similar dose conformity as the DCA plans. VMAT optimization was performed using PO algorithm with high modulation control to minimize the MLC complexity. All plans were normalized to 99.5% PTV coverage for a fair comparison. Plan quality was evaluated by modulation complexity score (MCS), Nakamura's conformity index (NCI), total MU, and normal brain tissue volume encompassed by 12 Gy and 6 Gy iso-dose lines (V12 and V6).

Results and Discussion

The mean values of total MU, MCS, and NCI for each type of plan are shown in Table 1. No significant changes were observed for V12 and V6 between the DCA and the VMAT/KBP plans (Table 2 and Figure 2).

	Total MU	MCS	NCI
DCA	3416 ± 601	0.55 ± 0.04	1.23 ± 0.07
VMAT	3457 ± 545	0.64 ± 0.09	1.20 ± 0.05
KBP	3577± 562	0.61 ± 0.05	1.20 ± 0.05

Table 1: Comparisons of average total MU, MCS, and NCI for the DCA, VMAT, and KBP plans.

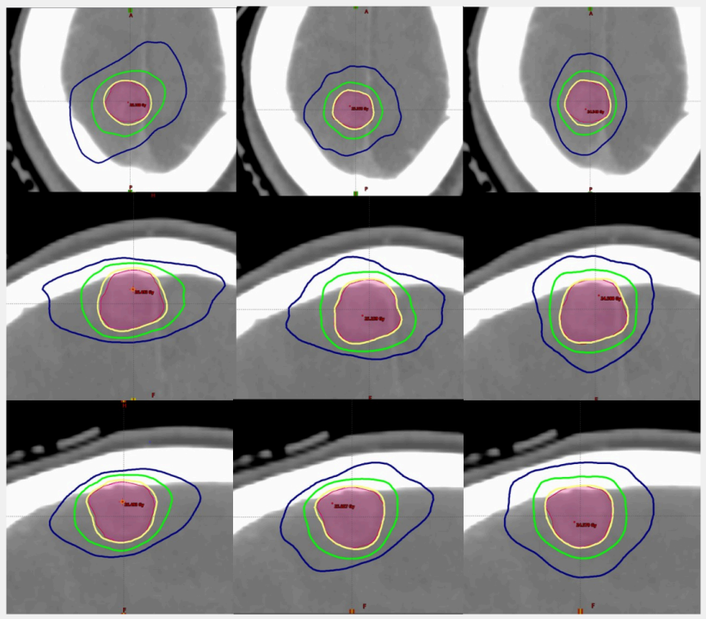

Figure 1: A representative comparison between the DCA (left), VMAT (middle), and KBP (right) plans showing in 3 views (top: axial, middle: coronal, bottom: sagittal). All the plans achieved 99.5% PTV (red shaded area) coverage by the 20 Gy prescription iso-dose line (yellow), and similar V12 (green) and V6 (dark blue).

	DCA					
	V12 (cc)			V6 (cc)		
	Mean	Min	Max	Mean	Min	Max
VMAT	-0.1±0.9	-1.9	1.5	-0.9±2.4	-6.3	3.0
KBP	0.4±1.1	-1.4	2.9	0.3±-3.2	-5.7	7.7

Table 2: The Mean, Min and Max differences in V12 and V6 between the DCA and the VMAT/KBP plans.

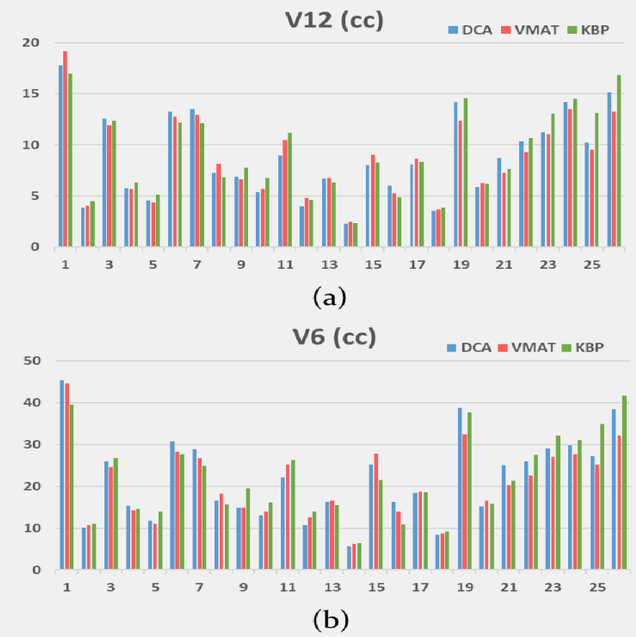

Figure 2: Comparisons of (a) V12, and (b) V6 values for the DCA, VMAT, and KBP plans.

Conclusions

RapidPlan knowledge-based planning and the VMAT PO algorithm with high modulation control offers comparable plan quality as the DCA technique and improves clinical efficiency and consistency for single small lesion brain SRS. Further efficiency could be achieved when combined with contouring and planning automation.