



Dosimetric comparison of fractionated radiosurgery (FSRS) treatment plans for large brain metastases using a gyroscopic radiosurgery delivery system



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Purpose/Objective

- Since its inception, the ZAP-X system has undergone advancements in treatment planning software and delivery capabilities, with DP-1010 introducing new optimization features and expanded beam delivery options compared to DP-1008.
- The objective of this study was to compare treatment plan quality between DP-1008 and DP-1010 for large (>2 cm) brain metastases (LBMs).
- Additionally, this study aimed to evaluate differences in treatment efficiency, including beam-on time, number of isocenters, and beam complexity

Material/Methods

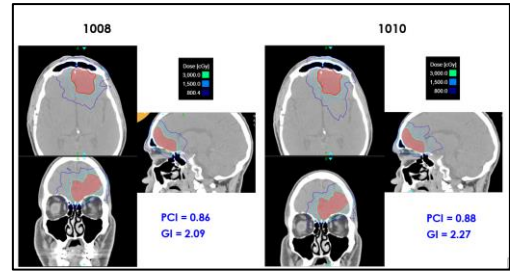
- 20 patients (10 with LBMs [27 Gy in 3 fractions] and 10 post-operative cavities [30 Gy in 5 fractions]) were planned using the latest platform (DP-1010) and the previous version (DP-1008).
- Plans were optimized not to exceed organ-at-risk (OAR) dose constraints and achieve a minimum target coverage (TC) of $\geq 99.5\%$ while maximizing the Paddick Conformity Index (PCI) and minimizing beam-on time (BOT) and Gradient Index (GI), in this order of importance.
- Plan quality metrics and delivery parameters between ZAP-X DP-1008 vs. DP-1010 were compared for all patients using a paired Wilcoxon signed rank test ($p < 0.05$) to evaluate for statistical significance.

Results

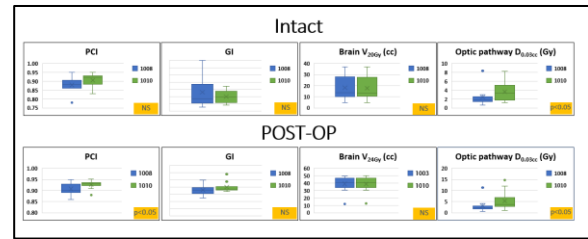
- Mean volumes of Planning Target Volumes (PTVs) for BMs and RC were 12.5 ± 7.3 cc and 31.9 ± 9.1 cc, respectively. All plans met clinical goals with TC $> 99.5\%$, except for one lesion adjacent to the brainstem, where the coverage with DP-1010 was 98.4%.

TREATMENT PLATFORM VERSION	Target		Organs-at-risk (OARs) Normal Brain		Treatment Delivery metrics		
	Median PCI	Median GI	V _{20Gy} [cc]	V _{12Gy} [cc]	# Isocenters	#Beams	Tx Time (min)
DP-1008	0.88	2.42	13.6	24.4	10	194	34.2
DP-1010	0.92 (NS)	2.44 (NS)	13.2 (NS)	26.0 (NS)	12 (NS)	252 (NS)	49 (p<0.05)
POST-OP RESECTION CAVITIES							
DP-1010	0.90	2.30	41.1	83.9	17	321	54.8
DP-1008	0.93 (p<0.05)	2.30 (NS)	40.4 (NS)	84.9 (NS)	22 (p<0.05)	371 (p<0.05)	67.0 (p<0.05)

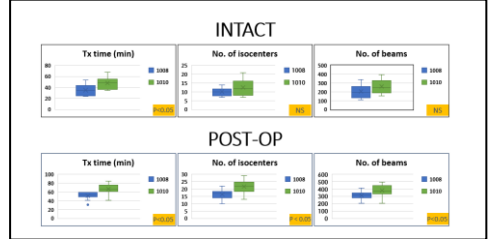
Plan quality metrics and delivery parameters of DP-1008 vs. DP-1010 ZAP-X plans



Comparison of dose distributions for a resection cavity case between plans DP-1008(Left) and DP-1010(Right)



Plan quality metrics comparison of DP-1008 vs. DP-1010 ZAP-X plans



Tx delivery metrics comparison of DP-1008 vs. DP-1010 ZAP-X plans

	Zap-X 1008	Zap-X 1010
Collimator	4, 5, 7.5, 10, 12.5, 15, 20, 25 mm	
Isocenter placement	•Auto-sphere packing •Manual	•Auto with user flexibility in defining parameters [manual adjustments after if needed]
Collimator size selection	•Auto with size selection option •Manual	•Auto [manual adjustments after if needed]
Path density	•Manual selection (3-17) •Min dose to target [2]-hard constraint •Max dose to target [5] •Max dose to target 5 mm extended margin [5] •Max MU per beam	•Manual selection (23)
Optimization: inverse planning	•Max dose to OAR [5] •No beam to OAR •Max dose to point[s] [5]	N/A
Results	No. of beams (& beam angles)/isocenter, MU/beam	

Conclusions

- DP-1010 platform improves flexibility in beam delivery through an increased solid angle, enabling additional beam paths, better targeting of inferior and posterior regions, and automated tools to enhance treatment planning efficiency
- DP-1010 produced plan quality metrics that were either superior or comparable to those from the previous version.
- DP-1010 plans showed longer treatment times and required a higher number of isocenters, and beams compared to DP-1008. Future software advancements may improve these parameters.