Gyroscopic Radiosurgery for Optic Nerve Sheath Meningioma: A Case Report

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Background & Objectives

- Primary optic nerve sheath meningiomas (ONSM) are benign tumors that account for approximately 2% of all orbital tumors and are a common cause of optic neuropathy due to compression of the optic nerve [1-2].
- Management of this tumor can be surgery or radiotherapy, but radiotherapy is the preferred treatment modality due to the risk of damage of vasculature and resulting vision loss in surgery [1-2].
- The ZAP-X is currently the newest cranial stereotactic radiosurgery platform. There are no reports describing its use or outcomes for ONSM.
- We present the case of the first documented patient to undergo ZAP-X SRS for the treatment of a primary ONSM.

Methods

- The patient was a 68-year-old female diagnosed with ONSM who presented with proptosis.
- Magnetic resonance imaging (MRI) revealed a 0.27 cm^3 enhancing lesion centered along the left optic nerve near the orbital apex with unilateral fluid distention of the left optic nerve sheath.
- The treatment plan consisted of 6 isocenters placed in the target and with a prescription dose of 25 Gy in 5 fractions at the 61% isodose line (Figure 1).
- The plan utilized 4 and 5 mm collimators (total collimator size = 26 mm), path 10 gantry movement (total path number = 60), and 252 beams.
- Forward- and inverse- planning was performed using a 0.5 mm dose grid, limiting the dose to the eyes, lens, optic nerves, optic chiasm, cochleae, brainstem, and spinal cord based on Timmerman organ-at-risk (OAR) recommendations [3].

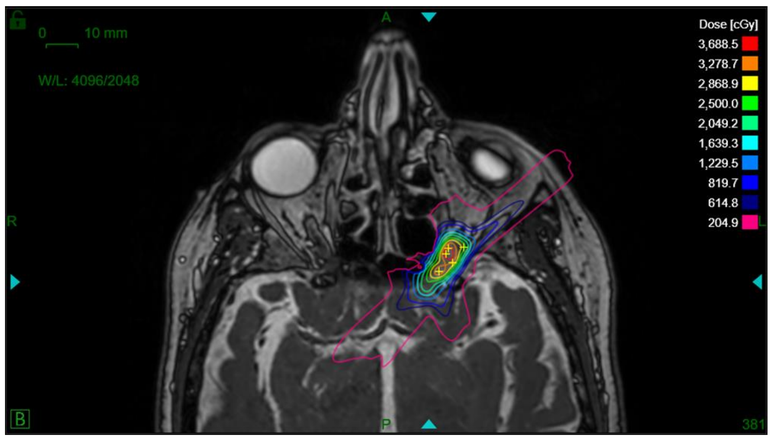

Figure 1. ZAP-X Optic Nerve Sheath Meningioma SRS with 6 isocenters placed in the target and a prescription dose of 25 Gy in 5 fractions at the 61% isodose line.

Results

- Table I summarizes the various dosimetric parameters.
- Table II summarizes plan quality metrics and doses to the target and OARs.
- All machine QA tests were within the recommended tolerances.
- Secondary check maximum dose accuracy was 99.7%.
- Gamma passing rate was 99%.
- The average treatment time per fraction was 38.2 ± 1.6 minutes.
- The maximum dose to 0.035 cm^3 (D0.035cc) of the left and right optic nerves was 1454.9 and 26.4 cGy respectively.
- The volume receiving 2300 cGy (V2300cGy) for the left and right optic nerves was 0.006 and 0 cm^3 respectively.
- The maximum point dose (Dmax) to the left and right eye was 82.1 and 22.2 cGy respectively.
- Dmax to the left and right lens was 54.1 and 19.2 cGy respectively.
- Optic chiasm D0.035cc and V2300cGy was 515.7 cGy and 0.001 cm^3 respectively.
- CI and GI were 1.438 and 3.451 respectively.
- The patient tolerated the procedure well with no complications.
- Six-months post-treatment, the patient had completely resolved left eye pain and pressure, with significantly reduced proptosis.
- Upon follow-up MRI imaging (Figure 2), the tumor volume was contoured and measured to be 0.15 cm^3, a 44% reduction in tumor volume with no vasogenic edema.
- However, there was no improvement in the patient's vision, and continues to only have light perception in the left eye.

Table I. ZAP-X ONSM SRS dosimetric results delivering 25 Gy in 5 fractions.

Dosimetric Parameter	ZAP-X ONSM SRS
Target Volume (cm^3)	0.27
Prescription Dose (Gy)	25
Prescription Isodose Line (%)	61
Fraction Number	5
Isocenters	6
Beams	252
Avg Collimator Size (mm)	4.3 ± 0.5 (4 – 5)
Total Collimator Size (mm)	26
Total Path Number	60
Second MU Check Accuracy (%)	99.7
Gamma Passing Rate (%)	99
Delivered Fraction MU	7423.75 ± 0.13 (7423.54 – 7423.87)
CI	1.438
PCI	0.795
GI	3.451
HI	1.639
Target Sphericity	0.626
Avg Treatment Time (min/Fx)	38.2 ± 1.6 (36.6 – 40.6)
Avg Setup Time (min/Fx)	3.6 ± 1.7 (2.3 – 6.4)
Avg Gantry Time (min/Fx)	21.3 ± 1.2 (20.6 – 23.3)
Avg kV Imaging and Processing Time (min/Fx)	7.6 ± 1.5 (5.2 – 9.2)
Avg Beam Time (min/Fx)	5.27 ± 0.03 (5.23 – 5.3)

Table I. Plan quality metrics and doses to the target and OARs.

Dosimetric Parameter	Metric	Constraint	ZAP-X ONSM SRS
GTV	V100%	≥ 95%	98.69%
	CI	≤ 1.2 – 1.5	1.438
	GI	≤ 4.3 – 5	3.451
Left Optic Nerve	D0.035cc	≤ 2500 cGy	1454.9 cGy
	V2300cGy	≤ 0.2 cc	0.006 cc
Right Optic Nerve	D0.035cc	≤ 2500 cGy	26.4 cGy
	V2300cGy	≤ 0.2 cc	0 cc
Optic Chiasm	D0.035cc	≤ 2500 cGy	515.7 cGy
	V2300cGy	≤ 0.2 cc	0.001 cc
Left Cochlea	D0.035cc	≤ 2200 cGy	61.2 cGy
Right Cochlea	D0.035cc	≤ 2200 cGy	23.3 cGy
Left Lens	Dmax (cGy)	≤ 100 – 200 cGy	54.1 cGy
Right Lens	Dmax (cGy)	≤ 100 – 200 cGy	19.2 cGy
Left Eye	Dmax (cGy)	≤ 100 – 200 cGy	82.1 cGy
Right Eye	Dmax (cGy)	≤ 100 – 200 cGy	22.2 cGy
Brainstem (excluding medulla)	D0.035cc	≤ 3100 cGy	108.5 cGy
	V2300cGy	≤ 0.5 cc	0 cc
Spinal Cord (including medulla)	D0.035cc	≤ 2800 cGy	24.4 cGy
	V2200cGy	≤ 0.35 cc	0 cc
Skin	D0.035cc	≤ 3850 cGy	404.1 cGy
	V3650cGy	≤ 10 cc	0 cc
Brain - GTV	V2400cGy	≤ 16.8 cc	0.001 cc

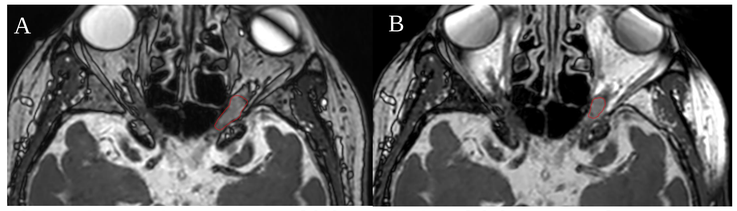

Figure 2. MRI Comparison of (A) pre-SRS and (B) six-months post-SRS.

Conclusion

- This case presents the successful use of ZAP-X SRS for the treatment of optic nerve sheath meningiomas.
- The treatment was delivered safely with no side effects and was confirmed to have decreased the tumor volume.
- This action resulted in symptomatic resolution in this patient, with no complications related to radiation toxicity or otherwise.
- Although requiring further investigation, such studies are needed to define long-term efficacy of the platform.

References

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