

Proton Therapy Versus Volumetric Modulated Arc Therapy For Benign Tumors of The Skull Base and Sellar Location

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Background: The skull base and sella are surrounded by critical neural organs at risk, and thus minimizing the integral dose while treating tumors in this location is advantageous. Our aim is to evaluate the dosimetric differences of volumetric modulated arc therapy (VMAT) as compared to 3-D proton therapy (PBT).

Methods: Ten patients with pituitary adenomas (N=5) and skull base meningiomas (N=5) who were treated with PBT and had a comparison VMAT plan available were evaluated. The average mean and maximum doses to the bilateral optic structures, cochlea, and nearby brain were compared across treatment modalities using a paired Student's T-test, with use of the Bonferroni correction for multiple comparisons.

Results: Median dose was 50.4 CGyE (45-52.2). Target volume coverage was comparable in both proton and VMAT plans for all cases. Compared to VMAT, PBT plans showed a significant reduction in mean and maximum doses to the right lens and eye, with a trend towards a significant reduction for the mean dose to the right optic nerve. Doses to other structures were comparable between plans, with a trend towards lower doses for proton plans.

Conclusions: PBT as compared to VMAT resulted in meaningful dose reductions to organs at risk while maintaining comparable target coverage. Further refinements in proton therapy including intensity modulation may have the potential to further minimize dose to critical neural structures in the skull base and sella.

Table 1. Dosimetric Comparison Proton and VMAT Plans

Structure/OAR	Proton	VMAT	P-value
Right Eye			
Average Mean (cGy)	111	684	<0.0001**
Average Max (cGy)	798	1672	0.0025**
Left Eye			
Average Mean (cGy)	577	996	0.022
Average Max (cGy)	1855	2158	0.117
Right Lens			
Average Mean (cGy)	3	435	<0.00002**
Average Max (cGy)	13	514	<0.000005**
Left Lens			
Average Mean (cGy)	207	507	0.040
Average Max (cGy)	307	545	0.129
Right Optic Nerve			
Average Mean (cGy)	3038	3565	0.006
Average Max (cGy)	5206	5010	0.135
Left Optic Nerve			
Average Mean (cGy)	4010	3906	0.360
Average Max (cGy)	4437	5053	0.092
Optic Chiasm			
Average Mean (cGy)	4598	5129	0.164
Average Max (cGy)	5229	5224	0.454
Right Cochlea			
Average Mean (cGy)	1545	2524	0.032
Average Max (cGy)	2271	2978	0.115
Left Cochlea			
Average Mean (cGy)	3018	3721	0.145
Average Max (cGy)	3995	4332	0.128
Brain			
Average Mean (cGy)	772	1575	0.063
Average Max (cGy)	5308	4816	0.155

** denotes a significant p-value at $\alpha = 0.05$, Bonferroni correction applied to all tests

Figure 1. Comparison of VMAT (top row) and proton (bottom row) dose distributions to the optic structures and brainstem

