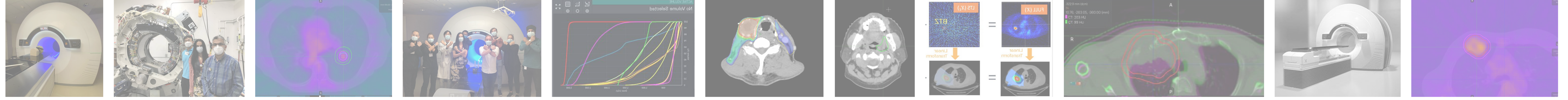

A Dosimetric Comparison of Head and Neck Plans Generated for Linac-based VMAT, linac-based VMAT using Autoplanning Script and a Ring-based IMRT Delivery System

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Background

For head and neck cancers, IMRT based treatment has become the standard of care as it is able to reduce toxicities compared to traditional 3D forward planning techniques.. With the implementation of user-enabled scripting software, automated treatment plans can be adopted readily within the clinic. At our institution, a planning script was developed using the Varian Eclipse Scripting Application Interface (ESAPI, Varian Medical Systems, Palo Alto, CA) to auto-generate head and neck VMAT plans. In our department, head and neck patients are treated on a ring-based treatment delivery system (RefleXion X1, Hayward, CA). For these patients, a linac-based VMAT plan is also generated as a back-up for treatment. With the availability of an auto-planning script, there is a potential to reduce the additional resource burden of generating back-up plans

Aims & Objectives

This is a retrospective study to compare the dosimetry between manually generated VMAT plans, autoplan-based VMAT plans and ring-based gantry treatment plans .

Methodology

- Ten head and neck patients previously treated on Reflexion X1 were used for this retrospective analysis including five patients with unilateral treatment (50-66Gy in 30-33fractions) and five patients with bilateral head neck treatment (50-70Gy in 30-33 fractions)
- Each patient had a Reflexion X1 plan (*RFX-X1*) and a linac-based VMAT (*VMATmanual*) approved for clinical treatment. Linac-based VMAT plans were generated on Eclipse treatment planning system (v15.6). For the clinically approved VMAT plans, 2-3 partial arcs or 3-4 full arcs were used for unilateral and bilateral head and neck cases, respectively. All VMAT plans were calculated on the Acuros (Varian Medical System, Palo Alto, CA) dose calculation model using a 2mm dose grid. The RFX-X1 plans were generated with a 20mm jaw and the dose calculated using a collapsed-cone convolution superposition (v1.0.46) algorithm with a 2mm calculation grid. To generate the autoplan *(VMATautoplan)*, the target structures and OARs approved by the physician were used for plan generation (Figure 2).
- For all plans, the dose covering 95% of the PTV, dose to organs at risk, maximum dose to the PTV and maximum dose to 2% of the PTV (PTV D2%) were used for analysis. A one-way ANOVA analysis was used to determine any significant difference (*p<0.05*) in dose to OARs and plan homogeneity between the three plans.

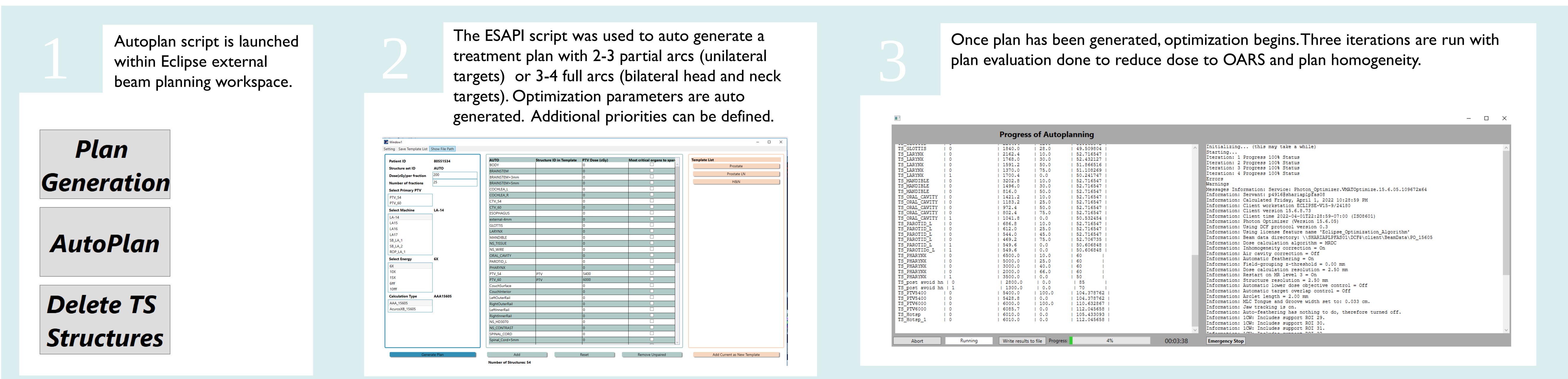

Figure 2. Head and Neck VMAT auto-plan generator using Varian Eclipse Scripting Application Interface (ESAPI)

Results

All plans were able to achieve an average minimum coverage of 99% of the prescription dose to 95% of the target PTV. Compared to *VMATmanual* plans, *VMATauto* plans showed a significantly higher homogeneity index of 1.09 vs 1.07 (p = 0.01). There was no significant difference in plan homogeneity between *RFX-X1* plans and *VMATautoplan* (*p>0.05)*. For all plans, dose to organs at risk were within institutionally accepted constraints (Table 1). Apart from the dose to the contralateral brachial plexus and contralateral submandibular gland, there were no significant differences in dose to organs-at-risk between *VMATmanual* and *VMATauto* plans (Figure 3).

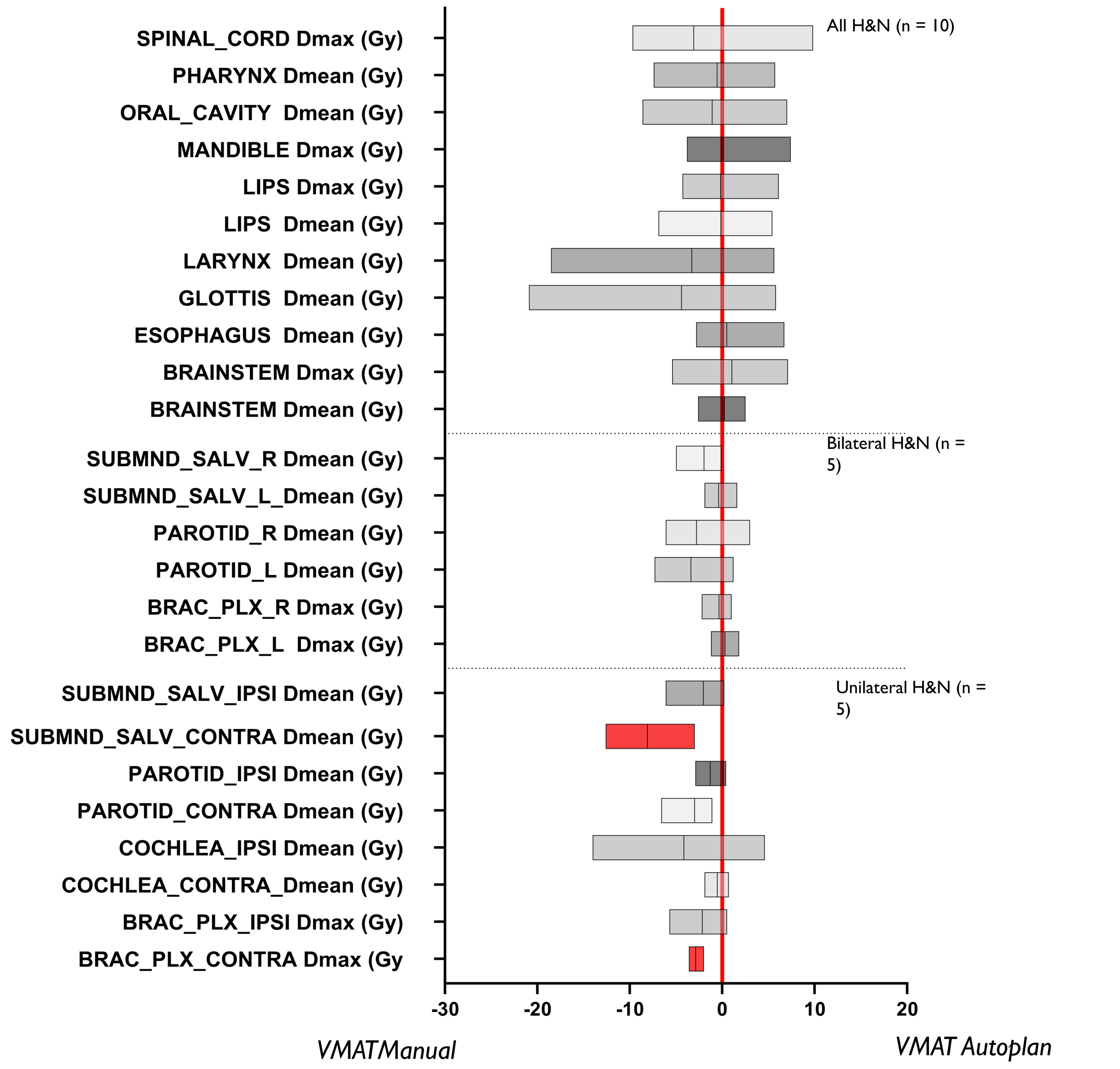

Figure 3. Box-plot of median difference in dose to organs-at-risk between VMATmanual and VMATautoplan in head neck treatment.

Target/OAR	VMAT manual (Gy)	VMAT autoplan (Gy)	RefleXion X1 (Gy)	Autoplan vs Manual	Autoplan vs RFX	Manual vs RFX
PTV 70	70	70	70.1			
PTVp 66	66.2	65.8	66.3			
PTVn 66	66	66	66.2			
PTV 63	63.1	64.5	63.4			
PTV 60	60	59.7	60.1			
PTV 56	56.6	57	56.8			
PTV 54	54.4	54.1	54.4			
PTV 52	52	52.4	52.3			
PTV 50	50	50.6	50.4			
PTV Dmax (n = 10)	1.07	1.09	1.07	0.01	0.07	0.09
Bilateral (n = 5)	1.07	1.10	1.08	0.12	0.27	0.14
Unilateral (n = 5)	1.06	1.08	1.07	0.02	0.18	0.60
PTV D2% Total (n = 10)	1.04	1.06	1.05	0.01	0.12	0.00
Bilateral (n = 5)	1.04	1.08	1.06	0.05	0.31	0.00
Unilateral (n = 5)	1.04	1.05	1.05	0.01	0.07	0.01
Brainstem (Dmean)	4.7	4.5	3.1	0.88	0.04	0.04
Brainstem (Dmax)	17.6	16.5	14.5	0.73	0.46	0.21
Esophagus (Dmean)	16.1	15.7	13.7	0.85	0.08	0.18
Glottis (Dmean)	25.8	30.3	24.5	0.34	0.08	0.36
Larynx ((Dmean)	28	31.3	27.1	0.42	0.15	0.54
Lips (Dmean)	19.8	20	20	0.99	1.00	0.88
Lips (Dmax)	40.1	40.4	38.1	0.98	0.55	0.61
Mandible (Dmax)	58.7	58.8	58	1.00	0.72	0.71
OralCavity (Dmean)	25.1	26.2	26	0.74	0.99	0.44
Pharynx (Dmean)	32.8	33.33	32.9	0.91	0.89	0.98
SpinalCord (Dmax)	27.1	30.2	23.5	0.36	0.02	0.03
BrachialPlexus_Rt (Dmean)	56.5	56.9	56.9	0.88	1.00	0.86
BrachialPlexus Lt (Dmean)	57.3	57	56.7	0.88	0.89	0.06
Parotid Rt (Dmean)	21	23.8	20.7	0.30	0.30	0.30
Parotid Lt (Dmean)	22.7	26	23.5	0.23	0.37	0.67
Submand Glnd Rt (Dmean)	44.4	46.4	41.1	0.15	0.29	0.56
Submand Glnd Lt (Dmean)	47.5	47.9	43.8	0.92	0.67	0.68
BrachialPlexus_Contralateral (Dmean)	12.4	15.3	10.9	0.01	0.11	0.63
BrachialPlexus Ipsilateral (Dmean)	55.6	57.8	56.8	0.36	0.77	0.35
Parotid Contralateral (Dmean)	4.5	7.5	4.8	0.08	0.20	0.90
Parotid Ipsilateral (Dmean)	42.5	43.8	44	0.50	0.98	0.44
Subman Glnd Contralateral (Dmean)	8.5	16.6	7.3	0.05	0.11	0.60
Submand Glnd Ipsilateral (Dmean)	52.6	54.7	51.8	0.42	0.57	0.81
Cochlea Contralateral (Dmean)	3.5	4	3.3	0.65	0.66	0.92
Cochlea Ipsilateral (Dmean)	11	15.2	13.1	0.60	0.91	0.68

Table 1. Table showing the average dose to PTV covering 95% of the volume, dose metrics including PTV maximum dose index, maximum dose index to 2% of the PTV and max/mean dose to organs at risk. Values highlighted in red indicate a significant difference (p≤0.05)

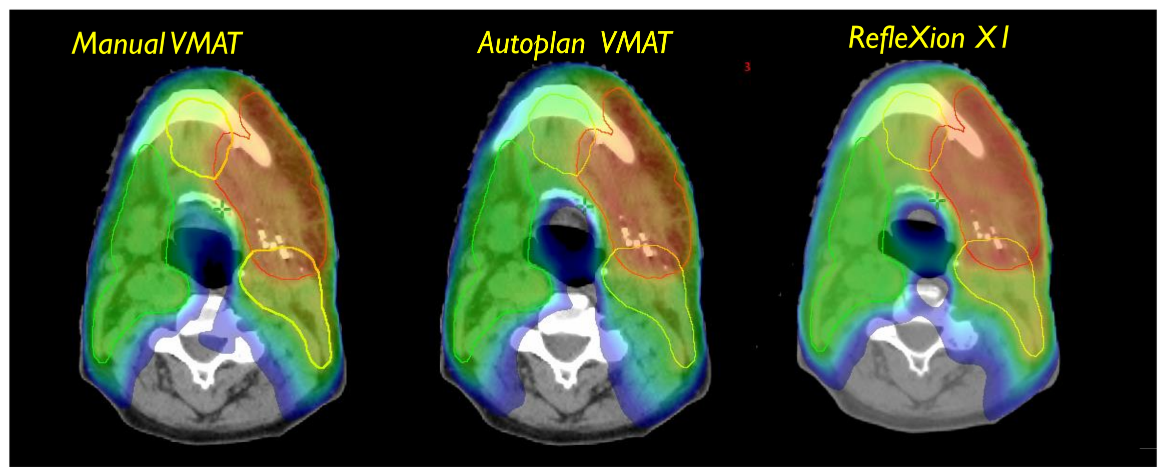

Figure 1. Examples of dose distribution for manual VMAT plans, auto-plan VMAT plans and RefleXion[TM] for a head neck cancer patient receiving dose of 60Gy in 30 fractions.

Conclusions

ESAPI scripting can be used to auto-generate clinically acceptable VMAT head and neck plans. Apart from a slightly higher homogeneity index to the manual planning method, autoplanned VMAT cases did not show significantly different homogeneity compared to RefleXion plans. Limitations of this study included the small number of cases used and the heterogeneity of disease sites. Further investigation into particular head and neck disease sites can better inform utility of auto-planning scripts.

Acknowledgements/Contact

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