From contour to ideally desired dose distribution to high quality deliverable larynx SBRT plan

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INTRODUCTION

Stereotactic body radiation therapy (SBRT) has been shown effective in treating early-stage laryngeal cancer. However, treatment planning is challenging due to its demand of uniform dose distribution in the targets and steep dose falloffs in nearby OARs. Traditional treatment planning using objective functions, constraints, and weight adjustment is an iterative process. It introduces lengthened planning time and increased inter-planner variability. Our study aims to develop an efficient treatment planning approach with minimal manual interventions to generate high quality SBRT plans for laryngeal cancer patients.

METHOD

This study includes four laryngeal cancer patients who were treated with SBRT using VMAT technique at our center. 2 planning target volumes, PTV_42.5 and PTV_32.5, were delineated to receive 42.5 and 32.5 Gy in 5 fractions. OARs in proximity include cricoarytenoid unit (CA), carotid, esophagus and spinal cord. The clinical goals on targets and OARs are listed in Table 1.

This novel planning approach has 3 steps:

1. Generating an ideally desired dose distribution based on contours of targets and nearby critical structure using an in-house developed script. The ideal dose distribution includes five dose levels of 42.5, 32.5, 24, 12 and 0 Gy. An example is shown in Fig 1. c).
2. Utilizing “Fallback planning” in RayStation to generate an initial deliverable plan mimicking the ideal dose.
3. Finalizing the plan by RayStation Fine-tune tool based on clinical goals.

RESULTS

The dose mimicking-based plans achieved equivalent plan quality compared to the clinical plans for all cases. The average PTV_42.5 coverage and hot spot (D0.01cc) were 95.2% and 4482 cGy, respectively, compared to 96.6% and 4430 cGy of the clinical plans. The average maximum dose to 0.01cc of spinal cord and esophagus were 448 and 1217 cGy, respectively, compared to 500 and 1202 cGy of the clinical plans. The total planning time upon completing contouring for the proposed approach was within one hour for the four test cases. for left/right carotid artery,

Table 1. Clinical goals and achieved value by the mimicking and clinical plans of 4 patient cases

Patient			1	2	3	4	Avg
PTV_42.5	V4250 (%) > 95%	Mimicking	95.0	95.2	95.2	95.4	95.2 ± 0.2
		Clinical	95.3	96.7	96.9	97.4	96.6 ± 0.9
	D0.01 (cGy) < 4500	Mimicking	4454	4486	4499	4490	4482 ± 20
		Clinical	4440	4450	4443	4388	4430 ± 28
PTV_32.5	V3250(%) > 95%	Mimicking	96.8	99.4	98.3	98.7	98.3 ± 1.1
		Clinical	99.7	97.9	98.3	99.6	98.9 ± 0.9
CA	V2000(%) < 10%	Mimicking	10.9	1.9	0.2	0.1	3.0 ± 5.0
		Clinical	8.4	1.9	0.4	0.2	3.0 ± 4.0
	V1500(%) < 30%	Mimicking	24.3	4.4	5.2	2.9	9.0 ± 10.0
		Clinical	17.6	5.6	5.5	1.6	8.0 ± 7.0
	V1000(%) < 50%	Mimicking	50.8	11.5	23.0	13.4	25.0 ± 18.0
		Clinical	36.8	26.86	38.8	11.5	28.0 ± 12.0
	Mean(cGy) < 1200	Mimicking	1181	660	851	724	854 ± 232
		Clinical	1028	808	960	697	873 ± 149
Left Carotid	D0.1 (cGy) < 2700	Mimicking	684	611	547	1526	842 ± 459
		Clinical	704	734	448	1578	866 ± 492
Right Carotid	D0.1 (cGy) < 2700	Mimicking	1564	1658	2632	622	1901 ± 903
		Clinical	1610	1527	2631	477	1760 ± 921
Esophagus	D0.01 (cGy) < 1500	Mimicking	1393	814	1396	1266	1217 ± 276
		Clinical	1408	954	997	1450	1202 ± 263
Spinal Cord	D0.01 (cGy) < 600	Mimicking	588	384	598	381	448 ± 122
		Clinical	552	480	494	474	500 ± 36

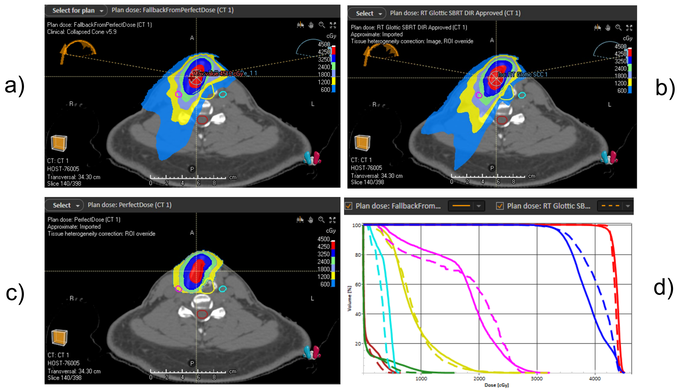
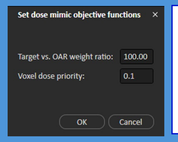
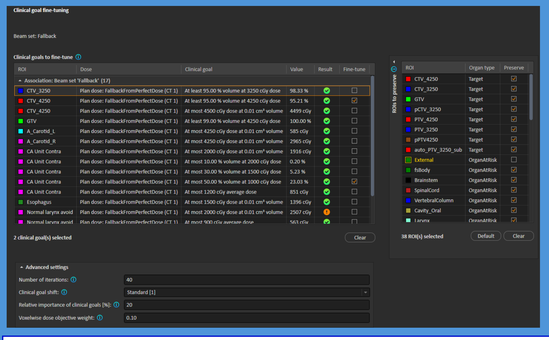


Fig 1. Plots of dose distribution of patient #3. a) is the mimicking plan generated in this study. b) is the clinical plan. c) is the ideal dose used for dose mimicking. d) is DVH comparison between mimicking and clinical plans.



MIMIC DOSE OPTIMIZATION

One click optimization to mimic dose on a voxel-per-voxel level and in terms of DVH curves.



Fine-tuning Clinical goals

CONCLUSIONS

This dose mimicking-based planning approach was able to generate high quality SBRT larynx plans with high efficiency using a commercial treatment planning system.