Insurance 3D plan comparisons using RayStation TPS Automation

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PURPOSE

The purpose of this study is to determine whether automatically created 3D-CRT plans based on the clinically intended VMAT plan are of sufficient quality to meet prior authorization guidelines with minimal planner input.

INTRODUCTION

Radiation oncology treatment planning has evolved from 2D- and 3D-conformal therapy (3D-CRT) to intensity-modulated radiation therapy (IMRT) including volumetric-modulated radiation therapy (VMAT), resulting in treatment plans with better dose conformality, lower organs at risk (OAR) doses, and shorter patient treatment times[1]. A barrier to IMRT/VMAT planning is attaining prior authorizations (PA) and the subsequent need to create 3D-CRT comparison plans[2]. According to institutional data from fiscal year 2022, on average, MD Anderson dosimetrists dedicated approximately 10% of their case load to creating 3D comparison plans (D3D). The additional hours devoted to the development of comparison plans resulted in $500-$1500 of personnel costs per plan[3].

Automation allows the TPS to select the ideal combination of segment shapes and collimator, gantry, and couch angles based on either clinical goals or by trying to mimic an existing IMRT/VMAT plan. Comparison plans were generated in the RayStation treatment planning system using two approaches, beginning with predefined beam angle templates based on the anatomical tumor site. Using optimization objectives inherited from the VMAT plan (AO3D) and a fallback planning automated system (FB3D) to mimic dose distribution, the adoption of an effective 3D-plan generating script may result in decreased workloads and personnel costs and expedite patient treatment.

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Table 1: OAR Goals

Comparison of the number of clinical goals met by the dosimetrist created 3D plan (D3D), Automatically Optimized 3D(AO3D) and Fallback Planning (FB3D) for 20 randomly chosen thoracic cases. The comparison plans were all planned uniformly to the highest dose level if SIB. The clinical goals used for comparison were based on the original VMAT and 3D dosimetrist plans.

Table 1: Comparison of D3D, AO3D and FB3D in meeting OAR Goals

				Number of Met OAR Goals:		
Case ID:	SIB vs NonSIB	Prescription	Total Goals	3D Dosimetrist (D3D)	3D Optmization (AO3D)	Fallback Planning (FB3D)
LL02	Non-SIB	45Gy 15fx	25	23	23	23
LL03	SIB	30Gy 10fx	20	10	10	16
LL05	Non-SIB	45Gy 15fx	17	13	14	14
LL07	SIB	60Gy 10fx	14	14	10	10
LL09	SIB	60Gy 15fx	13	10	12	12
LL11	Non-SIB	70Gy 8fx	24	19	20	19
LL12	Non-SIB	30Gy 10fx	17	8	10	11
LL13	Non-SIB	70Gy 10fx	31	29	29	29
M01	SIB	66Gy 30fx	19	13	11	11
M05	SIB	66Gy 30fx	15	13	14	13
M06	Non-SIB	45Gy 30fx	15	13	13	14
M07	Non-SIB	50Gy 25fx	15	15	14	14
M11	Non-SIB	45Gy 25fx	14	4	4	3
RL01	SIB	52.5Gy 15fx	20	18	20	20
RL02	SIB	52.5Gy 15fx	25	19	21	19
RL05	SIB	60Gy 15fx	17	15	16	16
RL06	SIB	70Gy 10fx	23	16	16	18
RL08	Non-SIB	45Gy 15fx	17	17	17	17
RL09	Non-SIB	60Gy 15 fx	10	5	5	8
RL11	Non-SIB	45Gy 15fx	19	17	19	18

Table 2: OAR Dose Statistics

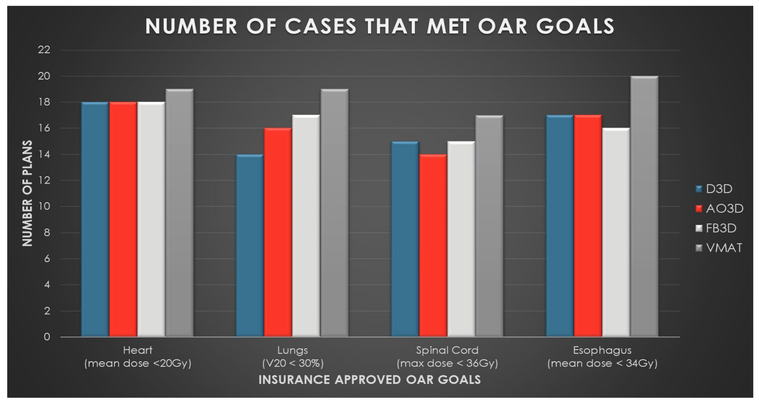
Detailed investigation of 4 criteria (Heart Max Dose, Lung V30, Cord Max Dose and Esophagus mean dose) used in insurance justification for IMRT/VMAT. Numbers highlighted in red indicate the goals that did not meet OAR constraints.

Table 2: Insurance Criteria for OAR Statisticsc

	OAR Dose Statistics:											
	Heart			Lungs			Spinal Cord			Esophagus		
	At most 2000 cGy average dose			At most 30.00 % volume at 2000 cGy dose			At most 3600 cGy dose at 0.00 cm³ volume			At most 3400 cGy average dose		
	D3D	AO3D	FB3D	D3D	AO3D	FB3D	D3D	AO3D	FB3D	D3D	AO3D	FB3D
LL02 (NONSIB)-15fx	1776	897	815	20.91%	8.72%	7.81%	141	515	427	1096	273	242
LL03 (SIB) -10fx	1695	727	1055	31.60%	30.67%	35.97%	3207	2633	2974	2141	2119	2168
LL05 (NONSIB) -15fx	1296	1217	1275	29.97%	23.39%	29.56%	3596	4446	4732	2766	2819	2767
LL07 (SIB) -10fx	32	27	20	8.97%	7.72%	6.48%	1217	1532	1278	5419	7063	5941
LL09 (SIB) -15fx	1062	1000	1021	5.78%	8.38%	7.49%	692	577	1054	288	144	625
LL11 (NONSIB) -8fx	1162	927	999	10.87%	11.41%	12.21%	1426	2488	1830	1549	2574	3441
LL12 (NONSIB) -10fx	900	544	513	20.89%	18.31%	13.35%	2946	1676	2353	2281	2156	2155
LL13 (NONSIB) -10fx	10	5	4	7.96%	4.39%	4.17%	786	1829	1570	588	482	322
M01 (SIB) -30fx	3115	2928	3121	50.63%	42.02%	54.13%	3987	4893	6010	3989	3680	4479
M05 (SIB) - 30fx	224	204	194	22.45%	13.99%	12.90%	6998	3328	4533	2905	2046	1925
M06 (NONSIB) - 30fx	647	453	399	38.77%	27.28%	28.28%	3314	3973	3176	2327	2139	1889
M07 (NONSIB) - 25fx	1557	1583	1325	22.33	18.69	16.8	4401	4772	4687	1688	1518	1376
M11 (NONSIB) -25fx	3558	2705	3235	43.38%	49.13%	45.02%	4884	5283	5266	3712	3721	3620
RL01 (SIB) -15fx	1043	1466	1141	33.67%	24.96%	24.33%	2903	3058	3466	608	786	689
RL02 (SIB) -15fx	1663	1727	1365	21.55%	17.79%	14.48%	2664	1646	2792	884	608	552
RL05 (SIB) -15fx	1641	1845	1393	24.15%	22.50%	13.66%	4090	2974	2901	1130	1068	691
RL06 (SIB) - 10fx	48	5	42	18.47%	19.58%	19.63%	308	3967	2482	563	43	287
RL08 (NONSIB) -15fx	480	553	462	20.49%	18.77%	16.97%	3215	2722	2809	1250	1400	1217
RL09 (NONSIB) -15fx	601	579	418	30.32%	31.17%	26.51%	3381	3001	2617	1503	1009	1107
RL11 (NONSIB) - 15fx	906	692	672	3.40%	4.16%	2.75%	2452	3326	2732	1015	834	880

Figure 1: VMAT comparison

Identifies the number of plans that met OAR goals for all four techniques (D3D, AO3D, FB3D and VMAT).

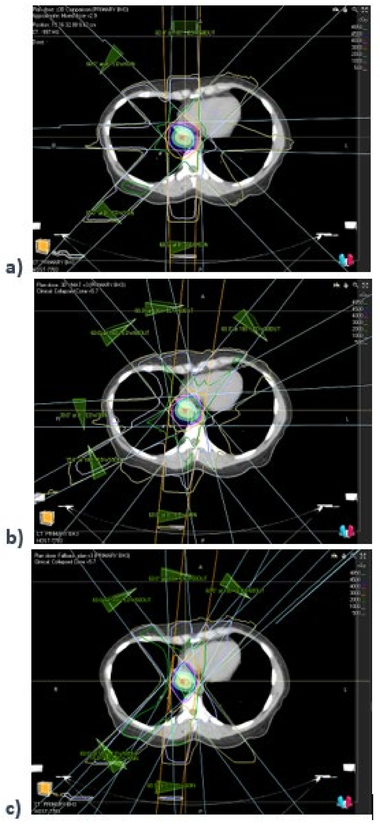


METHOD

- ❑ Twenty cases were randomly selected and organized according to tumor site: right lung (RL), left lung (LL), and mediastinum (M).
- ❑ 3D plans were created in RayStation 12A using 3D optimization (AO3D) and fallback planning (FB3D). All AO3D and FB3D plans used the same physician-approved contours for all target volumes and OARs, treatment machine, 6MV energy, and prescription as its matching D3D plan.
- ❑ The TPS was set to optimize the segment shapes, segment MU, gantry, collimator, and wedge. AO3D was based on the optimization goals from clinical VMAT plan with no modifications, while FB3D's optimization was based on the dose distribution from the clinical VMAT plan.
- ❑ SIB plans were planned to the GTV volume receiving at least 99% of the prescription dose. Non-SIB plans were planned to the PTV volume receiving at least 95% of the prescription dose.
- ❑ Right- and left-sided cases used beam templates with 6 evenly spaced beams with gantry angles ranging from 30 to 350 degrees (RL) and 10 to 330 degrees (LL). The mediastinum cases used 7 beams with gantry angles from 20 to 330 degrees.

Figure 2: Dose Distribution

Dose distribution for case RL11 where a) D3D, b) AO3D and c) FB3D.



PLANNING TIME (mins)

CONCLUSION

This study investigated whether automatically generated 3D-CRT plans based on approved VMAT plans were of comparable quality to D3D created for insurance comparisons. AO3D and FB3D can generate clinically deliverable thoracic plans with lower doses to the heart, lungs, and esophagus than D3D plans. Furthermore, both AO3D and FB3D plans met one to two more OAR goals compared to D3D plans. Automated techniques also significantly reduce planning times compared to D3D at an average of 5 minutes versus 30 minutes respectively. These techniques can be integrated into the clinical workflow to decrease workloads, lower personnel costs, and streamline the process of patient treatment.

REFERENCES

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3) Ning, M. (2023). Comparison Plans for Insurance Authorization. MD Anderson [PDF].