

# On the feasibility of daily delivered dose evaluation using RTapp™ for adaptive lung SBRT treatment

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## INTRODUCTION

Image guidance plays a vital role in patient's alignment and repositioning for daily treatment. Cone-beam CT (CBCT) is a commonly used for visualization of the anatomy. Usually, treatment is delivered by assuming that patient anatomy remains same as that of the plan. This assumption might compromise the accuracy of the treatment delivery when changes in geometry and relative positions of anatomical structures are not considered<sup>1</sup>. A more precise daily dose evaluation is needed to solve this deficiency of the current practice. A new software RTapp™ is being developed by SegAna LLC (Orlando, FL) for a fast evaluation of daily treatment delivery.

### RTapp™ Software

- It uses registration information and daily CBCT to perform a bidirectional deformable image registration (DIR)<sup>2</sup>. The implementation of DIR allows quick and auto-segmentation of structures to update patient geometry and the dose to target and organs-at-risk (OARs).
- Dosimetric endpoint values based on Radiation Therapy Oncology Group (RTOG) protocols are used as the metrics to assess the quality of treatment delivery. The treatment plan is evaluated by comparing the achieved values for every fraction against planning values, and RTOG recommended values.
- It enables cumulative dose analysis up to the current fraction, which helps to identify treatment plans that need to be reoptimized.

We studied the feasibility of RTapp™ for the stereotactic radiosurgery (SBRT) of lung by retrospectively analyzing 20 treatments. Lung SBRT is a highly conformal procedure to ensure dose escalation is accurately delivered to target with minimum exposure to OARs<sup>3,4</sup>. As a consequence, minor changes in the anatomy might cause a serious underdosing of target or overexposure of OARs. The ability of RTapp™ to identify plans at risk is advantageous in SBRT of the lung to assess quality of treatments and adapt plans to anatomical changes accordingly.

## METHOD

We retrospectively analyzed twenty patients who underwent lung SBRT treatment. Patients were treated on Varian TrueBeam (Varian Medical Systems, Palo Alto, CA) linear accelerator equipped with onboard CBCT imager. Elekta Body Frame (Elekta AB, Stockholm, Sweden) with chest compression plate and Civco Vac-Lok (CIVCO Medical Solutions, Orange City, IA) vacuum cushion were used for the immobilization of patients during the CT simulation and SBRT treatments. The prescription dose of 45-54 Gy was delivered to an isodose level of 80% to 90% in three or five fractions. Daily CBCT images were acquired for patient positioning. The alignment information was retrieved from the MOSAIQ R&V system. Dose-volume histograms (DVH) for all contoured structures were calculated.

## RESULTS

RTapp Report for Study ID 26428

PATIENT DEMOGRAPHICS					
Patient Name	Patient ID	DOB	Physician	Anatomy Type	Plan Date
RTAT_D043	RTATID0656			Thorax SBRT	08 Jul 2017 08:13:45

PLAN DETAILS					
Target Structures	Dose (Gy)	%	Dose Fx (Gy)	Plan Structure	Max / Mean Dose (Gy)
SBRT_L_Lung	50	100	10	RTOG_PTV	58.86 / 54.63

DOSIMETRIC					
Structure Name	RTOG Constraint	Plan Constraint	Plan(cc) / Def Volume(cc) Info	Achieved Value	SumDose (%)
RTOG_PTV	V100 % >= 95 %	V100 % >= 92.91 %	23.22 / 22.67	94.45 %	94.45
RTOG_PTV	V90 % >= 99 %	V90 % >= 98.98 %	23.22 / 22.67	99.74 %	99.74
ITV	V100 % >= 99 %	V100 % >= 100 %	6.44 / 6.52	100 %	100
ITV	V100 % >= 99 %	V100 % >= 100 %	5.28 / 5.38	100 %	100
Total_Lung_no_tv	V2.5 Gyfx >= 118.11 cc	V2.5 Gyfx >= 118.11 cc	3658.89 / 3642.99	119.92 cc	23.77
Total_Lung_no_tv	V2.7 Gyfx >= 112.48 cc	V2.7 Gyfx >= 112.48 cc	3658.89 / 3642.99	114.78 cc	23.36
Heart	Dmax <= 105%	Dmax <= 44.71%	726.7 / 724.73	42.29 %	
Heart	V5.4 Gyfx <= 15 cc	V5.4 Gyfx <= 41.71 cc	726.7 / 724.73	42.29 %	57.81
Cord	Dmax <= 50Gy	Dmax <= 43.0Gy	60.03 / 61.01	6.29 Gyfx	
Cord	Dmax <= 30Gy	Dmax <= 43.0Gy	60.03 / 61.01	6.29 Gyfx	
Cord	V4.5 Gyfx <= 0.25 cc	V4.5 Gyfx <= 0 cc	60.03 / 61.01	0 cc	14.19
Cord	V2.7 Gyfx <= 0.3 cc	V2.7 Gyfx <= 1.61 cc	60.03 / 61.01	1.66 cc	16.84
Airway	Dmax <= 105%	Dmax <= 3.67%	29.68 / 29.85	4.57 %	
Airway	V3.5 Gyfx <= 4 cc	V3.5 Gyfx <= 0 cc	29.68 / 29.85	0 cc	0.2
Esophagus	Dmax <= 105%	Dmax <= 8.43%	12.81 / 13.16	7.86 %	
Esophagus	V5.5 Gyfx <= 5 cc	V5.5 Gyfx <= 0 cc	12.81 / 13.16	0 cc	6.24
SBRT_PTV_MLC_Edge			34.85 / 33.08		Unavailable
LL_Lung_no_tv			1530.89 / 1517.88		Unavailable

Table 1: RTapp™ reports dosimetric evaluation based on dosimetric endpoints recommended by RTOG protocols. It performs two types of comparison, 1) values that exceed plan values will be marked "REVIEW", 2) values that exceed RTOG constraints will be marked "NOT MET".

Case name	Rx dose [Gy]	Rx % isodose	No. of fractions	$\Delta$ PTV V <sub>100%</sub> [%]	$\Delta$ PTV V <sub>90%</sub> [%]	$\Delta$ ITV V <sub>100%</sub> [%]	$\Delta$ GTV V <sub>100%</sub> [%]
RTAT A561	54	90.0%	3	4.65	1.23	0.09	0.00
RTAT 2AC4	50	79.8%	5	3.01	0.49	0.00	0.00
RTAT 267D	50	89.2%	5	4.10	2.45	1.46	0.51
RTAT 20B8	50	78.6%	5	12.10	5.62	0.00	0.00
RTAT 3529	54	84.9%	3	2.16	6.02	3.22	2.45
RTAT 716F	54	86.8%	3	6.97	2.80	1.80	0.46
RTAT 74FE	50	83.7%	5	8.67	3.89	0.91	0.91
RTAT 8C16	50	78.8%	5	0.94	0.15	0.00	0.00
RTAT 7F44	50	88.4%	5	0.86	0.20	0.00	0.00
RTAT 2EC9	45	87.2%	5	5.57	0.80	0.28	0.07
RTAT 882B	54	89.7%	3	5.81	3.06	0.16	0.00
RTAT E83F	50	84.9%	5	8.83	1.36	0.09	0.00
RTAT DD43	50	84.9%	5	1.20	0.07	0.00	0.00
RTAT 74FD	40	90.1%	5	10.31	8.91	8.42	6.27
RTAT AF8F	50	79.5%	5	2.36	0.46	0.38	0.41
RTAT 3E47	54	82.9%	3	6.47	1.80	0.00	0.00
RTAT 2CA2	50	79.9%	5	0.80	0.28	0.00	0.00
RTAT C7CB	50	80.9%	5	3.54	0.26	0.00	0.00
RTAT FB7C	50	79.7%	5	3.62	0.35	0.00	0.00
RTAT 9F44	54	79.8%	3	10.95	4.16	0.00	0.00

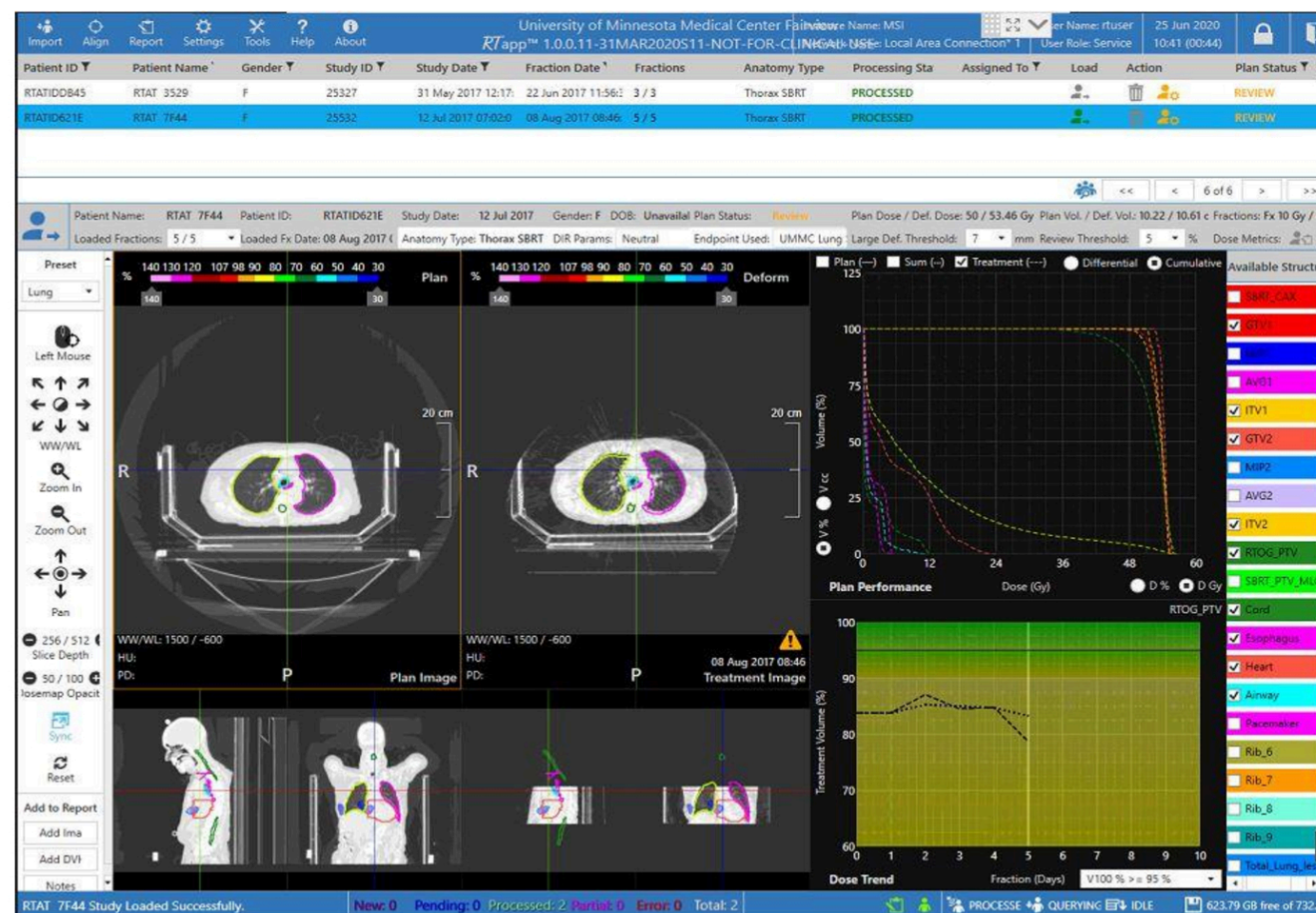


Figure 1: RTapp™ interface allows visualization of planning CT and treatment CBCT simultaneously. The plan performance panel displays DVH of planning dose, individual fraction dose and achieved dose at the end of treatment. The dose trend allows users to observe changes in target coverage or OARs exposure. Users can utilize the available features to examine the updated anatomy and assess the quality of the daily treatment to make clinical decision accordingly.

Table 2: Differences of tumor volume coverage at treatment completion of 20 cases between treatment plans and RTapp™. Positive values indicate planning overestimated delivered dose. V90 of PTV and V100 of ITV estimated by RTapp™ decreased more than 5% for three and one patients, respectively. The deviations were identified in fraction 3 for case RTAT 20B8 and in fraction 1 for case RTAT 3529 and RTAT 74FD. The cause of these discrepancies needs to be investigated further and the need for plan re-optimization before the treatment of the next fraction has to be determined.

## CONCLUSION

We confirmed the value of RTapp™ as a quick and simple tool for daily evaluation of treatment delivery accuracy before proceeding with dose delivery for lung SBRT patients as well as identifying the need for a re-plan. RTapp™ has the advantage of quick, automated structure recontouring and dose evaluation using DIR. It has potential to assist in adapting treatment plan by recognizing plan at risk and does not require CBCT density table for daily dose evaluation.

## REFERENCES

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