

Dosimetric impact of anatomic changes due to patient weight loss on TomoTherapy plan

Megavoltage computed tomography (MVCT) using a helical tomotherapy machine, Hi-ART II (TomoTherapy, Madison, WI), has been acquiring for routine patient positioning before radiation treatment at our institution. Using the MVCT images as well as Tomotherapy adaptive planning system, we investigated the dosimetric impact of anatomic changes into critical organs caused by losing patient body weight on Tomotherapy planning system used in intensity-modulated radiation therapy (IMRT) of head-neck cancers.

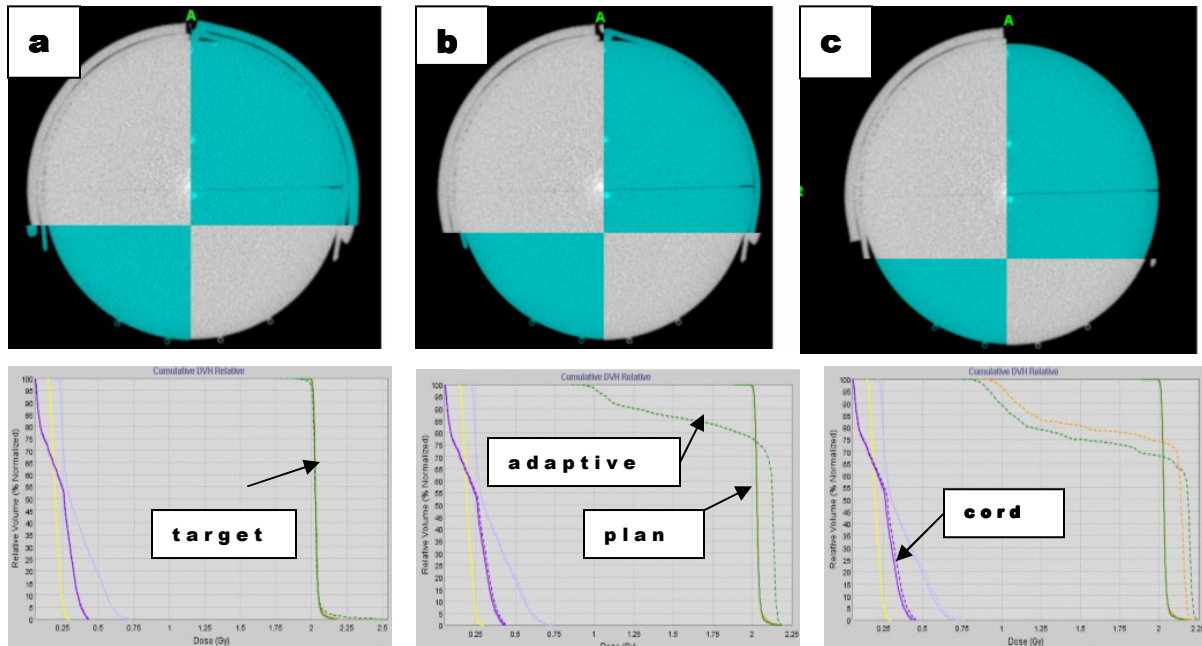


Fig. 1. Top row: MVCT images of Cheese phantom with (a) 1.5cm bolus, (b) 0.5cm bolus, and (c) no bolus; bottom row: DVHs from initial plan as well as adaptive plan (Plan_02 in Table 1). Cheese phantom wrapped with 1.5cm bolus was scanned for planning with MVCT to minimize the dosimetric uncertainties caused by using different images (kVCT vs. MVCT). Four different plans with fraction size of 2Gy were created with targets locating around the anterior/lateral areas of the phantom with different sizes. Critical organs were contoured for simulating spinal cord/brainstem located in the middle of the patient anatomy. Phantom plans were delivered with Hi-Art Tomotherapy machine with 1.5cm bolus to simulate no weight loss condition. Secondly, 1cm-bolus was taken out and then beam was delivered to simulate weight loss. Finally, additional 0.5cm bolus was taken out and then beam was delivered. Dose distributions were measured with A1SL ion chambers located in the middle of targets/critical organs and EDR2 films for individual case. Image fusions of planning images with 1.5cm bolus, 1cm bolus, and no bolus MVCT images were performed and then dose to targets and critical organs were recomputed with the Tomotherapy adaptive planning software. In addition, the QA plans of three head-neck clinical QA plans were delivered with 1.5cm bolus, 1cm bolus, and no bolus, respectively and dose distributions around the spinal cord region were measured with EDR2 films.

Table 1. Doses to target and to critical organ measured/calculated with 1.5cm bolus, 1cm bolus, and no bolus MVCT cases. Although there was good agreement between chamber measurements and adaptive planning results, there was uncertainty in dose to critical organ due to low dose regions. Mean ratios of dose between 1.5cm bolus and 1cm bolus was 1.06 ± 0.01 (target) and 1.04 ± 0.02 (critical organ) for measurements and 1.05 ± 0.02 (target) and 1.02 ± 0.01 (critical organ) for adaptive planning. Mean ratios of dose between 1.5cm bolus and no-bolus was 1.09 ± 0.02 (target) and 1.04 ± 0.01 (critical organ) for measurements and 1.07 ± 0.02 (target) and 1.05 ± 0.02 (critical organ) for adaptive planning, demonstrating that dose to critical organ was increased but in slightly lower than target regions.

	Ion chamber measurement						Adaptive planning system					
	Dose (Gy)			Dose Ratio*1			Dose (Gy)			Dose Ratio*1		
	Target	ROI 1	ROI 2 (cord)	Target	ROI 1	ROI 2 (cord)	Target	ROI 1	ROI 2 (cord)	Target	ROI 1	ROI 2 (cord)
Plan_01												
1.5 cm bolus	2.00	0.38	0.39	1.00	1.00	1.00	2.02	0.37	0.39	1.00	1.00	1.00
1 cm bolus	2.13	0.40	0.41	1.07	1.05	1.06	2.15	0.38	0.4	1.06	1.03	1.03
no bolus	2.19	0.39	0.40	1.09	1.03	1.03	2.18	0.39	0.41	1.08	1.05	1.05
Plan_02												
1.5 cm bolus	2.02	0.27	0.32	1.00	1.00	1.00	2.03	0.26	0.31	1.00	1.00	1.00
1 cm bolus	2.13	0.28	0.33	1.05	1.01	1.02	2.13	0.26	0.32	1.05	1.00	1.03
no bolus	2.18	0.28	0.33	1.08	1.02	1.03	2.18	0.26	0.33	1.07	1.00	1.06
Plan_03												
1.5 cm bolus	1.59	0.34	0.65	1.00	1.00	1.00	1.59	0.36	0.64	1.00	1.00	1.00
1 cm bolus	1.68	0.34	0.67	1.05	1.01	1.04	1.63	0.36	0.65	1.03	1.00	1.02
no bolus	1.77	0.37	0.68	1.11	1.08	1.05	1.67	0.36	0.66	1.05	1.00	1.03
Plan_04												
1.5 cm bolus	0.36	2.14	0.61	1.00	1.00	1.00	0.33	2.03	0.59	1.00	1.00	1.00
1 cm bolus	0.36	2.24	0.64	1.00	1.05	1.05	0.33	2.12	0.59	1.00	1.04	1.00
no bolus	0.35	2.28	0.66	0.99	1.07	1.07	0.33	2.17	0.63	1.00	1.07	1.07

Note: *1 = ratio of dose with respect to 1.5 cm bolus case

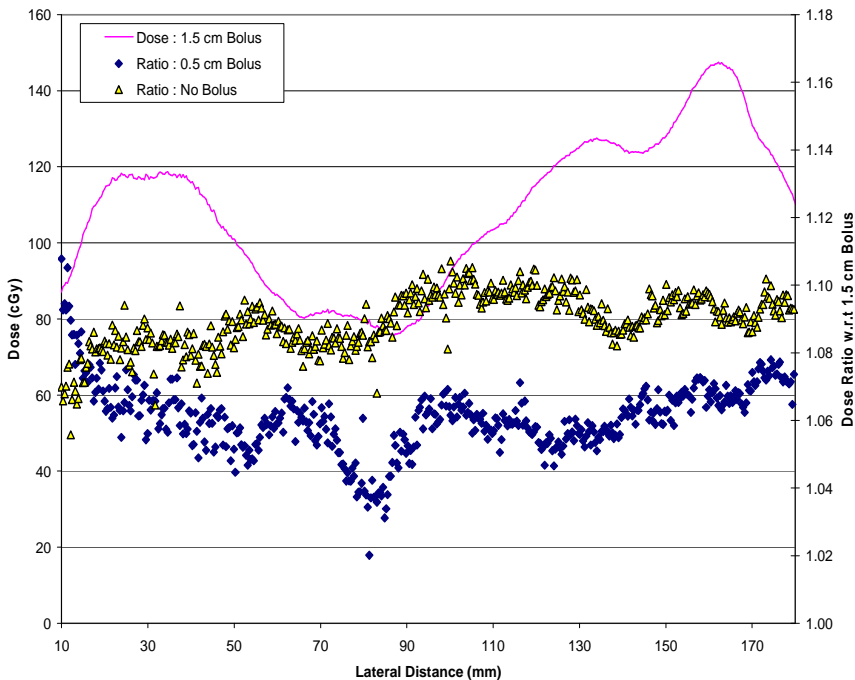


Fig. 2. Lateral dose distributions of a clinical QA plan delivered with 1.5cm bolus, 1cm bolus, and no bolus, respectively. Contours of spinal cord rather than targets were located in the middle of phantom and EDR2 film was placed on the coronal plane around the spinal cord region. As the thickness of bolus decreased, dose ratio with respect to 1.5cm bolus case increased in target as well as critical organ regions. Three clinical QA plans showed similar trends in dose to critical organs with decreasing bolus thickness.