

Deformable image and dose registration evaluation using two commercial programs

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Abstract

Purpose: To evaluate the daily dose delivered to the patients using daily imaging.

Methods: Thirty (n = 30) patients that were previously treated in our clinic (10 prostate, 10 SBRT lung and 10 abdomen) were used in this study. The patients' plans were optimized and calculated using the Pinnacle treatment planning system. The daily CBCT scans were retrieved and imported into the Velocity and RayStation software along with the corresponding planning CTs, structure sets and 3D dose distributions. In addition, the critical structures were contoured on each CBCT by the prescribing physician and were included in the evaluation of the daily delivered dose. After registering each CBCT scan to the planning CT using deformable registration, the dose volume histograms (DVH) for the organs at risk (OAR) and the respective planning target volumes (PTV) were calculated in Velocity and Raystation.

Results: For the prostate patients, we observed daily volume changes for the bladder, rectum and sigmoid. The DVH analysis for those patients showed variation in the sparing of the critical structures while PTV coverage showed no significant changes. Similar results were observed for patients with

abdominal targets. In contrast, in SBRT lung patients, the DVH for the critical structures and the PTV were comparable to those from the initial treatment plan. By using daily CBCT dose reconstruction, we proved PTV coverage for prostate and abdominal targets is adequate. However, there is significant dosimetric change for the OAR. These changes were random with no apparent trending. For lung SBRT patients, the delivered daily dose for both PTV and OAR is comparable to the planned dose with no significant differences.

Conclusion: Daily tracking of the delivered dose is feasible. The doses can be evaluated only if the OARs have been segmented taken into account any daily anatomical changes and not by deformation of the structures along.

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TABLE 1: Dose (Gy) and Volume (cc) from Velocity. The volumes are mapped from the planning CT to the CBCT using deformable registration. (The 'Plan' dose and volume are not included in the average and standard deviation.)

	Bladder		Rectum		Sigmoid		Prostate PTV	
	Volume	Dose	Volume	Dose	Volume	Dose	Volume	Dose
CBCT 1	107.3	26.06	49	23.26	54.3	15.73	233.9	45.88
CBCT 2	107	31.32	50.1	21.51	54.6	21.85	234.3	45.69
CBCT 3	107.2	34.28	49.5	20.61	54.7	28.72	233.6	45.73
CBCT 4	107.1	28.74	49.2	22.84	54.3	22.98	234	45.89
CBCT 5	107.3	29	49.4	25.44	53.9	27.45	234.9	45.87
Plan	107.2	26	49.4	21.66	54.5	18.34	234	45.93
Average	107.18	29.23	49.43	22.55	54.38	22.51	234.12	45.83
Std. Dev.	0.13	3.09	0.42	1.85	0.31	5.15	0.49	0.09

TABLE 2: Dose (Gy) and volume (cc) from RayStation. The volumes are mapped from the planning CT to the CBCT using deformable registration. (The 'Plan' dose and volume are not included in the average and standard deviation.)

	Bladder		Rectum		Sigmoid		Prostate PTV	
	Volume	Dose	Volume	Dose	Volume	Dose	Volume	Dose
CBCT 1	106.27	27	48.62	19.5	53.26	15.5	232.59	44.5
CBCT 2	106.27	18.25	48.62	21	53.26	10	232.59	42.5
CBCT 3	106.27	22.75	48.62	20.5	53.26	13	232.59	44.25
CBCT 4	106.27	20.75	48.62	22	53.26	9.25	232.59	43.5
CBCT 5	106.27	18.25	48.62	21	53.26	10	232.59	44.25
Plan	106.65	26.01	48.96	20.84	53.55	18.08	232.95	45.92
Average	106.33	21.40	48.68	20.80	53.31	11.55	232.65	43.80
Std. Dev.	0.00	3.66	0.00	0.91	0.00	2.64	0.00	0.82

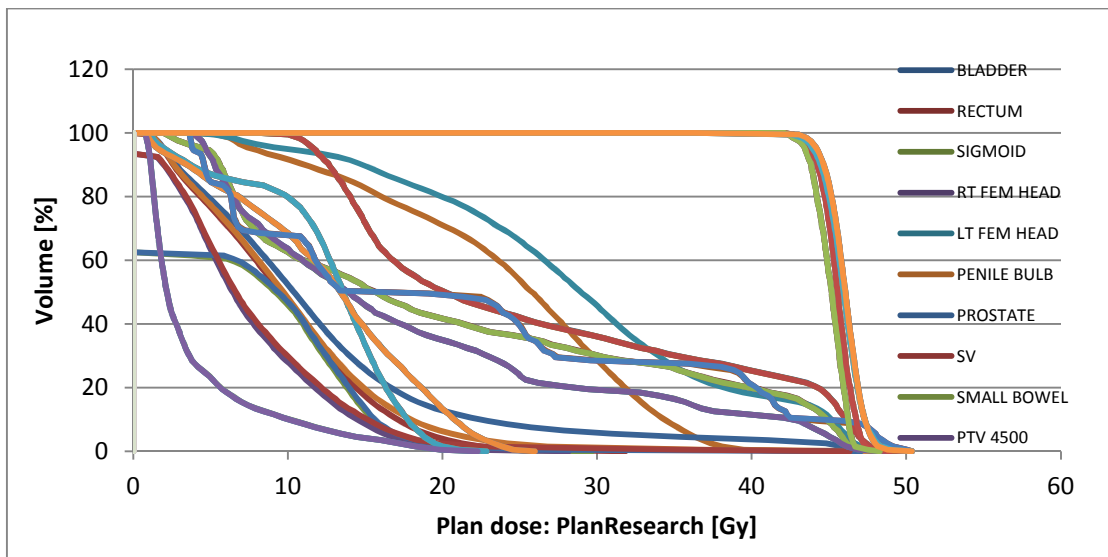


FIG. 1: DVH of CBCT 1 from Ray Station using deformable registration.