

Interim ¹⁸F-FDG-PET based response-adaptive dose escalation of proton therapy for head and neck cancer: a treatment planning feasibility study

Guillermo Garrido-Hernandez^{a*}, Helge Henjum^b, René Mario Winter^a, Mirjam Delange Alsaker^c, Signe Danielsena^{a,d}, Camilla Grindelar Boer^c, Kristian Ytre-Hauge^b, Kathrine Røe Redalen^a

^aDepartment of Physics, Norwegian University of Science and Technology, Trondheim, Norway

^bDepartment of Physics and Technology, University of Bergen, Bergen, Norway

^cDepartment of Radiotherapy, Cancer Clinic, St. Olav's Hospital, Trondheim University Hospital, Trondheim, Norway

^dDepartment of Oncology, St. Olav's Hospital, Trondheim University Hospital, Trondheim, Norway

^eDepartment of Oncology and Medical Physics, Haukeland University Hospital, Norway

*Correspondence:

Department of Physics, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

E-mail address: guillermo.g.hernandez@ntnu.no (Guillermo Garrido-Hernandez)

Additional File

Supplementary Tables

Supplementary Table 1. Patient data summary with corresponding PET scanning timepoint and studied lesions information.

Patient	Sex	Age	Baseline Scan	Interim Scan	Time between scans (days)	Number of lesions	Cystic lesion	Eligible for study
A	M	62	PET/MR	PET/MR	14	2	NO	YES
B	M	63	PET/MR	PET/MR	19	1	NO	YES
C	M	74	PET/MR	PET/MR	11	2	YES	YES
-	F	55	PET/CT	PET/MR	19	1	NO	NO*
D	M	62	PET/MR	PET/MR	14	1	NO	YES
E	F	51	PET/MR	PET/MR	24	1	YES	YES
-	M	62	PET/MR	-	-	-	NO	NO
F	F	63	PET/MR	PET/MR	26	1	YES	YES
G	F	69	PET/MR	PET/MR	22	1	YES	YES
H	M	58	PET/MR	PET/MR	20	1	NO	YES
I	M	67	PET/MR	PET/MR	20	1	NO	YES

*Patient was not imaged at baseline in radiotherapy position, i.e., only eligible only for preliminary assessment of segmentation methods but not for proton planning.

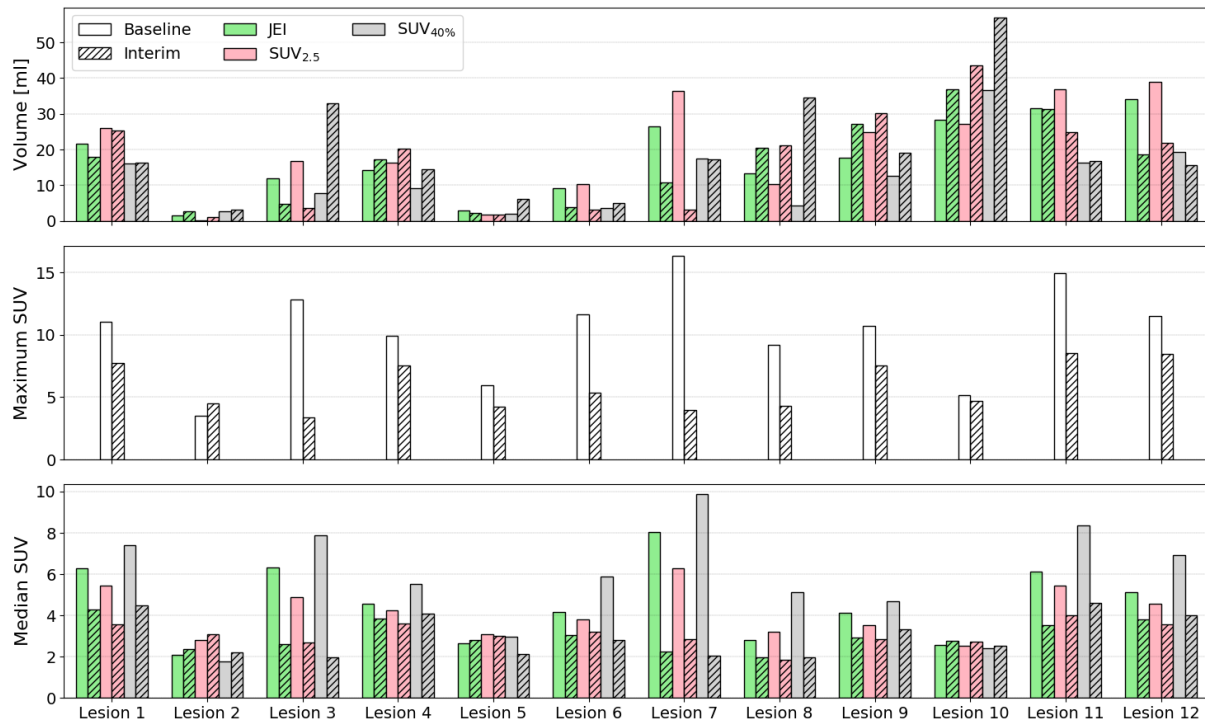
Supplementary Table 2. Volumetric similarity between high standardized uptake value (SUV) regions at baseline and interim for all patients and segmentation methods: just-enough-interaction (JEI) method, isocontouring SUV = 2.5 (SUV_{2.5}), and isocontouring a 40% of the local SUV_{max} (SUV_{40%}).

Patient		Dice coefficient			Fraction overlap		
		JEI	SUV _{2.5}	SUV _{40%}	JEI	SUV _{2.5}	SUV _{40%}
A	Lesion 1	0.84	0.82	0.85	0.93	0.83	0.85
	Lesion 2	0.38	0.14	0.44	0.31	0.09	0.41
B	Lesion 3	0.51	0.31	0.37	0.93	0.89	0.23
C	Lesion 4	0.65	0.70	0.58	0.60	0.63	0.47
	Lesion 5	0.36	0.36	0.33	0.43	0.37	0.21
-	Lesion 6*	-	-	-	-	-	-
D	Lesion 7	0.31	0.16	0.36	0.54	0.97	0.36
E	Lesion 8	0.55	0.55	0.21	0.45	0.44	0.12
F	Lesion 9	0.75	0.79	0.71	0.62	0.72	0.59
G	Lesion 10	0.83	0.75	0.69	0.73	0.61	0.53
H	Lesion 11	0.80	0.73	0.68	0.80	0.91	0.67
I	Lesion 12	0.60	0.73	0.68	0.80	0.91	0.67
Mean		0.60 ±	0.55 ±	0.54 ±	0.65 ±	0.67 ±	0.46 ±
		0.18	0.25	0.19	0.20	0.26	0.21

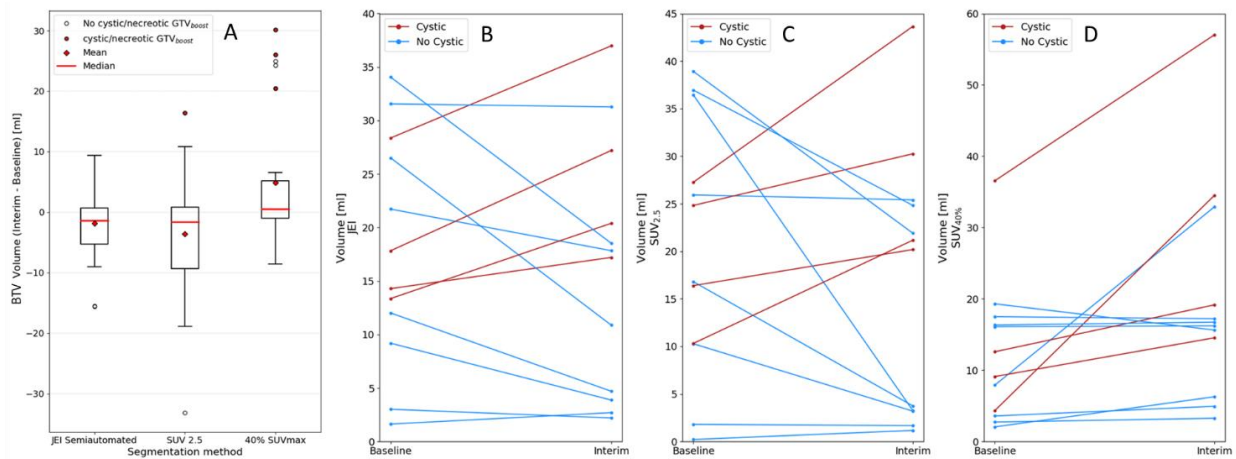
*Lesion 6 was found on a patient with a full body PET/CT scan at baseline and a head and neck PET/MR at interim: dice coefficient and fraction overlap were not calculated since data may have not been representative.

Supplementary Figures

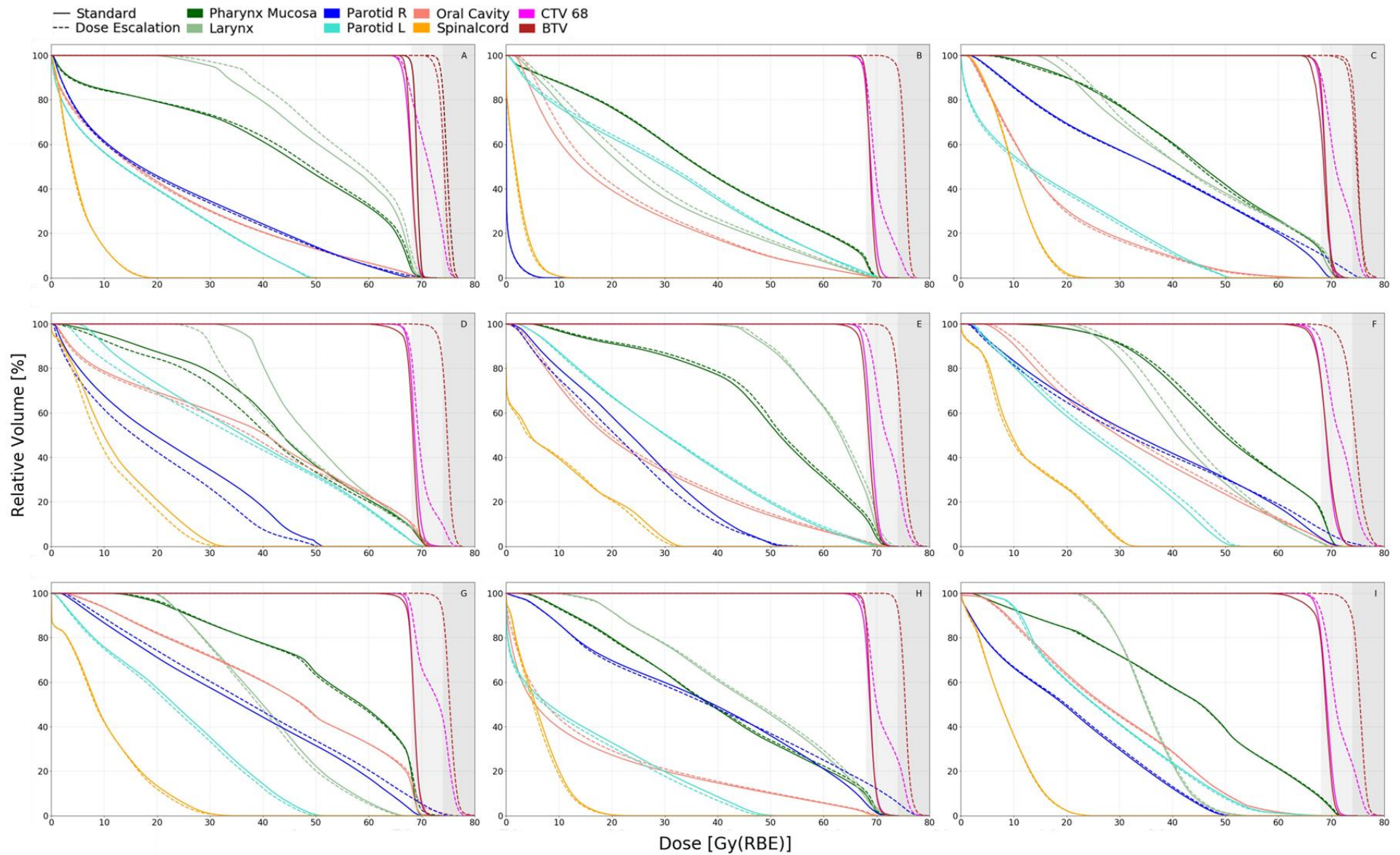
Comment: The top panel in Supplementary Figure 1 shows the volume change the high SUV volumes from baseline to interim. For the JEI (green) and SUV_{2.5} (pink) methods, we found a generalized volume reduction except for lesions 4, 8, 9 and 10 where the interim volume was larger than the baseline one. As for the SUV_{40%} (grey) segmentation method, results show no trend.



Supplementary Figure 1. Structure statistics from just-enough-interaction (JEI), isocontouring standardized uptake value (SUV) = 2.5 around lesions (SUV_{2.5}), and isocontouring a 40% of the local SUV_{max} around lesions (SUV_{40%}) segmentation methods (structure volume, maximum and median SUV within structure) for all studied lesions from patients eligible for preliminary assessment and study of ¹⁸F-fluorodexogycglucose (¹⁸F-FDG)-PET scans. Results shown for baseline and interim ¹⁸F-FDG-PET. Since the SUV_{max} data does not change between segmentation methods, the middle panel is shown with no color scheme.



Supplementary Figure 2. A: Distribution of biological target volume (BTV) volume differences between baseline and interim positron emission tomography (PET) scans for the just-enough-interaction (JEI), isocontouring standardized uptake value (SUV) = 2.5 around lesions (SUV_{2.5}), and isocontouring a 40% of the local SUV_{max} around lesions (SUV_{40%}) segmentation methods. Filled outlier points correspond to BTV with a cystic/necrotic core within. B, C and D: BTV at baseline and interim ¹⁸F-fluorodexogycglucose (¹⁸F-FDG)-PET scans for the JEI, SUV_{2.5}, SUV_{40%} methods respectively. Segments show changes on the volume of individual BTV structures, BTV with a cystic/necrotic core within (red) and BTV without a cystic/necrotic core within (blue).



Supplementary Figure 3. Dose volume histogram (DVH) plots for all head and neck cancer (HNC) patients eligible for the proton therapy planning part of the study. Shaded areas mark the dose objective for the standard plan (light: 68 Gy(RBE_{1.1})) and for the dose escalation (DE) plan (dark: 75 Gy(RBE_{1.1})).