Dose effects by interfractional variability of tumor and OAR on the example of prostate-Ca-patients

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Research for a Life without Cancer

Motivation and introduction

Best possible sparing of OAR und conformal dose application at target volume

various position and geometrie of OAR (especially rectum and bladder) and target volume

effects of interfractional variabilty on dose deviations are largely unknown

Material and methods

Datasets

- Retrospective analysis of 10 low- or intermediate-risk prostate-cancer-patients
- 6 MV photon IMRT treatment planning (TPS: RayStation, RaySearch) with a total dose of 76,5 Gy in 2,25 Gy fractions
- Patients were instructed to present to treatment with an empty rectum and a comfortably filled bladder
- All patients got a daily inroom-CT imaging (fxCT, SIEMENS Emotion)

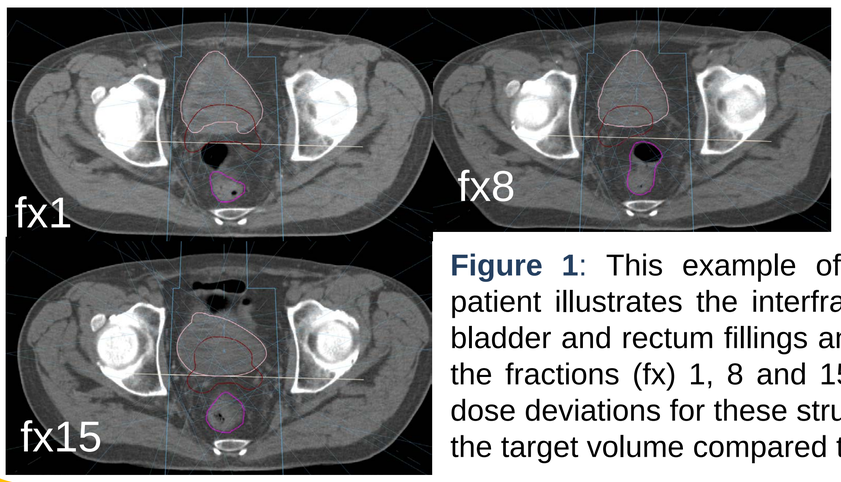
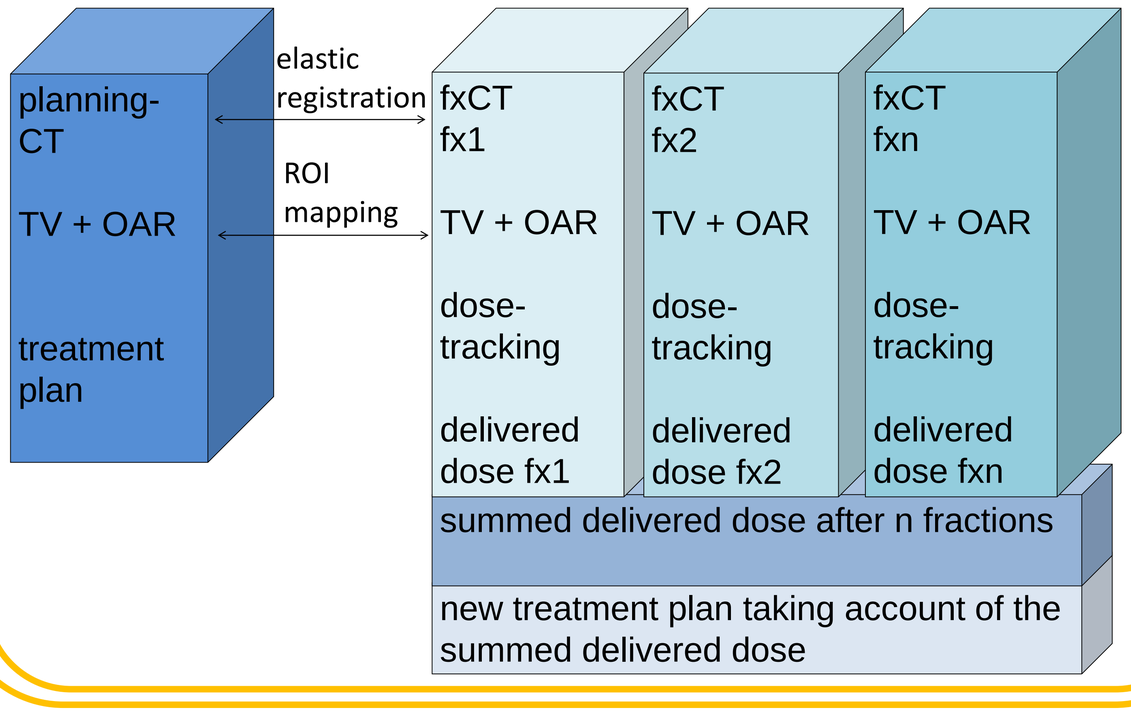


Figure 1: This example of a prostate cancer patient illustrates the interfractional variations of bladder and rectum fillings and organ position for the fractions (fx) 1, 8 and 15, which may cause dose deviations for these structures as well as for the target volume compared to the planned dose.

The steps from elastic registration over dosetracking to adaptive replanning



Results

Volumes and displacement

The mean CTV, PTV and rectal volumes were 74 ± 41 ml, 140 ± 90 ml and 76 ± 33 ml, respectively. The bladder was the organ with the biggest interfractional volumetrical variability with a mean volume of 286 ± 168 ml. The relative volumetric changes of these structures and the displacement of the PTV during radiotherapy are depicted in figure 2 and figure 3.

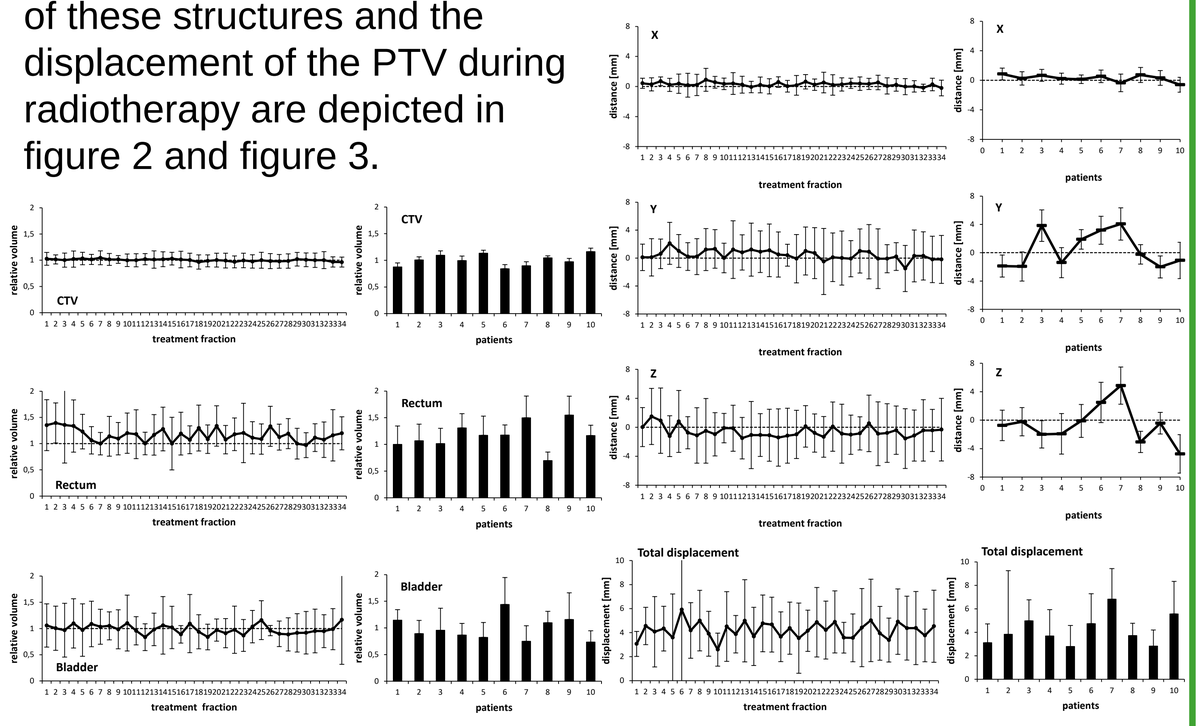


Figure 2: Relative volumetric changes of the clinical target volume (CTV), rectum and bladder during radiotherapy compared with the planning CT

Figure 3: Displacement of the PTV in x-, y- and z-direction during radiotherapy

Dose- and γ-analysis

The planned and delivered doses of the target volume and organs at risk are summarized in figure 4 and table 1.
The γ-analysis to a tolerance level of 3 mm and 3 % dose difference resulted in 95 ± 1.4%.

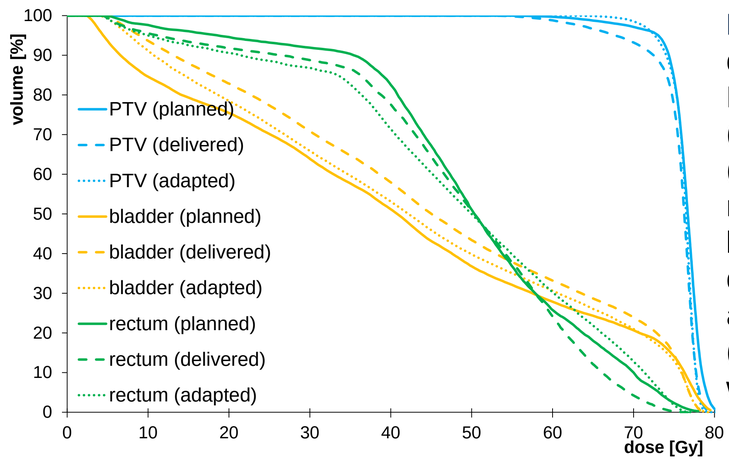


Figure 4: Comparison of the dose volume histograms of the PTV (blue curves), bladder (yellow curves) and rectum (green curves) between the radiation plan (continuous line), accumulated delivered dose (dashed line) and the applied dose when regular (twice during RT) re-planning was performed (dotted line).

Table 1: Summary of planned, delivered and delta dose values for the CTV, PTV and organs at risk of the study population.

		planned dose		delivered dose		delta	
		average	SD	average	SD	average	SD
CTV	D98	74,59	0,63	71,84	4,72	2,75	4,47
	D2	78,68	0,76	78,49	0,78	0,2	1
	D50	76,63	0,13	76,91	0,95	-0,28	1
PTV	D98	70,51	2,58	59,04	8,73	11,47	8,13
	D2	78,89	0,82	78,66	0,77	0,33	1,04
	D50	76,53	0,07	76,66	0,95	-0,13	0,96
bladder	D50	16,56	20,09	19,41	20,79	-2,84	6,17
rectum	D50	36,8	8,42	37,28	9,59	-0,49	3,5
femur r.	D50	23,3	4,13	24,02	3,47	1,09	2,4
femur l.	D50	23,66	3,93	22,57	4,88	-0,72	1,22

Conclusion

Significant dose deviations during RT of prostate-Ca patients were only evident for the bladder, while the PTV and the rectum showed only minor dose deviations. As a result, regular adaptive re-planning lead to lower doses to the organs at risk, particularly the bladder and more conformal doses to the PTV, which may potentially affect treatment-related toxicities.