

What is the dosimetric benefit of weekly and daily adaptive replanning for prostate cancer patients?

M. Lifferth¹, T. Bostel², P. Häring¹, C. Lang¹, and N.H. Nicolay³
1German Cancer Research Center, Heidelberg, Germany
2University Medical Center, Mainz, Germany
3University Hospital, Freiburg, Germany



INTRODUCTION

In radiotherapy of prostate cancer interfractional differences in rectum- or bladder-volume lead to dose deviations. As the precise effects of these are largely unknown, this analysis investigates the dosimetric consequences of weekly and daily adaptive replanning.

METHOD

The data of ten patients with prostate carcinoma (salvage radiotherapy to the prostatic bed, 68Gy in 34 fx, step-and-shoot IMRT) were investigated. Prior to each fraction, a diagnostic position-control-CT (fx-CT) was performed (SOMATOM® Emotion, SIEMENS). Based on the fx-CT, the target volumes (TV) and all OARs were contoured. Using a deformable registration algorithm, applied doses were tracked and weekly as well as daily (only for 3 patients, because of software limitations) adaptive replanning was done. The dosimetric effects were quantitatively compared.

CONCLUSIONS

The observed variability resulted in significant dose increases of the D₅₀ to the bladder, whereas in the PTV, only small non-significant dose deviations could be detected. By using an individualized plan-database a significantly lower dose to the OAR was achieved, while the target volume coverage was virtually unchanged.

RESULTS

The applied dose D₅₀ of the PTV with use of weekly replanning almost corresponded the planned dose. The D₉₈ of the PTV was 1.33Gy lower than prescribed but 3.35Gy higher than without adaption. Using weekly replanning, the D₅₀ of the bladder was 5.7Gy higher than the prescribed dose and 0.75Gy higher than without adaption. Weekly replanning effected an increase of the D₅₀ of the rectum (0.53Gy) but a marginally decrease of 0.25Gy compared to no adaption. The applied dose D₅₀ of the PTV with use of daily replanning was 1.2Gy higher than prescribed. Daily replanning effected a marginally increase of the D₉₈ of the PTV, but a significant increase of 10Gy compared to no adaption. Daily replanning slightly reduced the D₅₀ of bladder and rectum.

In detail:

Weekly adaptive replanning:
In 8 of 10 cases, we got a more conformal coverage of the PTV using weekly adaptive replanning compared to doing no adaption. In 5 of these 8 cases a better sparing either of the bladder (2 of 5) or of the rectum (3 of 5) could be reached. Only in 2 of 10 cases a better sparing of the OARs and a more conformal coverage of PTV could be reached at once.
Daily adaptive replanning:
On average daily adaptive replanning resulted in a more conformal coverage of PTV compared to doing no adaption. However, only in 1 of 3 cases a better sparing of the OARs and a more conformal coverage of PTV could be reached at once.

CONTACT INFORMATION

Mona Lifferth
m.lifferth@dkfz-Heidelberg.de

table 1: dose difference between applied dose with weekly replanning and planned dose, as well as applied dose with weekly replanning and without adaption for the PTV, CTV, bladder rectum averaged over ten patients

TV/OAR		applied dose with weekly replanning – planned dose [Gy]	applied dose with weekly replanning – applied dose without adaption [Gy]
PTV	D ₅₀	-0,01 ± 0,10	-0,12 ± 0,65
	D ₉₈	-1,33 ± 3,27	3,35 ± 3,72
	D ₂	-0,07 ± 0,96	0,34 ± 0,96
CTV	D ₅₀	-0,01 ± 0,22	-0,18 ± 0,62
	D ₉₈	2,20 ± 4,08	1,41 ± 1,47
	D ₂	-0,47 ± 1,18	-0,14 ± 1,23
bladder	D ₅₀	5,69 ± 7,68	0,75 ± 5,88
	D ₂	-0,28 ± 0,77	0,01 ± 0,95
rectum	D ₅₀	0,53 ± 4,63	-0,25 ± 5,98
	D ₂	-0,58 ± 0,68	0,89 ± 2,00

table 2: dose difference between applied dose with daily replanning and planned dose, as well as applied dose with daily replanning and without adaption for the PTV, CTV, bladder rectum averaged over three patients

TV/OAR		applied dose with daily replanning – planned dose [Gy]	applied dose with daily replanning – applied dose without adaption [Gy]
PTV	D ₅₀	1,2 ± 1,43	1,29 ± 1,73
	D ₉₈	0,70 ± 2,56	9,41 ± 2,97
	D ₂	1,17 ± 1,80	1,43 ± 1,91
CTV	D ₅₀	0,94 ± 1,54	1,02 ± 1,74
	D ₉₈	1,57 ± 1,34	2,84 ± 1,28
	D ₂	0,59 ± 1,70	0,69 ± 1,86
bladder	D ₅₀	-1,11 ± 1,95	-1,82 ± 4,62
	D ₂	0,96 ± 1,77	1,41 ± 2,22
rectum	D ₅₀	-0,52 ± 2,21	0,77 ± 5,20
	D ₂	1,16 ± 1,17	2,74 ± 0,23