Gloucestershire Hospitals
NHS Foundation Trust

Service evaluation project on the use of **adaptive planning target volume (PTV) margins** for prostate radiotherapy

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Background

Prostate radiotherapy treatment is currently planned from a single Computerised Tomography (CT) scan. These CT scans are a 'snapshot' of the patients' anatomy at a particular moment, and may not be reproducible on a daily basis. Prostate position can be affected by physiological changes in the bladder and rectum. A margin is added to the prostate to account for daily changes. This forms the Planning Target Volume (PTV) from which the patients radiotherapy is planned.

Adaptive radiotherapy moves away from standard 'population' based PTV margins, and employs an individual approach to the planning and treatment process.

Multiple approaches have been proposed for adaptive prostate radiotherapy. An offline PTV adaptation approach has been used in this study to investigate whether a PTV adaptation approach would allow for the reduction in PTV margins at Gloucestershire NHS Foundation Trust.

Methods

15 patients had their data retrospectively exported to the departments planning system for analysis. An adaptive PTV (10mm margin) and reduced margin adaptive PTV (7mm margin) was derived from the first five fractions (treatment) Cone Beam Computerised Tomography Scans (CBCTs) and the planning CT.

- Coverage of these adaptive PTVs were assessed on subsequent weekly CBCTs to ascertain whether they would have achieved adequate clinical coverage.
- A range of Dose Volume Histograms (DVHs) were created for each patients adaptive PTV and reduced margin adaptive PTV to assess dosimetric coverage.
- Additional DVHs were created to ascertain whether the delivered treatment varied from the original plan.

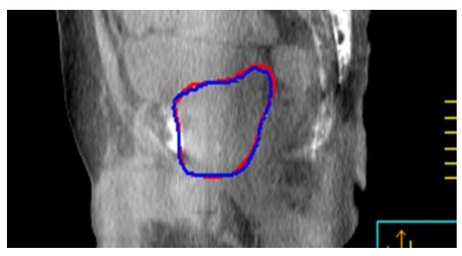
Results

Differences between the planned prostate dosimetric coverage (PTV1 D95) and adaptive prostate (PTV1 D95) were not statistically significant (p=0.078). There was a greater degree of variability in the dosimetric coverage of the adaptive prostate (S.D 4.02) than the originally planned PTV1s. For 7/15 patients the adaptive margin resulted in a lower D95 dose than planned, suggesting a less favourable dose coverage would be achieved with the adaptive margin. This means that the adaptive margin would not be appropriate for all patients.

Clinical coverage for the adaptive outlines demonstrated that for 97% of CBCT scans, the adaptive PTV1 would have adequately covered the Gross Tumour Volume (GTV).

PATIENT	D95 (Gy)- DOSE TO 95% OF THE PTV1 (PLANNED)	D95 (Gy)- DOSE TO 95% OF THE PTV1 (ADAPTIVE)	D95(Gy)- DOSE TO 95% OF THE PTV1 (REDUCED MARGIN)
A	60.4	54.7	59.2
B	65.1	66.2	68.8
C	60.4	62.1	65.3
D	58.9	53.4	57.2
E	62.7	63.6	65.9
F	61.2	58.6	63.5
G	62.3	63.3	64.4
H	68.2	64.7	67.3
I	63.9	65.4	68.1
J	61.1	58.8	61.1
K	59.9	60.6	62.0
L	60.8	60.6	63.7
M	62.0	59.6	61.2
N	63.7	64.3	67.1
0	64.1	55.3	61.3
MEAN OF ALL PATIENTS (RANGE)	62.3 (58.9-68.2)	60.7 (53.4-65.4)	63.7 (57.2-68.1)
STANDARD DEVIATION	2.39	4.02	3.40

D95 data- Dose that covers 95% of the volume of PTV1. Displaying individual and the cohort mean for the planned, adaptive and reduced margin volumes.



Transverse coronal, sagittal view of patient A, demonstrating similarity of adaptive PTV1 (blue) to planned PTV1 (red).

Conclusion

The adaptive technique used in this study was time consuming and variability in the dosimetric coverage for patients indicates that it is not an adequate class solution for this group of patients. Advances in technology such as instant plan adaptation and automation of adaptation processes may make adaptive prostate radiotherapy more viable in the future. More data is required in this field.

Data gained from this study is being utilized to further evaluate departmental margins using the Van Herk Formula.