Prostate SBRT Planning and Image Guidance: Initial Experience from Two Institutions

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Introduction

Stereotactic body radiation therapy (SBRT) treatment of localized prostate cancer has shown outcomes comparable to moderate hypofractionated treatments (1,2). The delivery of fewer fractions and shorter overall treatment time provide improvements for patient convenience and access (3).

The Saskatchewan Cancer Agency began offering prostate SBRT in 2019, complementing existing external beam and brachytherapy programs. Different immobilization devices were used, allowing for comparison between immobilization options (4,5).

The retrospective study summarizes our experience with planning dosimetry and image guidance, with attention to inter- and intra- fraction motion. The results will inform and guide future expansion of the program.

Method

24 patients (17+7) received prostate SBRT treatment between 2019 and 2022, prescribed to 36.25 Gy in 5 fractions every other day. Fiducial markers were implanted into the prostate followed by MRI and CT simulation one week after.

Standard prep for both institutions consisted of polyethylene glycol 3350 one week prior and drinking 500 mL water one hour prior. Patients were immobilized using knee rest only at one institution and vacuum bag + knee rest at the other institution.

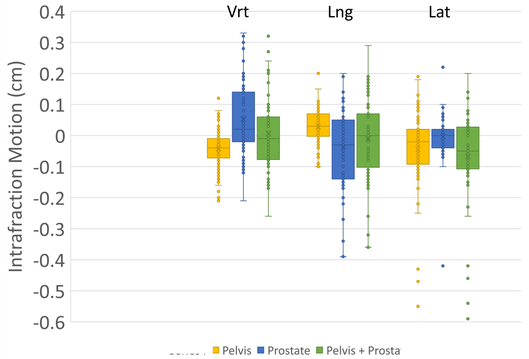
T1 and T2 MRI images were rigidly registered to the planning CT, based on MR fiducial voids and prostate soft tissue. A 5 mm PTV expansion was applied to the prostate and proximal seminal vesicle target, with delineation aided by magnetic resonance imaging.

Fiducial-based image guidance consisted of initial and verification pre-treatment imaging and post-treatment imaging. The verification CBCT was reviewed to ensure the prostate was positioned accurately at the start of treatment. Intrafraction motion was recorded by matching the prostate on the post-treatment CBCT, performed by an experienced Radiation Oncologist.

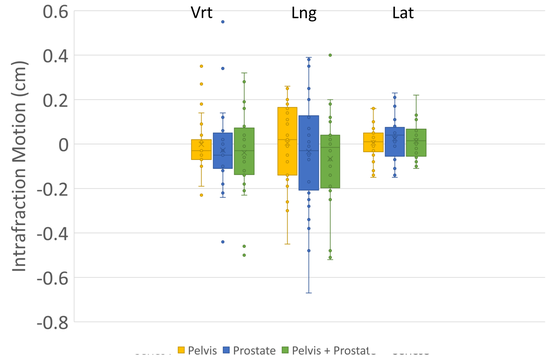
The intrafraction motion was partitioned into pelvis and prostate components. Pelvis motion represented the movement of the bony pelvis relative to the isocenter and was likely related to patient immobilization. Prostate motion represented the movement of the prostate relative to the bony pelvis due to internal bowel and rectum changes.

Results

The box and whisker plots show the data points along with the min/max (whiskers), quartile (box), median (line), and mean (x). Outliers are represented by data points beyond the whiskers.



Intrafraction motion for patients immobilized with knee rest. Motion was calculated for a) the bony pelvis b) the prostate soft tissue relative to pelvis and c) the prostate relative to isocenter (total intrafraction motion).



Intrafraction motion for patients immobilized with vacuum bag and knee rest.

Interfraction Motion	Mean ± St dev
Vrt	2.3 ± 2.2 mm
Lng	2.6 ± 2.0 mm
Lat	0.7 ± 0.5 mm

Prostate interfraction motion, showing the daily variation of the prostate position relative to the bony pelvis compared with the planning CT. The motion was > 5 and > 7 mm in at least one direction for 12% and 5% of the fractions, respectively.

Intrafraction Motion	% fractions with motion > 2 mm
Between initial and verification CBCT	19 %
Between verification CBCT and post-tx CBCT	7 %

Infraction motion before treatment compared to motion during treatment

Dose-Volume Metric	Median ± St dev
Conformity Index (RTOG)	1.10 ± 0.09
PTV 100%	98.0 ± 1.7 %
PTV Dmax	106.4 ± 1.0 %
Rectum D0.03cc	37.6 ± 0.5 Gy
Rectum D10	29.7 ± 3.5 Gy
Rectum D50	9.4 ± 4.0 Gy
Rectum volume overlapping with PTV	3.0 ± 2.6 %
Bladder D0.03cc	38.1 ± 0.4 Gy
Bladder D10	21.7 ± 7.2 Gy
Bladder D50	1.6 ± 3.7 Gy

Treatment planning dosimetry metrics. The conformity index is the 100% isodose volume divided by the PTV volume.

Conclusions

We have evaluated our prostate SBRT treatments to date and gained valuable experience to guide future program expansion. Despite the limited sample size, the results are pointing to the value of verification CBCT and the comparable yet differential performance of immobilization devices. It is interesting to note that intrafraction motion of the pelvis is predominantly in the lateral direction for knee rest immobilization and the vertical and longitudinal directions for vacuum bag. The occurrence of patient-specific large interfraction motion point to the need for image guidance contingencies for any future program involving prostate and nodal irradiation. Further data collection will increase the sensitivity of the analysis.

References

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