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Seminal vesicles move: displacement in image-guided radiotherapy of prostate cancer based on gold marker matching

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1. Introduction



2. Objectives



3. Methods



4. Results



5. Limitations

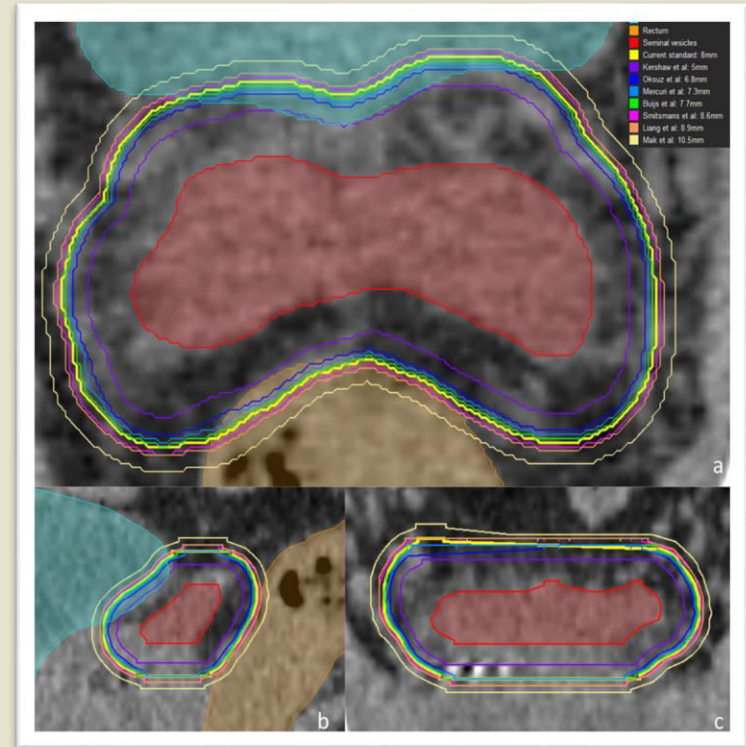


6. Conclusions



7. References

- Interfraction motion of the seminal vesicles (SV) can affect SV dose coverage.
- Interfractional motion of SV is caused by volume changes in bladder and rectum as well as organ deformation.
- Most studies show weak correlation between prostate and SV motion. SVs can move semi-independently from prostate with a larger amplitude [1].



Variance in reported PTV-margins grouped around the current clinical standard of 8 mm, each article represented by a different line; a: axial view; b: coronal view; c: sagittal view

Anatomy of Seminal Vesicles

Part of the male reproductive system.

3-5 cm long, 1 cm in diameter.

Attached bilaterally to prostate on cranioposterior plane.

Superior to rectum and inferior to fundus of the bladder.

Included in CTV for intermediate and high risk prostate patients.

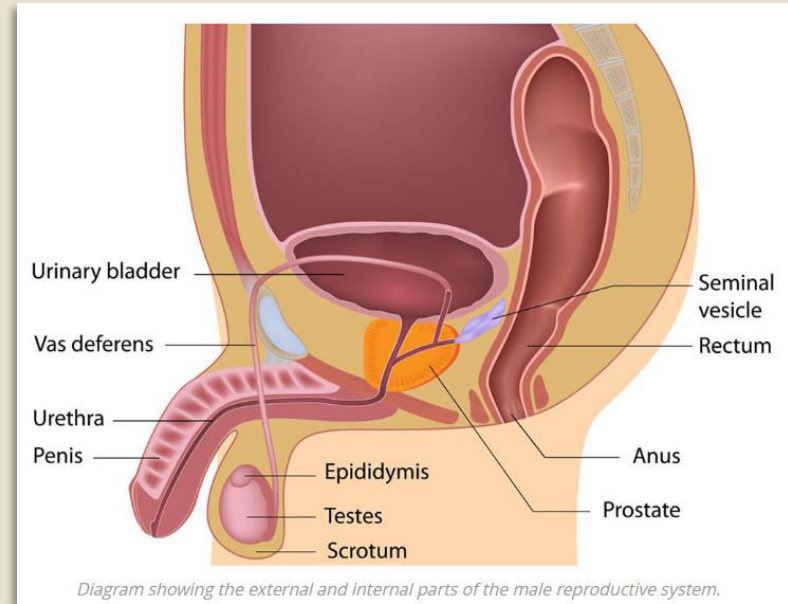


Diagram showing the external and internal part of the male reproductive system

Motivation for this study

1.

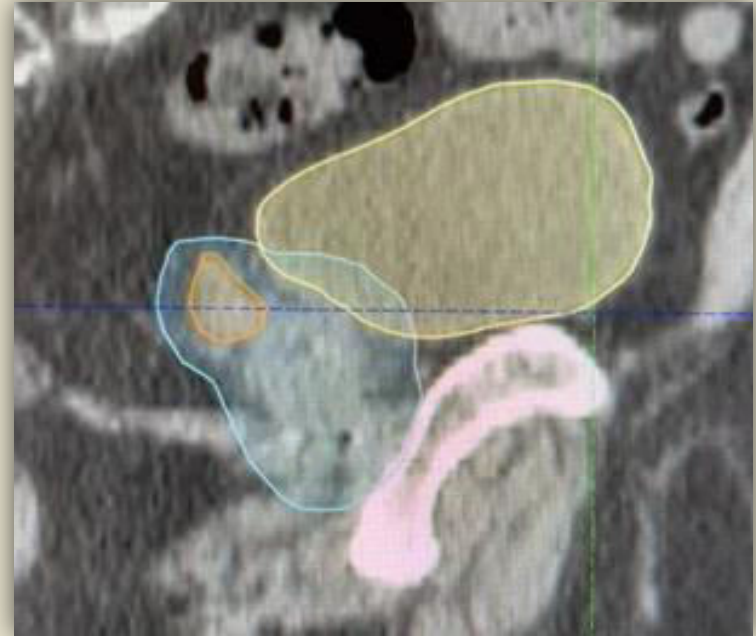
With gold marker based IGRT matching, we were seeing differences in SV position compared to their position in planning CT.

2.

Stark differences in SV position in patients with frequent changes in bladder and rectal filling.

3.

Noticing this difference, we wanted to evaluate if our margins were sufficient for PTV to prevent geographic miss.



Sagittal view of planning CT and CBCT in split-window showing GM-Match with difference in the SV position

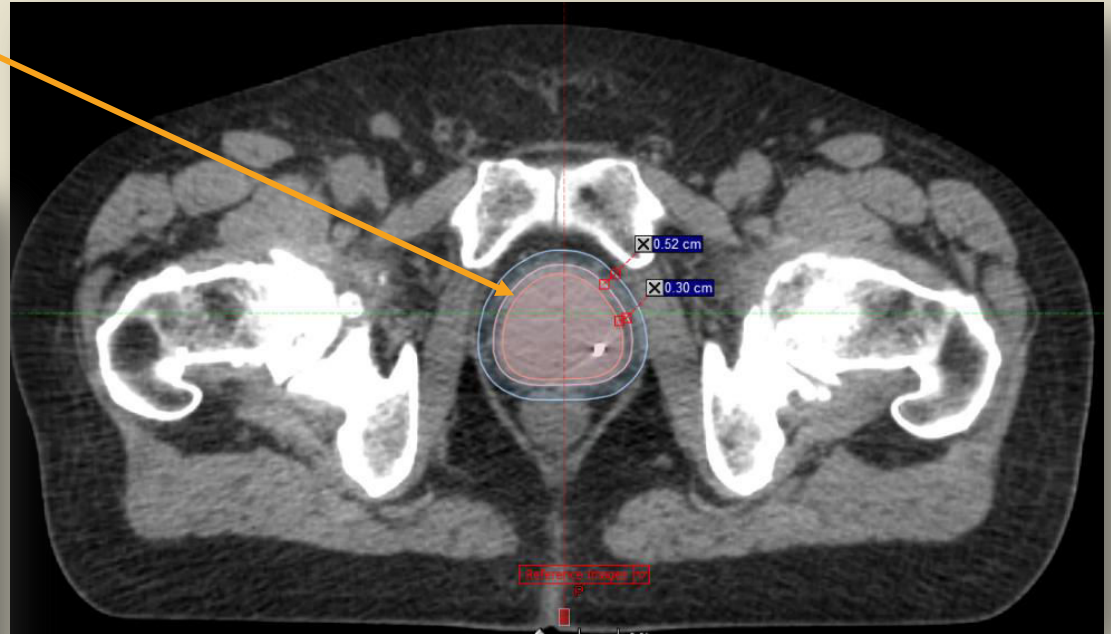
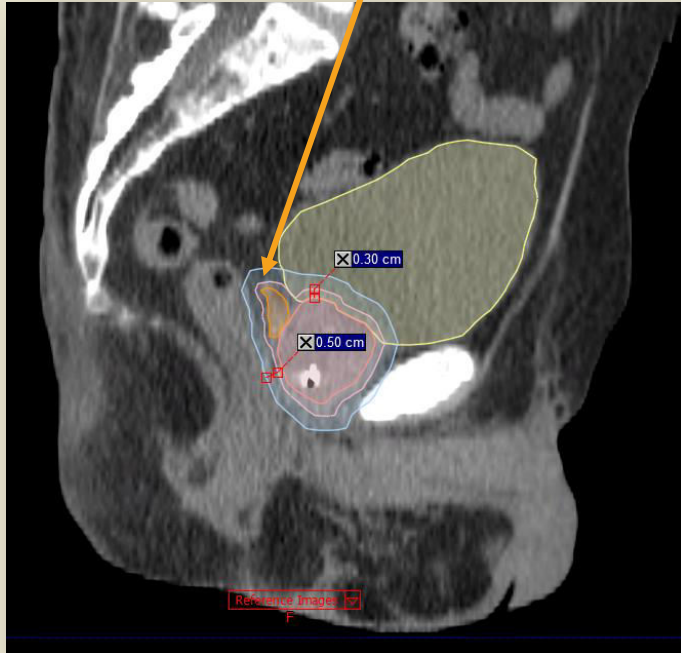
- We aimed to evaluate dose coverage of SV based on gold marker prostate IGRT, taking **interfractional** motion into account.
- Are our current clinical planning margins around SV appropriate for treatment of intermediate and high-risk prostate cancer patients treated with VMAT technique?



Axial view of planning CT and CBCT in split-window showing GM-Match with difference in SV position

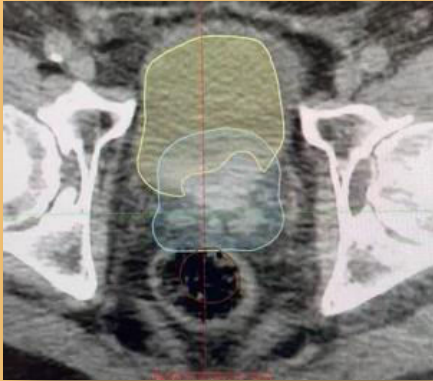
Margins?

- CTV: Prostata + 3mm
- PTV: CTV + 5mm



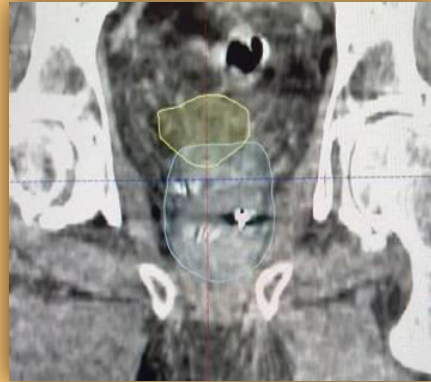
- Daily CBCT imaging
- Corrections in translations and rotations on a 6DoF couch
- GM-IGRT allows lowered margins and ensures targeting the prostate with great accuracy.

Axial view



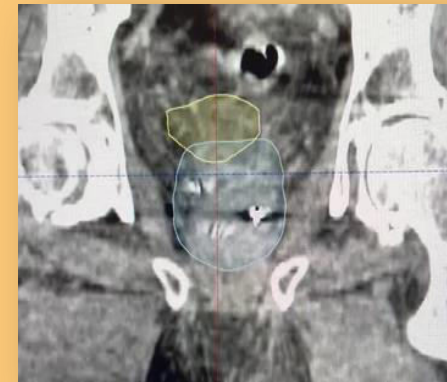
Vertical

Coronal view



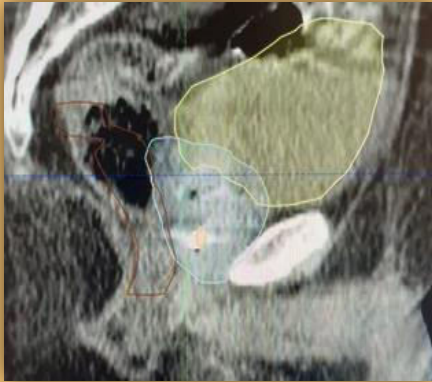
Longitudinal

Coronal view



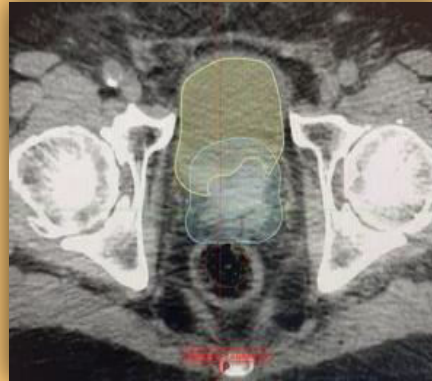
Lateral

Sagittal view



Pitch

Axial view



Roll

Coronal view



Rotation

Patient inclusion criteria

→ Patients with implanted gold markers

→ Intermediate and high risk prostate cancer

→ No boost and/or lymph node involvement

→ All patients:
28#, 2.5Gy per #, 70Gy

1.

Nine patients with implanted gold markers receiving curative prostate RT were selected.

2.

Total of sixty three CBCTs (seven CBCTs from every other fraction) per patient evaluated **retrospectively**.

3.

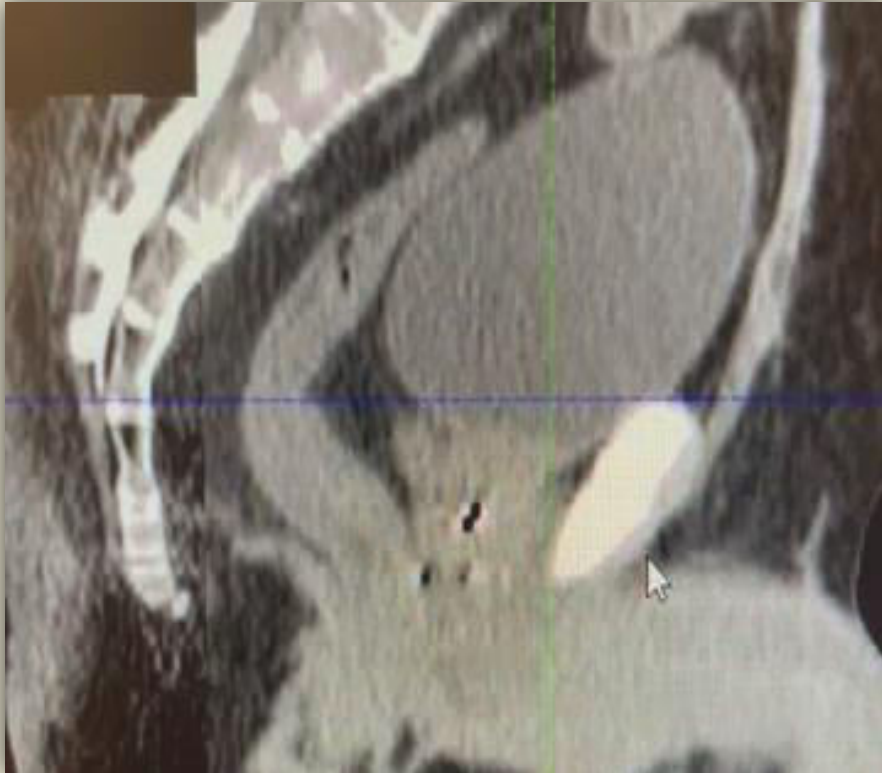
SV and prostate contoured by a physician on each CBCT with aid of saved online rigid-registrations.

Axial view of Planning CT and CBCT



Clip showing an example of planning CT and CBCT in axial view (rigidly matched on 6DoF to GM on treatment machine) with contours.

Sagittal view of Planning CT and CBCT



Clip showing an example of planning CT and CBCT in sagittal view (rigidly matched on 6DoF to GM on treatment machine) with contours.

4.

SV Contour was reviewed on each CBCT for consistency before copying them on planning CT. The copied SV contours were combined using add boolean operator to create **SUM_SV** contour.

5.

D99% and D95% to SUM_SV was evaluated for each patient.

6.

Geometric overlap of SUM_SV and PTV was assessed to determine required margins to achieve full dose coverage of SUM_SV with GM-based IGRT.





Mean coverage of SUM_SV with D99% was 83.1% \pm 16.8% of planned D99% of the PTV



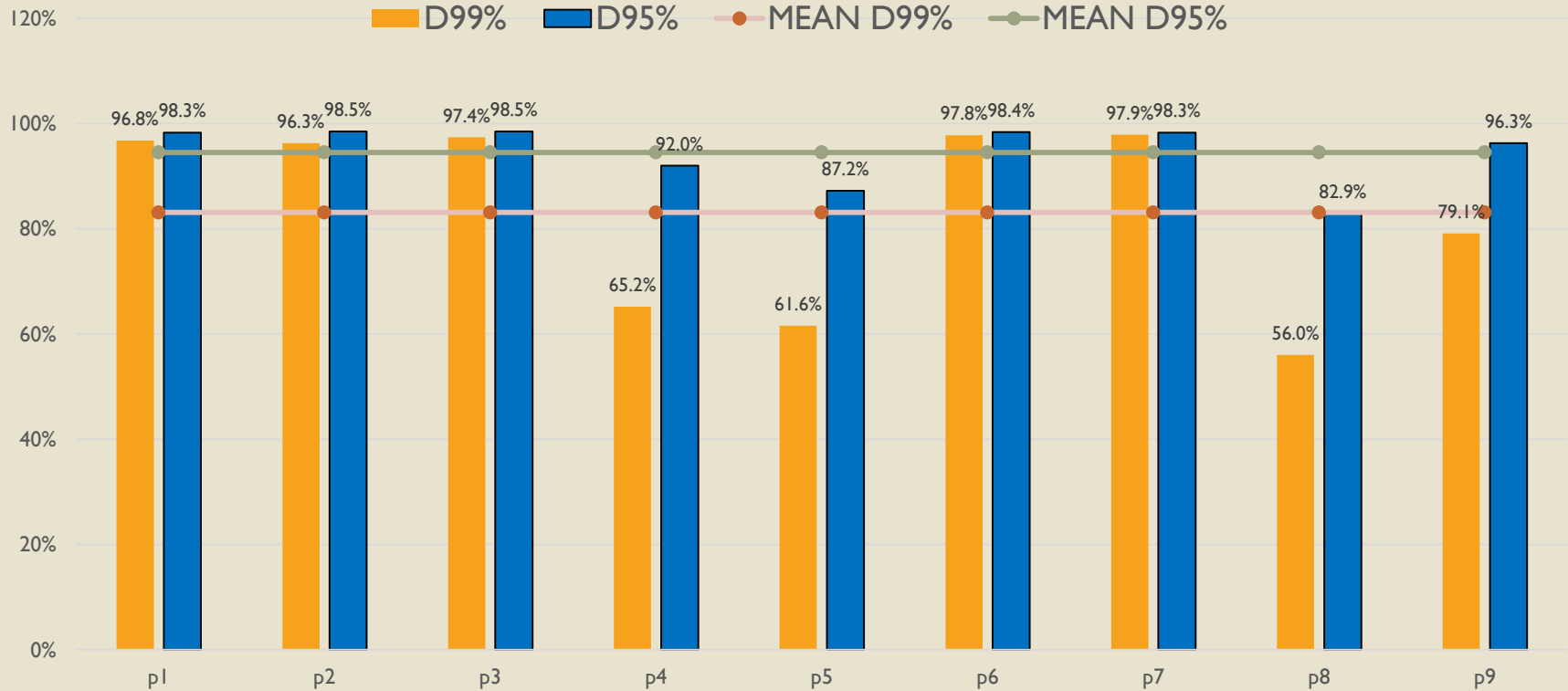
Average % of SUM_SV volume that overlapped with clinical PTV was 96.7% \pm 3.5%



After assessing geometric overlap of SUM_SV with PTV in the cohort, an extension of 2mm in superior and posterior directions was measured to get full dose coverage.

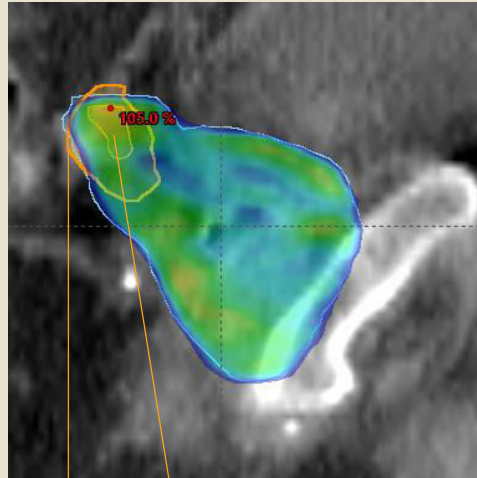


D99% and D95% of SUM_SV



Sagittal view showing 95% of prescription dose

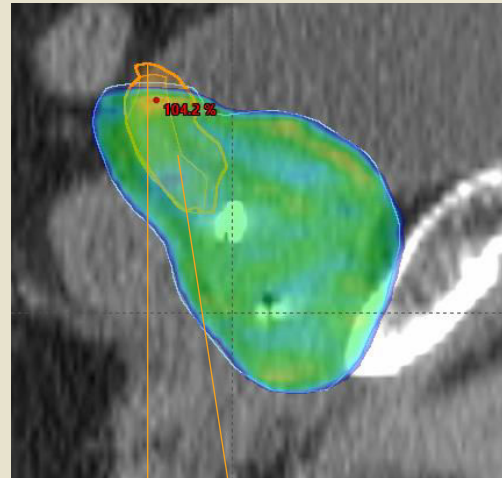
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SUM_SV in PL-CT

SV in PL-CT

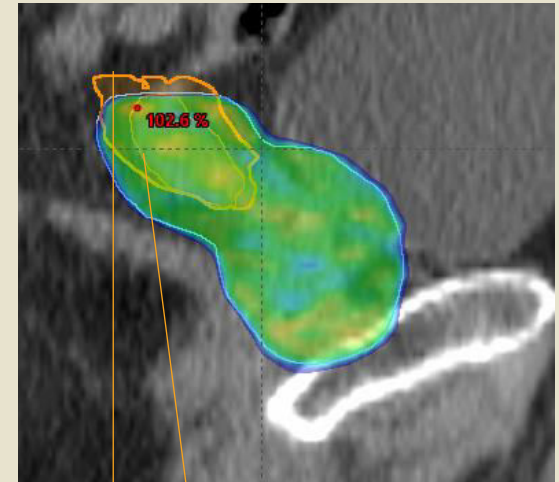
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SUM_SV in PL-CT

SV in PL-CT

p8



SUM_SV in PL-CT

SV in PL-CT

- Improve the cohort (i.e. include more patients and CBCTs per patient).
- CBCT Quality and evaluate quality of contours.
- Quantify interfraction motion.
- Quantify bladder/rectum volume and relate it to observed motion.
- What about intrafraction motion?
- Ultra-hypofractionation and margins?

✓ Interfractional motion of SV was observed and must be taken into account.

✓ Patients with frequent bladder and rectal volume changes may benefit from extension of PTV margin in superior and posterior directions by 2mm.

✓ Margin optimization is dependent on treatment technique, dose/fractionation, fiducial tracking, IGRT protocol and many other factors.

Herzlichen Dank

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1. Brand, V. J., Milder, M. T., Christianen, M. E., Hoogeman, M. S., & Incrocci, L. (2022). Seminal vesicle inter-and intra-fraction motion during radiotherapy for prostate cancer: a review. *Radiotherapy and Oncology*.

Result(s)

	UID	D2%	D95%	D99%	Mean	Overlap %
PROS_p1	9229904	103	98.3	96.8	100.3	100
PROS_p2	9399884	103.3	98.5	96.3	100.6	99.5
PROS_p3	9007530	102.9	98.5	97.4	100.5	100
PROS_p4	9571587	104.4	92	65.2	99.6	95
PROS_p5	9160076	103.2	87.2	61.6	98.5	94
PROS_p6	9534006	102.1	98.4	97.8	100	100
PROS_p7	9033408	101.9	98.3	97.9	100	100
PROS_p8	9163933	101.9	82.9	56	97.9	90
PROS_p9	9468082	103.3	96.3	79.1	100	94
MEAN				83.1222222	99.7111111	96.9444444
STD				16.7816552	0.86723628	3.54686438