Virginia Commonwealth University

Can rectum stability issues be managed with IGRT in prostate radiotherapy?

Mihaela Rosu-Bubulac*, Anthony Ricco, Alfredo Urdaneta, Siyong Kim, Elisabeth Wiess, Jatinder Palta

Department of Radiation Oncology, Virginia Commonwealth University, Richmond, Virginia, USA

Introduction:

Appropriate prostate coverage is achievable with IGRT, but simultaneously constraining rectal doses that are consistent with planned values is challenging, due to rectal shape/filling variability.

We investigated if rigid on-board alignment can fulfill rectum planning goals.

The daily rectal dose varies between the doses corresponding to two alignment endpoints that can be carried out consistently and with high degree of confidence throughout a protracted treatment regimen: prostate alignment ("P") and anterior rectal wall alignment ("R").

Innovation/Impact:

We consider this study to be innovative because: (1) rectal doses are analyzed based on the separation between the prostate and the rectal wall, the first time to our best knowledge and (2) it demonstrates that, if tissue deformations exist, the differences between the planned and the daily rectal doses cannot be resolved through rigid-shift based IGRT, while maintaining target coverage.

Materials and Methods:

- Daily CBCTs (dCBCT) and planning images (8 cases) were aligned by "P" and "R".
- Rectum alignment was to the anterior rectal wall as visible on CBCT through translations along AP direction. Given the deformable nature of the rectum, the alignment entailed splitting differences between consecutive axial slices, with emphasis on the regions adjacent to prostate. Alignments were validated by Physicians, who also contoured the rectum on CBCTs.
- Rectal doses were estimated by rigidly mapping the planned dose on dCBCT according to the respective alignment shift.
- Dosimetric comparisons between daily and planned rectal doses are difficult, due to changes in mass and volume. We chose the rectal volume covered by the 95% prescribed dose IDL for relative comparisons, as volumes enclosed by higher IDLs are more susceptible to alterations due to geometrical changes along the beam axis in highly conformal plans.
- Daily rectal doses similar to the planning doses demonstrate reproducible anatomy, larger indicate a non-reproducibile/less favorable anatomy, smaller indicate a non-reproducible/more favorable anatomy.
- The AP-shifts from "P" to "R" were used to evaluate %number-of-fractions with the shift magnitude larger than PTV margin (indicating potential target underdosage) and %number-of-fractions for which "R" alignment moved the rectum into higher isodose regions.

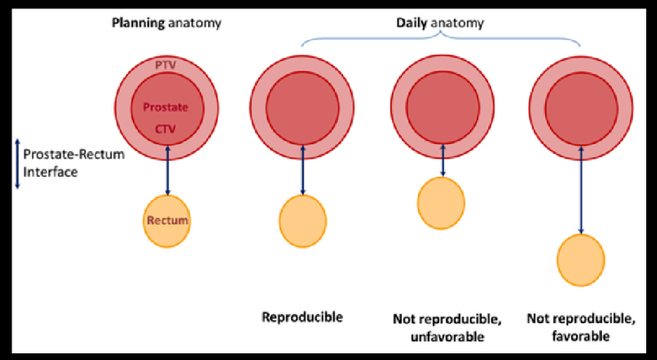

Figure 1: The size of the prostate – rectal wall interface determines the consistency of the planning anatomy. The separation varies along Sup-Inf direction, the alignment is focused on the region adjacent to the central part of the prostate.

Key Results:

Rectum V95% (cc) planning value (orange) and daily values for the prostate (red) and rectal (blue) alignment are shown for each patient in **Figure 2**.

Pt.	A	B	C	D	E
1	0.0	50.0	1.1	8.1	N↓
2	21.1	15.8	2.0	4.6	N↓
3	0.0	42.9	0.6	-4.9	N↑
4	10.0	40.0	0.1	-2.1	N↑
5	7.7	46.2	0.8	3.7	N↓
6	50.0	12.5	3.2	3.6	N↓
7	62.5	12.5	4.2	4.8	N↓
8	0.0	72.0	-2.2	-0.3	Y

Table 1. Summary data for each patient.

A: "R" shift > PTV margin (% number of fractions)
B: V95% larger in "R" then "P" (% number of fractions)
C: "P" minus "R" V95% (cc)
D: "P" minus "Planning" V95% (cc)
E: Is the anatomy reproducible? Yes Y; No, but more favorable N↑; No, and less favorable N↓.

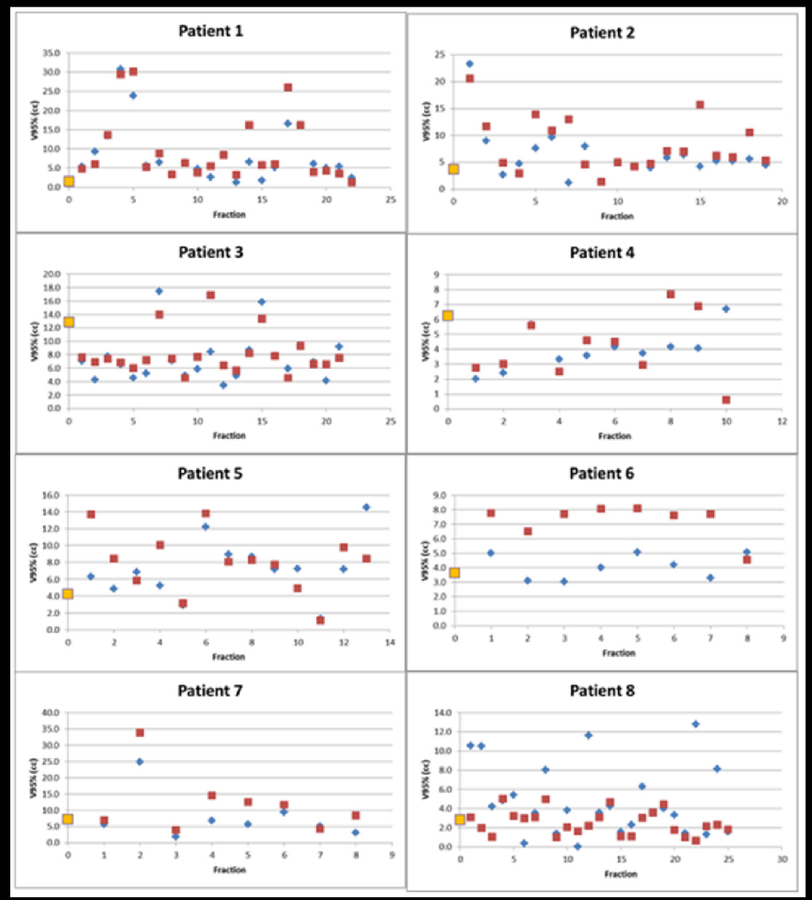

Figure 2: **Rectal V95% (cc) planning (orange) vs. prostate alignment "P" (red) vs. rectum alignment "R" (blue) for each fraction.**

Conclusion:

CBCT can provide snapshots of the daily anatomy; however, its usefulness with regards to achieving planning goals for rectum is questionable. Our study underscores the importance of scanning the patient in a reproducible anatomy.

*Mihaela.Rosu@vcuhealth.org