A Quantitative Study on the Dosimetric Comparison of Contouring of the True Rectum and Rectum Contouring Protocol of Radiation Technology Oncology Group on Prostate Cancer Patients

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Introduction

- RTOG defines the rectum inferiorly as the lowest border of the ischial tuberosities and superiorly as the level at which it loses its round shape and attaches to the sigmoid.[1]
- The true rectum however is defined as the level of the anorectal ring to the rectosigmoid junction.[1]
- While RTOG constraints are supported by the non-anatomic contouring of the rectum, the two different approaches may yield differences in dosimetry that can thus lead to challenges in applying to published constraints.

Objectives

- ✓ To estimate significant volume difference between RTOG rectum contouring and true rectum contouring
- ✓ To compare dose constraints of true rectum contouring and that of RTOG
- ✓ To generate a corrective factor for the dose constraints to allow clinicians to correlate true rectum goals to published constraints

Methods

- A retrospective chart review was conducted identifying successive prostate cancer patients who were:
  - Treated at CPRCC between January 2020 to February 2021
  - Received definitive external beam radiation using IMRT/VMAT with either:
    - 78-80 Gy (conventional [CF], 2 Gy/fraction)
    - 70 Gy (hypofractionated [HF], 2.5 Gy/fraction)
- Patients were excluded if treated with non-standard fractionation, had a rectal hydrogel spacer (as this would influence results), or treated after prostatectomy
- Treatment plan data was collected from Raystation 9A treatment planning system
- Two rectal contours were generated:
  - RTOG guidelines – bottom of ischial tuberosities to rectosigmoid junction
  - "True" rectum – anorectal ring (level of levator ani) to rectosigmoid junction
    - Inferior aspect was extended to the bottom of the high dose PTV or anorectal ring, whichever was more inferior in anticipation of practical optimization applications
- Dose-volume parameters were captured using the original/delivered plan:
  - Rectal $V_{75\,Gy}$, $V_{70\,Gy}$ and $V_{50\,Gy}$ (CF) and $V_{45\,Gy}$, $V_{40\,Gy}$, $V_{55\,Gy}$, $V_{65\,Gy}$, $D_{15\%}$, $D_{25\%}$, $D_{35\%}$, and $D_{55\%}$ (HF) based on published constraints[2]
- Paired t-test was utilized to compare mean differences between rectum contours
- To create a more practical correction factor if contouring true rectum, the mean % or Gy for RTOG dosimetry was divided by corresponding "true" rectum values

Results

- A total of 58 patients were identified, 30 with HF and 28 with CF
  - Included seminal vesicles: 86% (CF) and 90% (HF)
  - Included lymph nodes: 61% (CF) and 43% (HF)
- Median prostate volume for CF and HF patients was 39.6 cc (range, 18.2-176.3 cc) and 49.9 cc (17.9-100.0 cc), respectively
- "True" rectal volumes were smaller for both subsets when contoured
  - CF: -13.1 cc ± 1.1 cc, p<0.01
  - HF: -17.1 cc ± 1.5, p<0.01
- PTV coverage (volume receiving high dose prescription >95%) was met in 96% (CF) and 87% (HF), respectively, often to allow for meeting rectal constraints

Results (cont.)

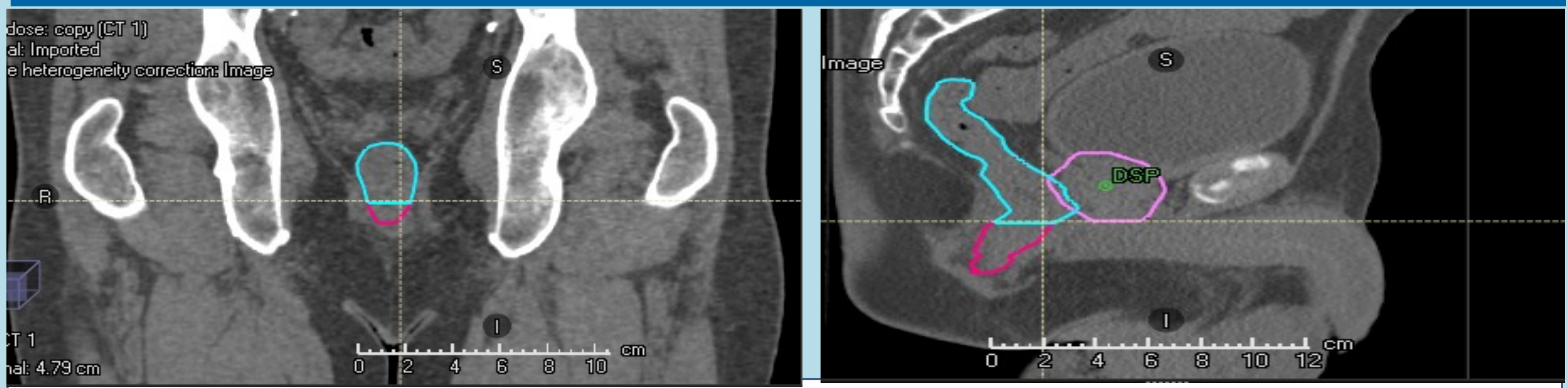

Figure 1: Coronal and sagittal view showing RTOG rectum (rectosigmoid junction to lowest border of ischial tuberosities) and true rectum (rectosigmoid junction to anorectal ring).

Dose/ Volume Parameter	RTOG rectum Mean %/Gy ± SD	True rectum Mean %/Gy ± SD	Correction factor (RTOG/True)	Mean correction factor	Mean absolute difference ± SD	*p* value
CONVENTIONAL FRACTIONATION						
$V_{75\,Gy}$	5.94 ± 2.41	6.73 ± 2.83	0.88		0.80 ± 0.97	<0.01
$V_{70\,Gy}$	9.15 ± 3.50	10.44 ± 4.07	0.88	**0.88**	1.29 ± 1.41	<0.01
$V_{50\,Gy}$	25.5 ± 8.00	28.97 ± 10.23	0.88		3.49 ± 3.91	<0.01
HYPOFRACTIONATION						
$V_{45\,Gy}$	20.81 ± 5.66	24.009±7.355	0.87		3.20 ±2.78	<0.01
$V_{40\,Gy}$	27.08 ± 6.53	31.329±8.454	0.86	**0.87**	4.25 ± 3.36	<0.01
$V_{55\,Gy}$	12.41 ± 4.06	14.229±4.948	0.87		1.82 ± 1.62	<0.01
$V_{65\,Gy}$	6.30 ± 2.49	7.181±2.914	0.88		0.88 ± 0.90	<0.01
$D_{15\%}$	51.13 ± 6.03	53.34 ± 6.42	0.96		2.21 ± 1.84	<0.01
$D_{25\%}$	41.54 ± 5.01	44.10 ± 5.81	0.94	**0.94**	2.55 ± 1.76	<0.01
$D_{35\%}$	35.56 ± 4.03	38.08 ± 5.04	0.93		2.52 ± 2.12	<0.01
$D_{55\%}$	30.02 ± 4.70	32.17 ± 5.00	0.93		2.15 ± 1.44	<0.01

Table 1: Dosimetry parameter comparison using paired t-test

Discussion/Conclusion

- There was consistent increase in clinical dosimetry from RTOG rectum to "true" rectum contours. This difference was observed in each constraint provided, as a result of overall smaller "true" rectal volumes compared to RTOG consensus contouring.
- Corrective factors generated can be used if choosing to contour anatomic/true rectum for prostate cancer treatment, allowing application to published NRG/RTOG constraints.

Limitations

- Aside from the anatomic boundaries of the rectum, rectum behind the prostate PTV was still included in the contours for optimization purposes. There were, however, no outliers in rectal volumes recorded.
- Variability likely exists with rectal and prostate contouring that may result in small differences in numbers provided

References

1. Gay HA, Barthold HJ, O'Meara E, et al. Pelvic normal tissue contouring guidelines for radiation therapy: A Radiation Therapy Oncology Group consensus panel atlas. Int J Radiat Oncol Biol Phys. 2012; 83(3):e353-62
2. Hall WA, Paulson E, Davis BJ, et al. NRG oncology updated international consensus atlas on pelvic lymph node volumes for intact and postoperative prostate cancer. . Int J Radiat Oncol Biol Phys. 2021; 109(1), 174-185.