Dosimetric Effect of Unplanned Rectal Gas Cavities for 1.5-T MR-Linac Guided Prostate SBRT

M Wronski[1,2], M Ruschin[1,2], C McCann[1,2], M Davidson[1,2], B Keller[1,2], A Kim[1,2], J Detsky[1,2], A Loblaw[1,2], K Wong[1,2], M Campbell[1,2] and D Vesprini[1,2]

1 Odette Cancer Centre, Sunnybrook Health Sciences Centre, Toronto Ontario Canada

2 Department of Radiation Oncology, University of Toronto, Toronto, Ontario, Canada

JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING

EASTERN TIME [GMT-4]

INTRODUCTION

Previous studies have suggested that the presence of unplanned air cavities during radiation therapy treatment delivery on an MR-Linac can result in detrimental dosimetric effects owing to the electron return effect. This is one of the first investigations into the clinical significance of unplanned rectal gas for MR-Linac guided prostate SBRT. All patients in this study were imaged, contoured and treated on the MR-Linac.

AIM

To investigate the effect of unplanned rectal gas cavities on clinically relevant dosimetric criteria in prostate SBRT patients treated on a 1.5-T MR-Linac (MRL).

METHODS

Five prostate SBRT patients were treated on MRL with a prescribed dose of 40 Gy in 5 fractions. Daily IMRT treatment planning was performed in Monaco using 11 beams. The planning target volume (PTV) consisted of the prostate and proximal 1 cm seminal vesicles with an added 4 mm margin. Any rectal gas cavities were overridden with an electron density of 1 g/cc to yield plans insensitive to potential changes in gas volume and location during treatment delivery. Retrospectively, an unplanned gas cavity was included in the plans by overriding the rectum to a density of 0 g/cc with the exception of a region within 3 mm of the rectal contour which represented the rectal wall. To quantify the combined effect of lack of attenuation, electronic disequilibrium and a possible electron return effect at the interface between the unplanned gas cavity and rectal wall, clinically-relevant dose-volume criteria were extracted for rectal wall and PTV.

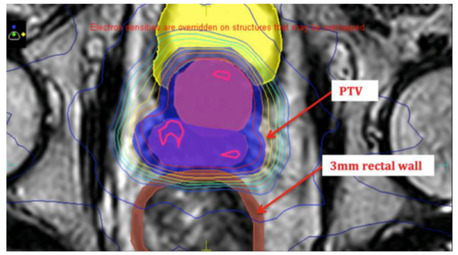

Fig 1: Illustration of representative PTV and rectal wall contours

RESULTS

- The presence of an unplanned gas cavity resulted in minor changes of 0.02±0.84% and 0.04±0.23cc in rectal wall maximum dose and V38Gy, respectively.
- The PTV volume receiving 105% of the prescribed dose increased by 5.8±4.9%, most likely due to a reduction in photon attenuation for the posterior IMRT beams.
- All dosimetric constraints were met with the rectal gas present with the exception of 2/5 patient plans where the PTV V105% exceeded a 10% tolerance. All plans with and without rectal gas did not exceed a maximum PTV dose of 44 Gy (110%).
- These results represent the extreme scenario where the gas cavity persists in place for all 5 fractions, which is unlikely in practice.

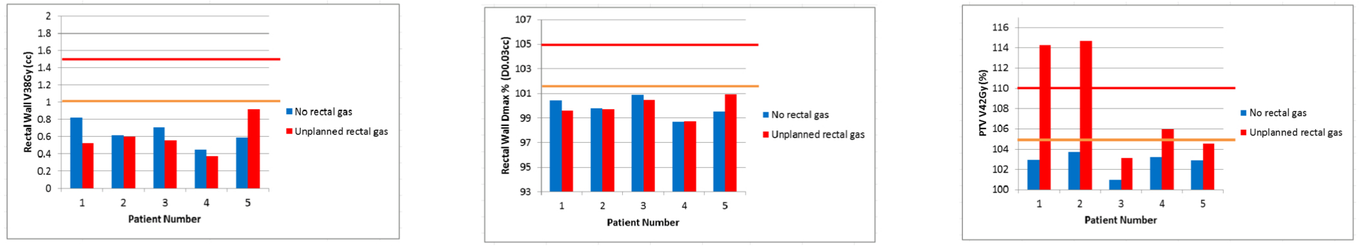

Fig 2. Graphical representation of all patients analyzed in the present study. The orange and red lines represent the protocol warning and action levels, respectively

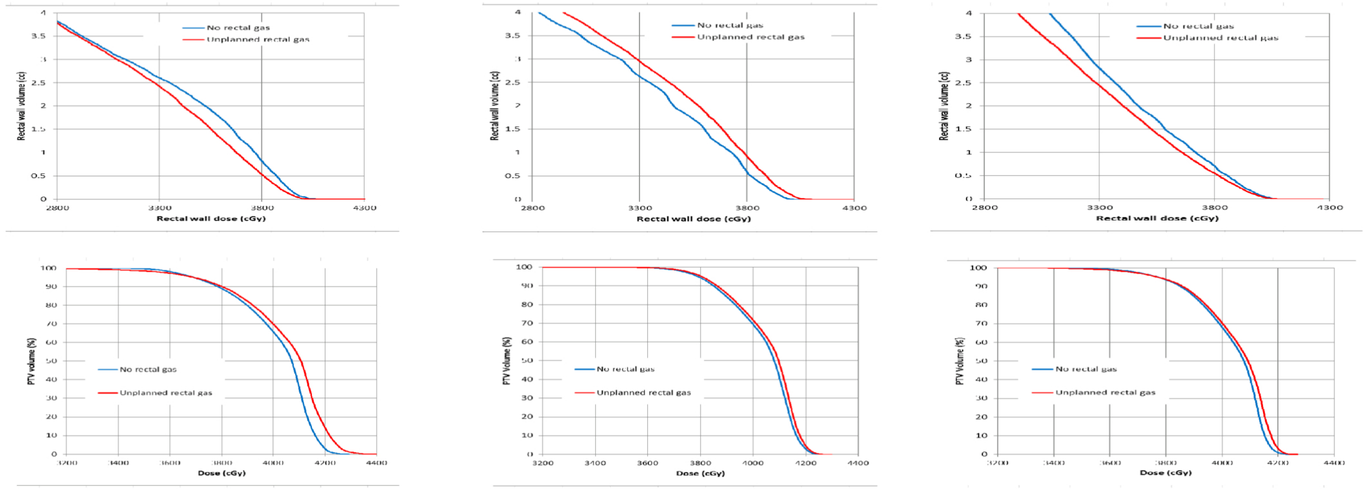

Fig 3. Dose volume histograms for three sample patients. DVH plots for rectal wall volume (cc) and PTV volume (%) are in the top and bottom rows, respectively

CONCLUSIONS

- Unplanned rectal gas cavities are unlikely to result in clinically significant dosimetric changes for prostate SBRT patients treated with 11 IMRT fields on a 1.5-T MRL.
- A daily treatment planning protocol consisting of overriding the rectum to 1 g/cc produces plans that are largely insensitive to unplanned gas.
- A larger study is underway to confirm that unplanned gas does not result in a statistically-significant degradation of rectal wall dosimetry.

REFERENCES

1. Shortall J, Chuter R, McWilliam A et al. Assessing localized dosimetric effects due to unplanned gas cavities during pelvic MR-guided radiotherapy using Monte Carlo simulations. Med Phys 46: 5807-15. 2019.

2. Scripes P, Subashi E, Burleson S. Impact of Varying Air Cavity on Planning Dosimetry for Rectum Patients Treated on a 1.5 T Hybrid MR-linac System. J Appl Clin Med Phys. 2020.

CONTACT INFORMATION

matt.wronski@sunnybrook.ca