University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (Thompson Rivers University, 2017)

"SpaceOAR© Hydrogel Optimization and Management for Rectal Sparing in Prostate Cancer Patients"

Department of Physics and Astronomy

Monday, September 9, 2019
12:30 P.M.
Cornett Building
Room B145

Supervisory Committee:
Dr. Isabelle Gagne, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Magdalena Bazalova-Carter, Department of Physics and Astronomy, UVic (Co-Supervisor)

External Examiner:
Dr. Steven Thomas, Department of Surgery, University of British Columbia

Chair of Oral Examination:
Dr. Alison Murray, Department of Anthropology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

External beam radiation therapy for prostate cancer can result in urinary, sexual, and rectal side effects, often impairing quality of life. A polyethylene glycol-based product, SpaceOAR© hydrogel (SOH), implanted into the connective tissue between prostate gland and rectum can significantly reduce the dose received by the rectum and hence risk of rectal toxicity. The optimal way to manage the hydrogel and rectal structures for plan optimization is therefore of interest.

A retrospective planning study was completed with 13 patients to examine optimal planning and treatment methods. Computerized tomography (CT) scans were taken pre- and post-SOH implant. Six hypofractionated (60 Gy in 20 fractions) treatment plans were produced per patient using either a structure of rectum plus the hydrogel, termed composite rectum wall(CRW),or rectal wall RW) as the inverse optimization structure and intensity modulated radiotherapy (IMRT) or volumetric modulated arc therapy (VMAT) as the treatment technique. Dose-volume histogram metrics were compared between plans to determine which optimization structure and treatment technique offered the maximum rectal dose sparing. RW structures offered a statistically significant decrease in rectal dose over CRW structures, whereas the treatment technique (IMRT vs VMAT) did not significantly affect the rectal dose. However, there was improvement seen in bladder and penile bulb dose when VMAT was used as a treatment technique over IMRT. Overall, treatment plans using the RW optimization structure offered the lowest rectal dose while VMAT treatment technique offered the lowest bladder and penile bulb dose. These treatment techniques and optimization structures have now been implemented at BC Cancer - Victoria based on this retrospective study.

SOH implant has been shown not to be equally effective in all patients. Determining *a priori* patients in which the implant will offer most benefit allows for effective management of SOH resources. Several factors have been shown to be correlated to reduction in rectal dose including distance between rectum and planning treatment volume (PTV), volume of rectum in the PTV and change in rectum volume pre- to post-SOH. Several of these factors along with other pre-SOH CT metrics were found via multiple linear regression models to predict reduction of rectal dose using data from 21 patients who received SOH implant. Two high rectal dose metrics were modeled, change in the relative volume receiving 55 Gy (ΔRV55Gy)

and change in the partial high dose integral(ΔHDI),integrating over the dose-volume histogram(DVH) from 55 Gy to 60 Gy. Models were also produced to predict pre-SOH RV55Gy (PreRV55). These models offered R^2 between 0.57 and 0.87 with statistical significance in each model. Applying a 3.5% lower limit on pre-SOH RV55Gy removed one third of patients as implant candidates. This may offer a clinically useful tool in deciding which patients should receive SOH implant given limited resources. Predictive models, nomograms and a workflow diagram were produced for clinical management of SOH implant.