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Quantifying Periprostatic Gel Placement for Prostate SBRT

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Objectives: SpaceOAR, an FDA-approved hydrogel, is used to create periprostatic space and decrease rectum toxicity during prostate radiotherapy. Periprostatic gel placement effectiveness is dependent on operator choice of injection site and biodistribution of the gel after injection. Aim of this analysis was to develop three parameters to quantify gel placement and correlate these with rectum dosimetry in a cohort of patients treated with stereotactic body radiotherapy (SBRT) for localized prostate cancer.

Methods: We retrospectively reviewed all low and intermediate risk prostate cancer patients at our institution treated with SBRT to 36.25 Gy in 5 fractions from 2015 to 2017. Normal tissue dose constraints were defined in RTOG 0938. All patients underwent periprostatic hydrogel spacer placement at most six weeks prior to starting radiotherapy. Three parameters quantifying hydrogel placement – 1) hydrogel volume as contoured on MRI; 2) angle θ formed by prostate, hydrogel, and rectum; 3) a "hybrid" parameter taking into account both gel volume and location, defined as the percentage of a 1 cm sphere located immediately posterior to the prostate that was occupied by the hydrogel – were measured and correlated with prostate-rectum distance, relative rectum D95%, and 1.5 cc maximum rectum dose.

Results: This single institution study cohort comprised 17 patients with a median follow up of 12 months (range 4-20 months). The following are the mean and standard deviation for each measurement: prostate-rectum distance, 9.6 mm, 4.2 mm; gel volume contoured on MRI, 9.8 cc, 4.5 cc; θ, 72.9°, 50.6°; hybrid parameter 44%, 23%; rectum D95% 0.03, 0.01; 1.5 cc maximum rectum dose 3454 cGy, 116.1 cGy. In one patient gel was located laterally to the prostate, resulting in 0 mm prostate-rectum distance. None of the parameters quantifying gel placement was related to rectum point dose maximum and rectum mean dose. Prostate-rectum distance correlated strongly with rectum D95% and 1.5 cc maximum rectum dose ($p<0.01$). On univariable analysis, gel volume, θ, and the hybrid parameter was each predictive of CTV rectum distance, rectum D95%, and 1.5 cc maximum rectum dose ($p<0.05$). On three-variable regression analysis of gel volume, θ, and hybrid parameter, only θ predicted for D95% and 1.5 cc maximum rectum dose ($p<0.05$). On two-variable analysis excluding the hybrid parameter, θ again predicted for D95%, 1.5 cc maximum rectum dose, and also CTV-rectum distance ($p<0.05$). Gel volume was not a significant predictor in this model. In two-variable analyses of 1) gel volume and hybrid parameter, or 2) hybrid parameter and θ, no single parameter predicted for rectum D95% and 1.5 cc maximum rectum dose. However, the hybrid parameter predicted for CTV-rectum distance in both cases ($p<0.05$).

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Conclusions: The magnitude of perirectal distance predicts for rectum dose in prostate SBRT. Gel volume and θ independently quantify gel placement. While gel volume, θ, and hybrid parameter each correlated with perirectal distance, θ correlated with rectum dose with the least variability. This correlation persisted on multivariable analysis. These data suggest that in our single institution cohort, gel effectiveness in optimizing rectum dosimetry is presently limited more by location than gel volume.