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Dosimetric Effects of Adaptive Gynecological HDR Brachytherapy Planning on a per-Fraction Versus per-Implant Basis

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INTRODUCTION

The clinical workflow for gynecological High Dose Rate (HDR) brachytherapy can be laborious and time-consuming as the treatment planning occurs in real-time, post-imaging. Specifically, it can involve creating a new plan for each fraction of treatment or delivering a single plan for both fractions of an implant. This work retrospectively analyzes the differences in EQD2 doses to the clinical target volumes (CTVs) and organs at risk (OARs) between two planning paradigms: one plan delivered for two fractions and a new plan generated for each fraction.

METHODS AND MATERIALS

Four patients treated with commercially available HDR hybrid applicators were analyzed. CTVs and OARs were contoured by a physician on CT scans taken for both fractions. These CTs and contours were sent to the Oncentra TPS for the planning process. Applicator models were applied and catheter digitization was performed. To ensure consistency of the delivered plans, the dwell times from the first fraction were decayed to align with the source strength at the time of retrospective calculation of the second fraction. Dose to 90% Equivalent Uniform Dose in 2 Gy/fx (D90 EQD2) to CTVs and dose to 2 cc Equivalent Uniform Dose in 2 Gy/fx (D2cc EQD2) to OARs were determined for both plan paradigms and the differences were analyzed using Bland-Altman Analysis.

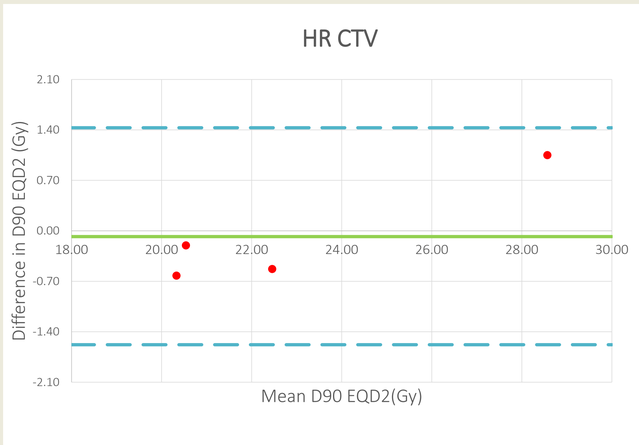
RESULTS

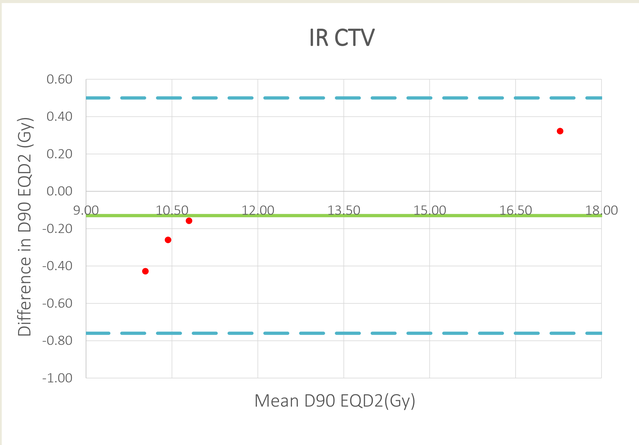
The differences in D90 (EQD2) to the high risk CTVs (HRCTVs) and intermediate risk (IRCTV) ranged between -0.62 to 1.05 Gy and -0.43 to 0.32 Gy, respectively. Negative values of dose differences signifies that the paradigm, in which a replan did not take place for the second fraction, resulted in a higher dose to the CTVs. Conversely, positive values signify that the paradigm, in which a replan did occur for the second fraction, resulted in a higher dose to the CTVs.

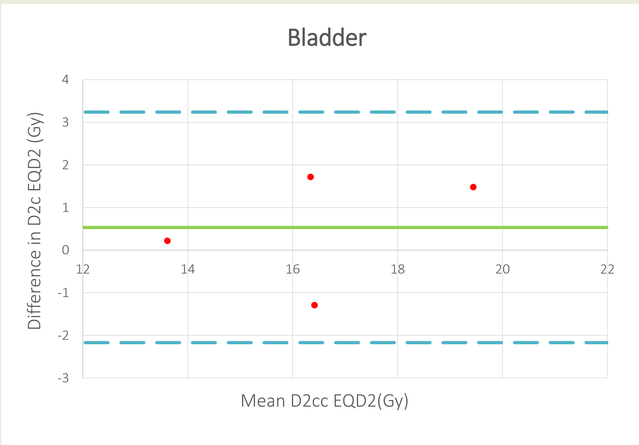
The D2cc (EQD2) for the bladder, bowel, and sigmoid differed within a range of -1.96 to 1.72 Gy across all patients, with an average bias of 0.12 Gy. The bias value represents the average difference between the two paradigms, with a positive bias signifying that the paradigm, in which a replan was made for the second fraction, resulted in a higher dose the OARs. Differences in the rectal D2cc (EQD2) ranged from -0.40 to 6.09 Gy, with a bias of 2.41 Gy.

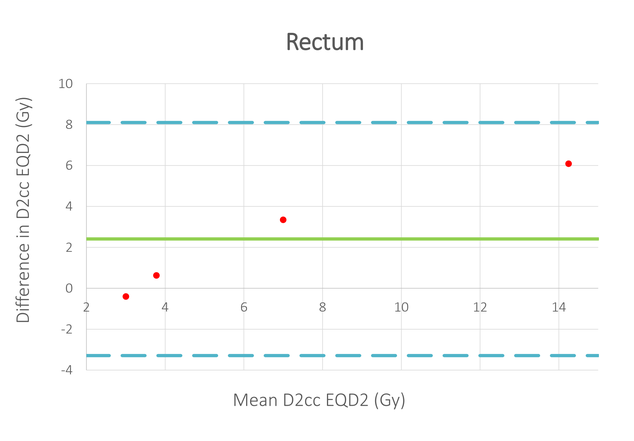
The Bland-Altman plots below show narrow limits of agreement (dashed blue lines) which indicates consistency in the delivered dose between the two paradigms. This bias value is shown by the solid green lines.

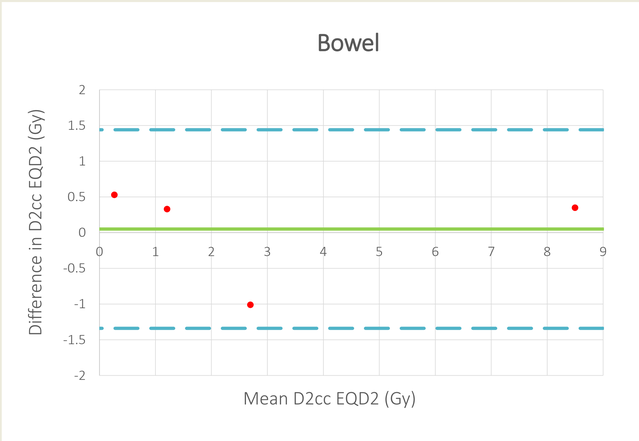
RESULTS cont.

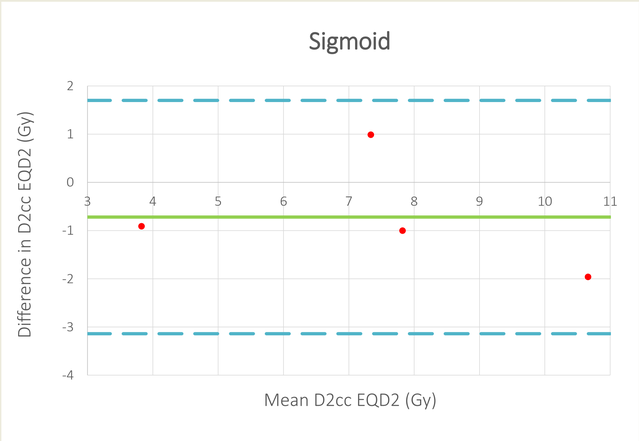












DISCUSSION / CONCLUSIONS

In the clinical setting, a physician can commonly opt to use the same plan for the second fraction of the same implant to reduce the amount of time a patient will need to lie on the table waiting for a new plan to be ready. This significantly cuts down on total treatment time and reduces patient discomfort. However, this decision is heavily based on the assumption that the applicator and internal organs have not shifted significantly between the first and second day of the implant. Overall, both paradigms resulted in a reasonable difference in dose to the CTVs and OARs. The dose to the rectum varied the most, which can be attributed to high variability in filling and proximity to the target on a daily basis. This work shows that both plan paradigms showed relatively consistent target coverage and dose to OARs.

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