Brandy Kossow, B.S., RT(R)(T)
Grand Valley State University
KossowB@mail.gvsu.edu

A Comparative Analysis of Dosimetric Effects:

Reusing vs. Generating New Dwell Times in Ring and Tandem HDR Treatment Simulations

Introduction

Utilizing an HDR boost instead of an external beam radiation therapy (EBRT) boost has been shown to exhibit dosimetric advantages, such as dose escalation to the target structure while simultaneously providing enhanced sparing of the surrounding organs at risk (OAR). Patients typically receive three to five fractions, each requiring separate simulation, planning, and treatment. A ring and tandem device is placed during each session, after which the patient must remain still for hours. This process is often very uncomfortable for patients; thus, efficiency is vital.

This study evaluates whether reusing dwell times from the initial HDR treatment, a time-saving process, affects dosimetric outcomes. Results are compared to plans using newly generated dwell times, focusing on target coverage and OAR sparing.

Methods

This fully retrospective study used ten previously treated ring and tandem HDR plans to compare the dosimetric impact of newly generated dwell times in ring and tandem HDR procedures. Subject data was obtained from a cancer center that performs over 80 ring and tandem procedures annually.

Eligibility Criteria

Each sample must have met the following criteria to have been included in this study.

- Had one the following diagnosis codes: C53.0, C53.1, C53.8, or C53.9
- Received five fractions, totaling 3000 cGy, using a ring and tandem procedure, with over 80% of dwell times being unique.
- Treated on a 3/24 iX HDR Afterloader machine with Iridium 192.
- Kept a consistent bladder size over each fraction.

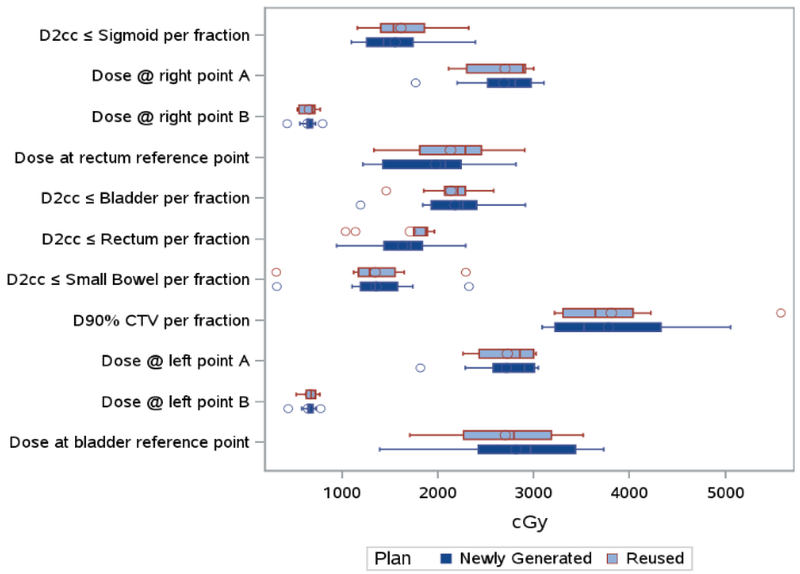
Data Collection

Each sample was evaluated using four treatment plans identical to the original, with dwell times copied from the first fraction. Dose-volume metrics (cm^3) were recorded for the rectum, bladder, sigmoid, and small bowel (max dose to 2 cc), dose to 90% of the target, and six reference points: point As, point Bs, anterior rectal point, and posterior bladder point. The total dose of the comparison plan was then compared to the initial plan to observe clinical significance.

Results

Constraint Type	Metric evaluated	Newly Generated (Mean±SD)	Reused (Mean±SD)	Effect Size	P-Value
OAR: Rectum	Max Dose (cGy)	1714.5 ± 337.3	1633.8 ± 432.4	0.34	0.304
OAR: Bladder	Max Dose (cGy)	2134.8 ± 302.8	2178.4 ± 458.5	0.23	0.49
OAR: Sigmoid	Max Dose (cGy)	1616.6 ± 356.5	1554.4 ± 391.5	0.25	0.454
OAR: Small Bowel	Max Dose (cGy)	1347.5 ± 496.3	1356.8 ± 506.9	0.07	0.819
Target: CTV	D90 (cGy)	3809.5 ± 704.3	3779.4 ± 642.6	0.09	0.779
Reference Point: Lt Point A	Point Dose (cGy)	2725.5 ± 306.6	2716.0 ± 401.4	0.05	0.885
Reference Point: Lt Point B	Point Dose (cGy)	669.9 ± 79.8	654.1 ± 92.0	0.26	0.428
Reference Point: Rt Point A	Point Dose (cGy)	2700.4 ± 342.7	2688.9 ± 420.2	0.05	0.874
Reference Point: Lt Point B	Point Dose (cGy)	661.7 ± 89.3	648.3 ± 98.9	0.21	0.525
Reference Point: Anterior Rectum	Point Dose (cGy)	2131.1 ± 506.4	1978.4 ± 524.3	0.6	0.089
Reference Point: Posterior Bladder	Point Dose (cGy)	2703.1 ± 630.5	2815.7 ± 798.3	0.52	0.137

Table 1. Summary of dosimetric comparisons between plans using reused dwell times and those with newly generated dwell times. Statistical significance was evaluated using p-values, and practical significance was assessed using effect size metrics.



Graph 1. Boxplots representing the differences in dose (cGy) when reusing versus generating new dwell times. Each boxplot highlights the median, interquartile range, and outliers.

Conclusion

The comparative dosimetric analysis between reused and newly generated dwell time plans revealed no statistically significant differences across any of the eleven dose constraints measured. While several constraints showed near-normal distribution and some approached showing a statistical significance, all comparisons yielded small effect sizes, indicating minimal clinical impact.

These results suggest that reusing dwell times could offer a clinically similar treatment plan to those with newly generated dwell times, potentially introducing increased efficiency during the treatment planning process without compromising treatment accuracy or patient safety. However, future studies should use a larger sample size to better understand the clinical impact of dwell times on OARs and targets.

Limitations

The primary challenge encountered during this research was identifying samples with dwell times that differed enough between initial and subsequent HDR treatments to allow for meaningful comparison. Many cases contained minimal change in dwell time distributions, limiting the ability to assess the impact of reusing versus regenerating dwell times. Using dwell time differentiation as an inclusion criterion may have influenced statistical comparisons. Prospective studies need to use a broader range of clinical scenarios to account for this. This factor should be considered when interpreting or applying these results in a clinical practice.

References

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