# The Dosimetric Impact of Multichannel Vaginal Cylinder Applicator Rotation in the Treatment of High Dose Rate Gynecological

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## Purpose

This study investigated dosimetric effects of applicator rotational errors of the multi-channel cylinder. The results will provide guidance for the multichannel vaginal cylinder quality assurance regarding dosimetric consequences for daily treatment error.

## Materials and Methods

- Seven consecutive GYN cancer patients who received multi-channel high dose rate brachytherapy had dose distributions re-evaluated to assess the impact of rotational errors.
- As shown in Figure 1, errors were simulated by virtually rotating the 3D dose cloud using commercial image registration software. The rotational errors of ±1°, ±3°, ±5°, ±7°, ±15°, ±30°, ±60°, ±90° along the central axis of the applicator were simulated.
- Tabular DVHs were generated for the target and critical structures (i.e. small bowel, sigmoid, rectum, and bladder).
- Differences in dosimetric parameters between the reference plan and each angle of rotation were analyzed for the target D90% and D2cc for several organs-at-risk (OARs).

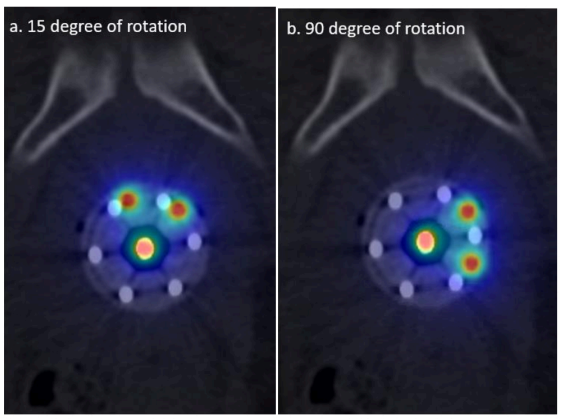
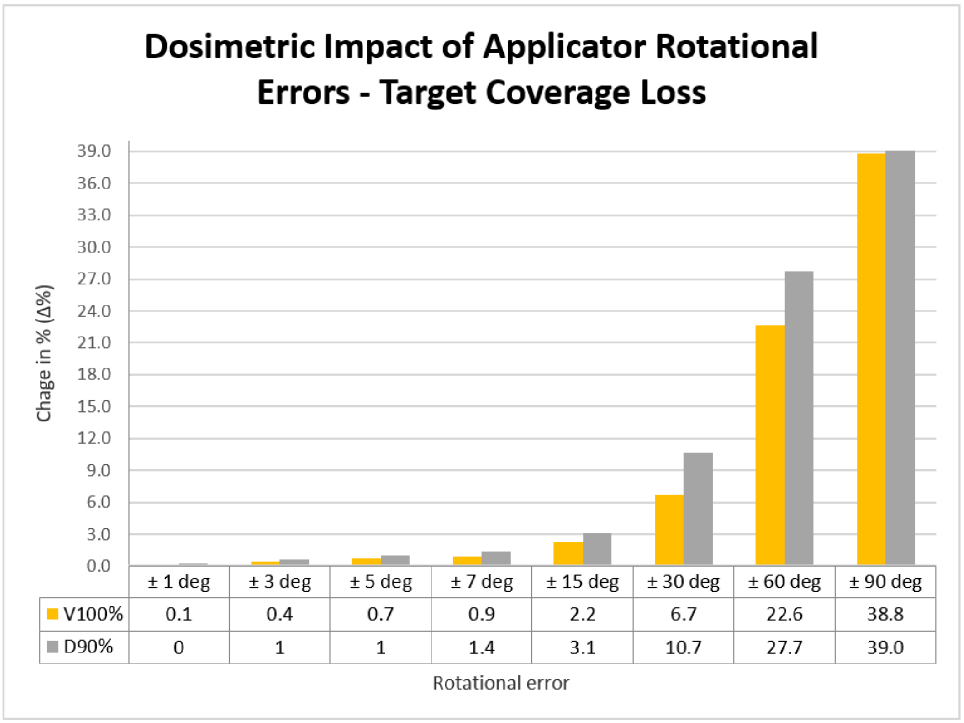


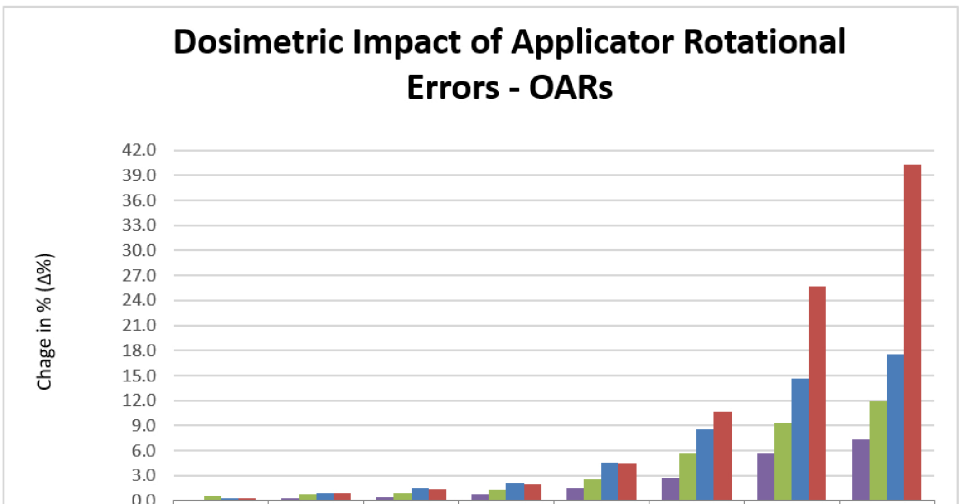

Figure 1. Simulation of 3D dose cloud rotation of 15° (a) and 90° (b)

## Results/Discussions




| | ± 1 deg | ± 3 deg | ± 5 deg | ± 7 deg | ± 15 deg | ± 30 deg | ± 60 deg | ± 90 deg |
|---|---|---|---|---|---|---|---|---|
| V100% | 0.1 | 0.4 | 0.7 | 0.9 | 2.2 | 6.7 | 22.6 | 38.8 |
| D90% | 0 | 1 | 1 | 1.4 | 3.1 | 10.7 | 27.7 | 39.0 |

Figure 2. Simulated target dosimetric impacts (%) by virtually rotating the dose cloud




| | ± 1 deg | ± 3 deg | ± 5 deg | ± 7 deg | ± 15 deg | ± 30 deg | ± 60 deg | ± 90 deg |
|---|---|---|---|---|---|---|---|---|
| Samll Bowel | 0.1 | 0.3 | 0.5 | 0.8 | 1.6 | 2.8 | 5.6 | 7.4 |
| Sigmoid | 0.5 | 0.8 | 0.9 | 1.3 | 2.6 | 5.7 | 9.3 | 11.9 |
| Bladder | 0.3 | 1.0 | 1.5 | 2.2 | 4.5 | 8.6 | 14.6 | 17.5 |
| Rectum | 0.3 | 0.9 | 1.4 | 2.0 | 4.5 | 10.7 | 25.7 | 40.3 |

Figure 3. Simulated OARs dosimetric impacts (%) by virtually rotating the dose cloud

Target:

- As shown in Figure 2, the dose variation due to device rotation indicated relatively small changes in D90% (i.e. <5% ) for angles of rotation less than or equal to 15° as compared to those for 30°, 60° and 90° angles of rotation that resulted in differences of 11% , 28%, and 39%, respectively.

OARs:

- As shown in Figure 3, the change in D2cc for all OARs was also under 5% for angles of rotation less than or equal to 15°.
- Among the studied OARs, the change in rectal D2cc was observed as the most sensitive to a large angle of rotation resulting in 10.7%, 25.7%, and 40.3% when the dose cloud was rotated by 30°, 60°, and 90°, respectively.
- In contrast, the small bowel D2cc had relatively low dosimetric change (7.4%) even at a higher angle of rotation (90°).

## Conclusions

- We report rotation-induced variations in dosimetric parameters that were determined with the help of commercially available software.
- Limiting the applicator rotation to less than 15° keeps dosimetric deviation under 5% for both the target and the OARs.
- Before each treatment, applicator immobilization and QA checks should be employed to prevent multichannel vaginal cylinder rotation.

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