2026 JOINT AAPM | COMP MEETING
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Investigating Systematic Errors In Model-Based Dose Calculation Algorithms Using the TG-186 Generic Applicator

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Introduction

Commercial model-based dose calculation algorithms (MBDCAs) show promise for advancing intensity-modulated brachytherapy (IMBT). However, transitioning from the TG-43 protocol to MBDCAs requires benchmark studies against reference dosimetry.

This work introduces a normalized-dose methodology to better characterize systematic errors in MBDCA implementations, using the TG-186 generic applicator and two commercial algorithms as a test case.

Methods and Materials

TG-186 test case 4 data were used with the ^{192}Ir source centered in the applicator. Dose distributions from BrachyVision ACUROS (BVA) and Oncentra ACE were compared against Monte Carlo (MC).

For each algorithm, three-dimensional dose matrices were normalized to a point 5 mm beyond the applicator surface along the source central axis, consistent with the reference point used for global dose-difference metrics in prior work. This normalization enabled voxelwise comparison of normalized isodose values as a coverage-based assessment. Conventional local and global dose-difference distributions were also reconstructed and compared with the proposed normalized-dose method.

Results

In unshielded regions, BVA isodose lines closely matched those from MC. In shielded regions, dose discrepancies of up to ~20% were observed near the distal and proximal ends of the shielding material, with the largest deviations (up to ~50%) at the apical tip and across the central lumen.

ACE showed discrepancies of up to ~60% in both centrally shielded and some unshielded regions. When interpreted solely through local or global dose-difference maps, these discrepancies appeared unrealistically high or low, respectively, making their impact on coverage difficult to judge.

The normalized-dose comparison provided a more intuitive visualization of where coverage could be compromised.

Conclusions

The normalized-dose distribution methodology offers a practical way to localize and interpret systematic dose discrepancies in MBDCAs for shielded applicators and complements conventional local and global dose-difference metrics during the transition from TG-43 to model-based calculations.

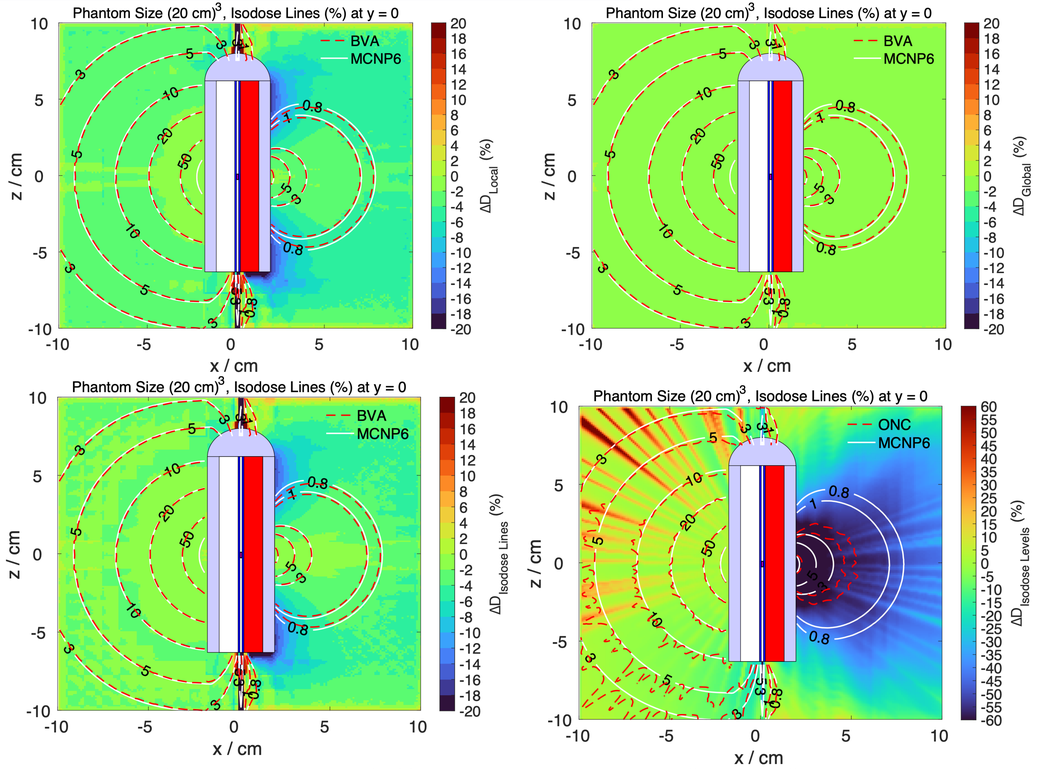

Figure. Comparison of MBDCAs versus Monte Carlo (MC) for the TG-186 generic applicator using different dose-difference metrics. **Upper left**: Coronal view of the TG-186 generic applicator dose distribution with corresponding local dose-difference map, D_{Local}(%), for BVA vs MC. **Upper right**: Same case reconstructed with the global dose difference metric, D_{Global}(%), for BVA vs MC. **Bottom left**: Normalized isodose-level (line) comparison $D_{Isodose}$(%) for BVA vs MC, highlighting coverage-based differences after normalization at 5 mm beyond the applicator surface along the source axis. **Bottom right**: Normalized isodose-level (line) comparison $D_{Isodose}$(%) for Oncentra ACE (ONC) vs MC. The normalized isodose-based approach provides a more intuitive visualization of where clinically relevant coverage may be compromised than either local or global dose-difference maps alone.

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