

Absorbed dose rate algorithm comparison in ^{177}Lu -based molecular radiotherapy dosimetry.

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Introduction: Calculation of absorbed dose rate (ADR) is an important step in the Clinical Dosimetry Workflow (CDW). Local energy deposition (LED) and voxel S value (VSV) convolution are the most common algorithms used in current commercial software. Monte Carlo (MC) simulations are not as widely used due to their long calculation times but represent the ground truth for ADR calculation benchmarking.

Methods: This work compares LED and DVK convolution against MC simulation. Data was collected during 3D dosimetry of the first two cycles of a group of five patients who received Lutathera® treatment at ICM (10 clinical dosimetry studies with four time points each). ADR calculations were carried out with and without density correction. Dosimetry was performed using the open-source software OpenDose3D. For each clinical dosimetry study, ADR calculation was performed using the Monte Carlo code GATE, in homogeneous medium or based on CT-derived density maps. To ensure a more comprehensive assessment, the study incorporated 3D gamma index maps for ADR comparisons Figure 1, going beyond mean value comparisons.

Results: Results in homogeneous soft tissue show that LED underestimates ADR due to cross-irradiation. Furthermore, these results allowed verifying convolution approach with VSV Figure 2. To assess the impact of heterogeneities on energy deposition, an analysis was conducted using MC results in homogeneous and heterogeneous media. Results with density correction in soft tissue show 3%-5% of LED underestimation, whereas convolution showed a better agreement, with slight differences less than 1%. However, the ADR comparisons for bone marrow demonstrated higher underestimation from 6%-25%.

Keywords: Absorbed dose rate algorithms, OpenDose3D, ^{177}Lu -DOTATATE therapy.

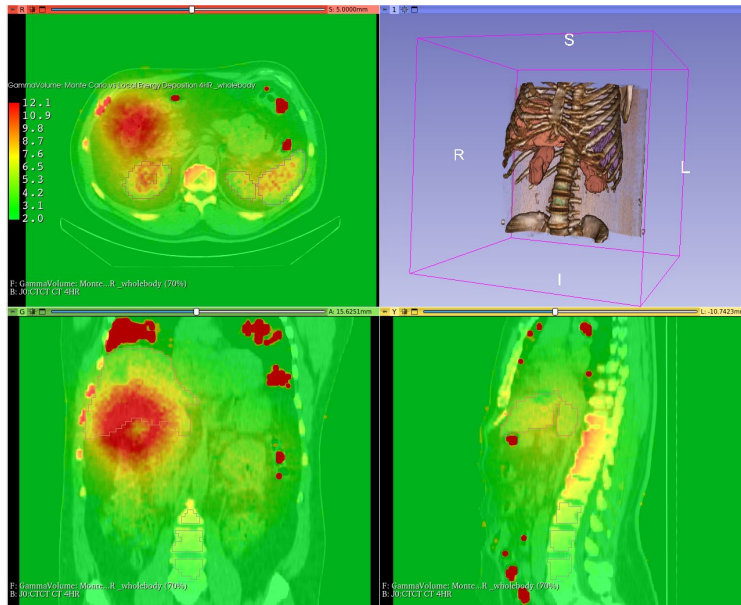


Figure 1: 3D gamma index map computed between Monte Carlo and LED ADR images. 2% of absorbed dose difference criteria and 5 mm of distance to agreement was used as criteria. Values were scaled by 100 for better representation.

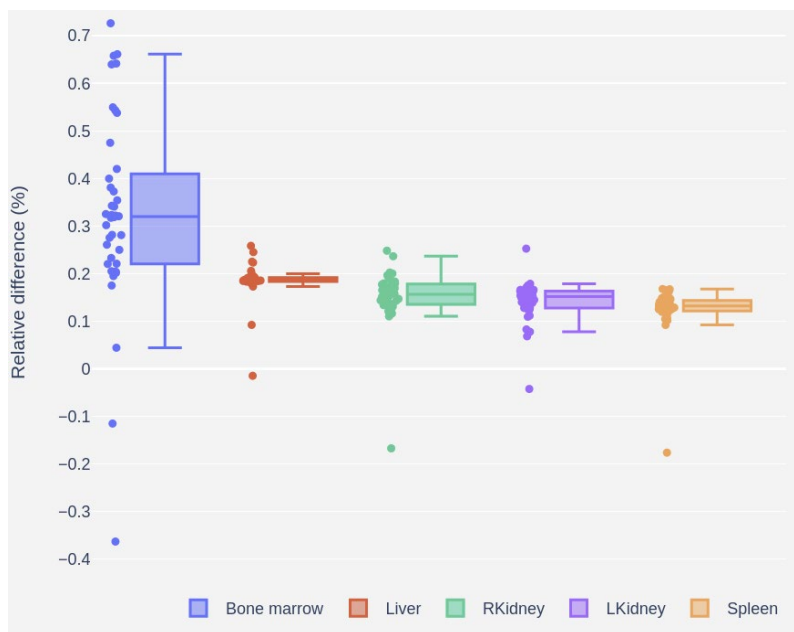


Figure 2: Comparison between VSV convolution and Monte Carlo simulation for OAR in homogeneous soft tissue. 10 clinical dosimetry studies with four time points each = 40 ADR per OAR.