Clinical Dosimetry Workflow comparison with OpenDose3D in molecular radiotherapy

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Background: The aim of this study was to compare three different Clinical Dosimetry Workflows (CDWs) within one software, OpenDose3D, to explore the impact of specific methodologies and workflow variations on absorbed dose (AD) calculations during PRRT with 177Lu.

Methods: Images from 5 patients (4 SPECT/CT time-points per patient) from the first cycle of Lutathera® treatment were used. The dataset included five organs at risk (segmented automatically [Wasserthal et al. 2023] based on the CT) and 14 tumours (segmented on the SPECT images, keeping each tumour volume constant between time points).

Three CDWs were compared:

- Activity CDW (ACT): Segmentation at the first time-point and rigid registration (on the whole field of view – FOV) are performed, keeping the VOI constant. Cumulated activity in VOI is calculated, then the absorbed dose is computed using the Local Energy Deposition (LED) assumption on the average mass of the VOI.
- Absorbed Dose Rate (ADR): Segmentation and registration are performed as in ACT. Absorbed dose rates are calculated first at the voxel level using LED, averaged on the VOI and integrated to provide the absorbed dose.
- Automatic (AUTO): no registration is performed, and segmentation is done at each time point. The rest of the CDW is identical to ADR.

ACT is the most conventional approach, ADR is seen in some clinical dosimetry workstations, and AUTO is an attempt to simplify the CDW and decrease operator dependent sources of variation.

Results: Box plots were used to visualize the spread of absorbed dose values across patients and CDW. Initial results showed good agreement between ADR and ACT for OAR and tumours (between -4% and 4%) (Figure 1). ACT consistently reported lower AD, possibly due to a different way of computing the AD. ADR and AUTO presented significant differences in AD values (Figure 2). ADR consistently reported lower ADs, attributed to registration and VOI propagation issues. Aligning small tumours in the ADR CDW proved challenging.

Conclusion: Results highlighted the impact of registration and VOI propagation on the resulting absorbed doses. They suggest performing registration on each VOI rather than on the whole FOV. However, not knowing the ground truth limits the value of these comparative studies.

Keywords: Clinical dosimetry workflow, OpenDose3D, 177Lu-DOTATATE therapy.

References:

Wasserthal et al. arXiv. https://doi.org/10.48550/arXiv.2208.05868.

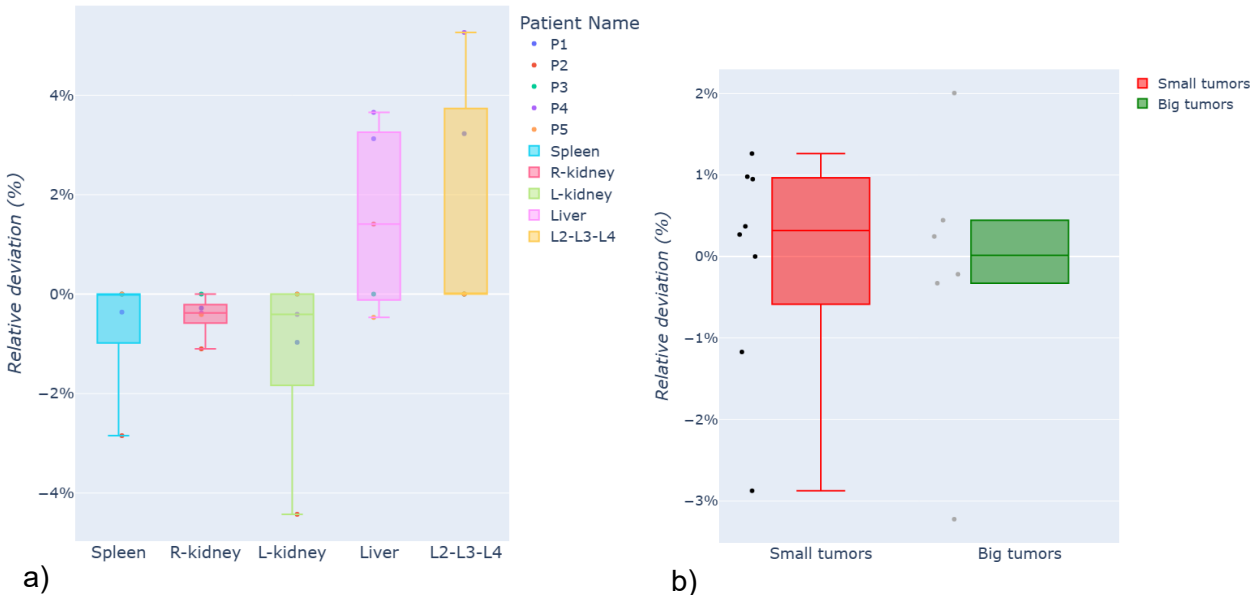

Figure 1: Relative deviation between ACT and ADR for OAR (a) and tumours (b)

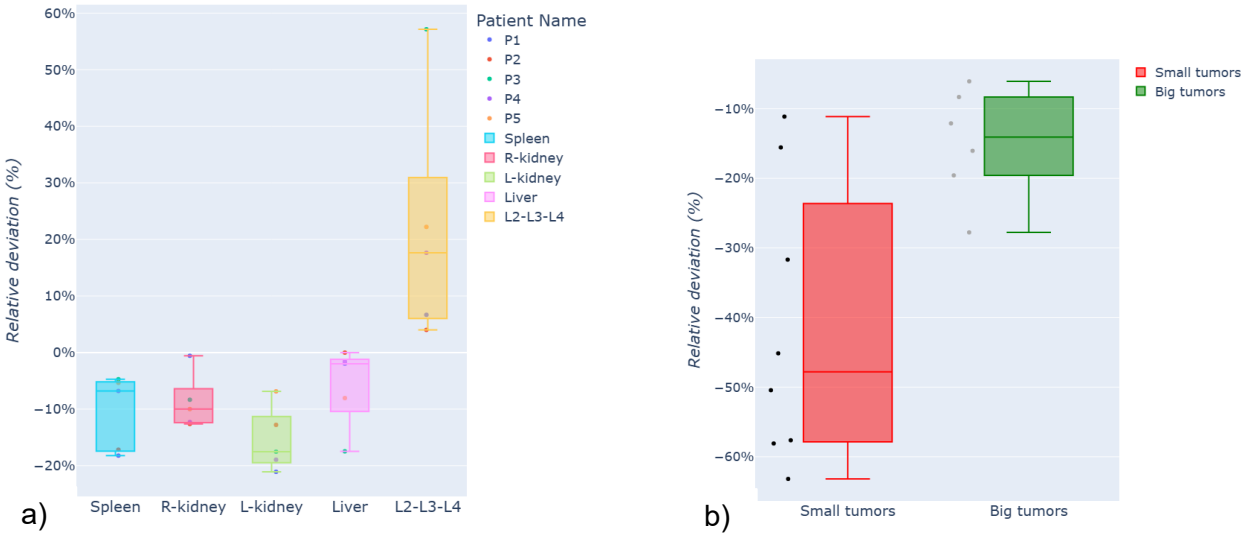

Figure 2: Relative deviation between ADR and AUTO for OAR (a) and tumours (b)