Validation of the "collapsed-cone superposition" for whole-body dosimetry in 177Lu-PSMA-617 therapy

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Résumé

Introduction: (177Lu)Lu-PSMA-617 therapy is a promising treatment for patients with metastatic castration-resistant prostate cancer (mCRPC). An accurate dosimetry technique is crucial for assessing the risk-benefit ratio of this treatment. The introduction of 360◦ CZT gamma cameras enables the development of personalized dosimetry using whole-body single photon emission computed tomography and computed tomography (SPECT/CT) data. SimpleDose (1), is an automated whole-body dosimetry software based on collapsed-cone superposition (CCS) approach (2,3). This study aims to validate CCS approach for whole-body dosimetry in (177Lu)Lu-PSMA-617 therapy by comparing it to Monte Carlo (MC) simulations at the organ, lesion, and voxel levels.
Material and Methods: Thirty patients with mCRPC were included in this study. SPECT/CT images were acquired after the infusion of (177Lu)Lu-PSMA-617 therapy on a VERITON-CT 200 (Spectrum Dynamics®, Caesarea, Israel). SimpleDose was used to generate dose rate map (mGy/h) from a single SPECT/CT scan. The dosimetry process is based on the CCS approach, which takes into account tissue densities in a rapid manner using dose-point kernels scaled to densities. Organ and lesion delineation was automated using the nnU-Net V2 neural network (4). MC simulations were performed using GATE 10 (5). The comparison was performed at organ, lesion and voxel levels.

Results: The organ wise comparison between CCS and MC showed a median (IQR) absolute percentage error of 3.92 (2.22), 1.11 (0.66), 0.78 (0.72), 3.13 (1.38), 4.76 (4.00), 2.74 (2.92), 3.06 (2.76), 3.10 (1.22) for bone marrow, kidneys, liver, lungs, pancreas, salivary glands, spleen and lesions, respectively, with no significant organ-level differences ($p > 0.70$). Voxel-level errors were mostly $< 2\%$. Median computation time was 24.5 seconds for CCS versus 6.8 hours for MC.

Conclusions: CCS showed high agreement with MC with greater computational efficiency, demonstrating its clinical potential for whole-body dosimetry.

References

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The authors declare no conflicts of interest.

Mots-Clés: Prostate Cancer, (177Lu)Lu PSMA 617, Dosimetry, Collapsed Cone Superposition, Monte Carlo.