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# First Voxel-wise Prediction of Post-therapy Dosimetry for 177Lu-PSMA I&T Therapy

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Introduction:
PSMA-directed radioligand therapy (RLT) has become one of the effective treatment options for metastatic castration-resistant prostate cancer (mCRPC). However, individual treatment planning is still not feasible as it is for the external beam radiotherapy. Our group has presented the first organ-based research in the prediction of post-therapy dosimetry in SSRMP 2018. However, an organ-based approach is unable to reveal the heterogeneity of dose distribution and therefore is not sufficient for the realization of treatment planning. In this study, we propose the first approach for voxel-wise prediction of post-therapy dosimetry via generative adversarial networks (GANs) from pre-therapy positron emission tomography (PET) images.
Materials and Methods:
30 patients with mCRPC treated with 177Lu-PSMA I&T RLT were retrospectively included in this study. Only those cycles with 68Ga-PSMA-11 PET/CT directly before the treatment and at least 3 post-therapeutic SPECT/CT dosimetry imaging were selected. Totally 48 treatment cycles were considered for this proof-of-concept study. 3D RLT Dose GANs were developed with a 3D U-net generator and a convolutional neural network (CNN) based discriminator. An advanced dual-input-model was designed to incorporate both information from PET and CT, for the purpose of anatomical coregistration. Both voxel-wise content loss alongside image-wise loss were taken into account for better synthesis performance. K-fold cross validation was applied to verify the trained network.
Results:
The proposed 3D RLT Dose GANs achieved the voxel-wise mean absolute percentage error (MAPE) of 17.56%±5.42%. The dual-input-model was able to synthesize dose maps with comparable accuracy while preserving anatomical consistency, which achieved a MAPE of 18.94%±5.65%.
Conclusions:
Our experimental results demonstrate the capability of artificial intelligence to estimate voxel-wise post-therapy dosimetry both qualitatively and quantitatively, may provide a practical solution to improve the dosimetry-guided treatment planning for RLT.

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