

Image Reconstruction and Target Delineation on PET/CT for Radiotherapy Treatment Planning

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PET/CT is a molecular imaging technique, providing fundamental information for cancer diagnosis and staging. For patients undergoing external beam radiotherapy, the PET/CT scanning is an essential part of the imaging for radiotherapy planning. The most widely used tracer for is [¹⁸F]-FDG, however amino acid and hypoxia tracers are used as well.

In the radiotherapy treatment planning, both the target volumes and the risk volumes are delineated on the acquired images. The target volumes are defined according to ICRU guidelines and consist of GTV (gross tumour volume), CTV (clinical target volume) and PTV (planned target volume).

- » PET information contributes to the GTV delineation and improves its consistency between the observers. However, PET does not solely define the GTV - information from CT, MR and clinical examination plays an important part in this process as well.
- » CTV is an extension of the GTV, including areas with risk of microscopic disease spread. PTV is an extension of the CTV – the CTV-PTV margin is based on the uncertainties in the radiotherapy process.
- » CT images are necessary to perform dose calculation for radiotherapy - the tissue density information, expressed in Hounsfield units can be converted to electron density and hence used in the dose calculation of the treatment plans.

Optimal image quality in PET is essential and following the EANM guidelines for tumour imaging is recommended. Metrics like maximum or peak standard uptake values (SUV_{max} or SUV_{peak}) are used to describe the findings. PET avid volumes are typically delineated based on percentage of SUV_{max} or SUV_{peak} thresholds.

Different methods of image reconstruction, together with choice of contouring (visual, threshold based or combined) can impact the delineated volume and hence the radiotherapy treatment plan. In the thorax area, the respiratory motion needs to be accounted for in order to reduce the uncertainties in the apparent tracer uptake and hence tumour delineation.

The often heterogeneous tracer uptake in the tumour can be used to biologically adapt the treatment plans: subvolumes of higher tracer uptake will be dose-escalated and hence receive higher radiation dose. However, dose-escalated treatments are not yet clinical routine, but part of radiotherapy clinical trials.

References:

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