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Impact of 18FDG-PET/CT on biological target volume (BTV) definition for treatment planning for non-small cell lung cancer patients

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Purpose: To test the feasibility of FDG based PET/CT data on target volume delineation in radiotherapy treatment planning of NSCLC patients, and impact of these outlined biological target volumes (BTV) for IMRT treatment.

Materials and methods: Patient diagnosed with non-operable NSCLC in the right upper lobe had a 3D conformal planning based on CT data with our hypo-fractionated regimen of 52.5 Gy in 15 fractions. Planning was redone with fusion of PET/CT data and 3D CT. Three target volumes were created: necrotic BTV (same as seen in CT), proliferating BTV (based on PET signal to background ratio 1:3) and hypoxic BTV (based on PET signal to background ratio of 1:19, believed to be related to anaerobic glycolisis inefficacy in ATP production). Two IMRT plans were created based on these three BTVs with the intention of giving different doses to each BTV. The first plan ("conservative plan") delivers 52.5 Gy to the necrotic BTV and 65 Gy to the hypoxic BTV. The second plan ("radical change") delivers 30 Gy to the necrotic BTV, 52.5 Gy to proliferating BTV and 65 Gy to hypoxic BTV.

Results: The use of BTVs in IMRT plan seems attractive because it increases dose to targets considered to need higher doses. It reduces considerably dose to the heart and spinal cord, organs considered to limit dose escalation approaches in NSCLC treatment. However, lower dose to the spinal cord comes at the expense of slight increase in the contra lateral lung dose, still way below V20 limit.

Conclusions: The "conservative"IMRT approach can be understood as a PET/CT based concomitant boost to the tumor expressing the highest FDG uptake. The "radical"IMRT planning implies a deviation from the traditional uniform dose target coverage approach, with the intention of achieving a better surrounding tissue sparing and ultimately allowing for dose escalation protocols in NSCLC patients. Several issues should be considered before treating patients using PET/CT based BTVs: tumor motion (patients could be scanned with 4D PET/CT and treated with gated RT), dose calculation accuracy with Monte Carlo based treatment planning algorithms, and specific tumor metabolic activity should be imaged with better radiopharmaceutical markers. We also intend to present four current recommendations for tumor outlining using PET: Qualitative Visual Method (Ciernik), CTV = 2.5 SUV units (Paulino and Johnstone), CTV = 40 % Iso of max Uptake Value (Erdi) and Linear SUV threshold function method (Black).

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