Purpose: PET imaging with FDG has been proposed for accurate tumor delineation in radiotherapy. Different methods have been proposed to segment tumors using PET-images. However, their sensitivity to imaging parameters variations is usually neglected. This work compares delineation techniques and investigates their sensitivity to imaging parameters.

Methods: PET/CT scans of twenty patients were acquired in both 2D and 3D mode. Ten images per patient were created by varying parameters in the reconstruction algorithm within clinical settings. Tumor volumes within each image were segmented using the techniques of thresholding (40% of maximum standardized uptake value), gradient-based (local-maximum gradient), and region-growing (nearest-pixel within a fixed phantom-based-cutoff). Percent volume change was used to assess the tumor volume sensitivity to imaging parameters for each segmentation technique.

Results:Tumor volumes were largest (29.2±46.2cm3) using gradient-based and smallest (20.1±36.6cm3) for thresholding. Thresholding was least sensitive to varying imaging parameters while region growing presented the largest volume discrepancies. Across the ten combinations of acquisition/reconstruction parameters variations, the volume differences were 10%±9% (range [-45%,60%]), 18%±15% (range [-70%,75%]) and 24%±24% (range, [-80%,140%]) for thresholding, gradient-based and region-growing respectively. Thresholding showed least sensitivity when iteration number and grid size were varied; however gradient-based was least sensitive to post-reconstruction-filter variation.

Conclusions: Phantom-based analysis showed small volume difference between segmentation techniques. However, analysis of patient images showed large range of volume variations to imaging parameters, even with more sophisticated segmentation methods, such as gradient-based and region-growing. Sensitivity studies of segmentation algorithms against imaging parameters must precede acceptance and use in the clinical environment, especially if these techniques are used in multi-centre clinical trials where inconsistency in tumor definition could have an effect on treatment outcomes.