Standardization of amino-acid PET windowing for GTV definition in recurrent glioblastoma

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Purpose or Objective: With its high sensitivity and specificity compared to MRI, amino-acid PET is increasingly used for diagnosis and radiotherapy treatment planning in recurrent glioblastoma. Defining the exact tumor extent is exceedingly crucial for planning of high-precision radiation (SRT, IGRT). Up to date, no standard for a visual or (semi-)automatic method for GTV delineation in amino-acid PET exists. In the present study, we investigated whether pre-defined PET windows would lead to a more consistent contouring of the target and - as a model with MRI-defined ground truth - normal tissues among observers.

Material and Methods: Pre-reiradiation imaging data (MRI and PET-PET) of 17 patients with recurrent glioblastoma were retrospectively evaluated. Two different pre-set window levels were created for PET-PET data, either normalized to SUVmax or normalized to the SUVmean of the contralateral non-tumor bearing hemisphere (SUVmean contra). The GTV was delineated in both data sets by 5 observers (radiation oncology and nuclear medicine specialists). Additionally, normal tissue with (superior sagittal sinus or lacrimal gland) and without physiological PET uptake (eye and lateral ventricle) were contoured. A reference contour for normal tissues was delineated in contrast-enhanced T1 MRI, and overlap volume (OV) and Kappa index (KI) were calculated for each structure.

Results: GTV volumes were larger by trend when normalized to SUVmean contra, but not significantly different between the two PET image normalization methods (18.72 ± 17.44 ml for SUVmean contra vs. 14.68 ± 12.34 ml for SUVmax, p=0.41). Linear correlation of the response between PET and MRI was 0.7, indicating that the LNs typically respond a little faster than the PT. However, within a patient, several involved lymph nodes (LN) were delineated and irradiated. It is currently, however, unknown if all intrathoracic lesions within the same patient demonstrate the same metabolic response. The purpose of this study was therefore to investigate the correspondence in response rate of the PT and involved LNs.

Conclusions: Normalization on the SUVmean of the contralateral hemisphere in PET-PET images helps to reduce inter-observer variability in the visual delineation of the GTV in patients with recurrent glioblastoma. However, neither improvement nor difference in the consistency of normal tissue delineation, as a model with MRI-defined ground truth, between the different windows was seen.

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Metabolic response between primary tumor and lymph nodes in NSCLC patients during treatment course

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Purpose or Objective: Repetitive functional imaging during the course of irradiation is a promising method to identify non-small cell lung cancer (NSCLC) patients that have poor or favourable response to radiotherapy [1]. In locally advanced lung cancer patient, the primary tumour (PT) and involved lymph nodes (LN) are delineated and irradiated. It is currently, however, unknown if all intrathoracic lesions within the same patient demonstrate the same metabolic response. The purpose of this study was therefore to investigate the correspondence in response rate of the PT and involved LNs.

Material and Methods: Eight locally advanced NSCLC patients included in an ongoing prospective clinical trial (NCT02315053) for repeat quantitative evaluation of tumour metabolism (using FDG-PET) weekly during treatment were analysed. Patients were treated with concurrent chemoradiation (CCRT) with curative intent, in 24 fractions of 2.75 Gy combined with daily cisplatin 6 mg/m2 with an overall treatment time of 32 days. All patients underwent a PET/CT for treatment planning and weekly low dose FDG PET/CT scans of the thorax in treatment position prior to the daily chemotherapy and radiotherapy administration. For the PT and each treated LN with a baseline SUVmax (median 3 LNs per patient; range 2-4), the SUVmax was normalized separately to the baseline value at the start of treatment. Consistency in the response between PT and LNs was evaluated by Bland-Altman analysis over the cohort (corrected for the number of lymph nodes per patients and excluding the baseline used for normalization) as well as total least squares (linear regression with the PT for each LN separately).

Results: Considerable variability in metabolic response for individual time points was observed in the pooled analysis of all patients (Fig 1a) with Bland-Altman limits of agreement (LA) of 46% and a bias of 10%. Despite these LA, the correlation in the response between PT and LN was reasonably high with a median value of 0.86 with an interquartile range of 0.21. The median slope of the regression analysis was of 1.1 with an interquartile range of 0.7, indicating that the LNs typically respond a little faster than the PT. However, within a patient, several involved lymph node stations exhibited a considerably different response as illustrated in Fig1b.

Conclusion: Normalization of the SUVmean of the contralateral hemisphere in PET-PET images helps to reduce inter-observer variability in the visual delineation of the GTV in patients with recurrent glioblastoma. However, neither improvement nor difference in the consistency of normal tissue delineation, as a model with MRI-defined ground truth, between the different windows was seen.