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-)automated 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 tumor and – as a model with MRI-defined ground truth - normal tissues among observers.

Material and Methods: Pre-reirradiation imaging data (MRI and FET-PET) of 17 patients with recurrent glioblastoma were retrospectively evaluated. Two different pre-set window levels were created for FET-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 FET 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 SUVmax contra vs. 14,68 ± 12,34 ml for SUVmean, p=0,41). Linear regression of inter-observer variability showed a significantly better agreement of the GTV contours when PET images were normalized to SUVmean contra (t=3,5). The intra-method comparison of PET data normalized to SUVmax or SUVmean contra showed the highest consensus for GTV (OVmean=0,5 and 0,52 and KI=0,64 and 0,66, respectively), whereas the lacrimal gland was the structure with the least congruency (OVmean=0,37 and 0,42 and KI=0,46 and 0,52, respectively). There was no overall significant difference between both PET windows (OVmean p=0,83;KI p=0,87).

Conclusion: Normalization on the SUVmean of the contralateral hemisphere in FET-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.
Conclusion: A reasonable high correlation in response during chemoradiation between the primary lung tumor and lymph nodes was observed, but a large inter- and intra-patient variability was observed. These preliminary results suggest that treatment plan modification based on metabolic treatment response should be tailored to individual lesions.


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Improving Tumor Response Assessment using DWMRI corrected by reversed gradient method and DCEMRI
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Purpose or Objective: Apparent diffusion coefficient (ADC), derived from diffusion-weighted MRI (DW-MRI) is a promising assessment method during radiotherapy treatment, but geometric distortion is its main disadvantage. This study investigates the use of the reversed gradient method (RGM) in DW-MRI for reduction in geometric distortion and vascularization from dynamic studies of MRI (DCEMRI), as a surrogate measure of oxygenation in H&N cancer.

Material and Methods: We studied the variation of ADC of three oropharynx cancer patients included in ARTFIBIO project. Three functional imaging scans were performed before treatment: PET/CT, DWMRI and DCEMRI; two MRI scans during the treatment; and three months after the treatment, the initial studies were repeated. Geometric distortion of DWMRI was corrected using RGM (SPM8 software, HySCO options). DCEMRI analyses were performed using Dynamika® v4.0 (www.imageanalysis.org.uk). Registration and mutual information were calculated with ARTFIBio tools. Mutual information of T2-weighted and DW-MRI was calculated for corrected and uncorrected DW-MRI. Initial Rate Enhancement (IRE) from DCEMRI was selected as a possible biomarker associated with vascularization / hypoxia.

Results: Table shows the increment in mutual information for the initial ADC maps of the three patients when correcting by RGM. For two first patients, a large increment is observed and for the third patient, although the mutual information didn’t show it, the visual appreciation is quite relevant. In Figure A, the visual improvement of corrected images can be appreciated.

We also measured the variation of ADC during the treatment (Figure B), and three months later. The colour in the dots shows the initial IRE values in arbitrary units. As the dose is delivered, best-vascularized dots move to the upper part of the cloud corresponding to different instants along the treatment.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Anterior shift</th>
<th>Posterior shift</th>
<th>Corrected by Reversed gradient</th>
<th>Anterior shift</th>
<th>Posterior shift</th>
<th>Corrected by Reversed gradient</th>
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</thead>
<tbody>
<tr>
<td>#1</td>
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<td>0.872</td>
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<td>0.381</td>
<td>0.445</td>
<td>0.730</td>
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<tr>
<td>#3</td>
<td>0.439</td>
<td>0.548</td>
<td>0.548</td>
<td>0.545</td>
<td>0.522</td>
<td>0.567</td>
</tr>
</tbody>
</table>

Conclusion: RGM improves registration and provides accurate ADC in tumors. We suggest correction of distortion with the RGM should form part of an imaging method for treatment response using ADC to assess tumor response or tumor cell density variation with treatment in cancer patients, and DCEMRI can be useful for characterizing hypoxia in H&N cancers. Supported by ISCIII Grant DTS14/00188

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Optimization of gross tumour volume definition in lung-sparring VMAT for pleural mesothelioma
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