PO-0683
Multiple training interventions improve PET/CT based target volume delineation in NSCLC RTP

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Purpose or Objective: PET/CT based radiotherapy planning (RTP) has been shown to improve the consistency of target volume delineation (TVD) in lung cancer radiotherapy, hopefully leading to improved local control. This study assesses the impact of a standardized delineation protocol and multiple training interventions on PET/CT based TVD in NSCLC.

Material and Methods: Over a one year period, nuclear medicine physicians (NAP) and radiation oncologists (RO) with limited experience in PET/CT based TVD from nine different countries participated in a multicenter study. The first training intervention included a three-day training course, consisting of three contouring assignments which formed the basis of a teaching discussion with the aim of identifying and correcting misinterpretations of practical guidelines, and various lectures on PET/CT based RTP. The second training event contained detailed individual feedback reports about previous performed contouring assignments and a webinar on PET/CT based TVD in NSCLC. Eleven teams consisting of a RO and NAP performed joint gross tumor volume (GTV) delineation of the primary tumor as per a standardized delineation protocol. In-house developed software called Big Brother recorded any user-software interaction, consequently allowing visual inspection of delineation strategies. Six delineation cases were performed before, during and after the training program and were compared with agreed expert contours (GTVexp) to assess delineation performance.

Results: Following the three-day training course overall concordance indices for 3 repetitive cases increased from 0.57±0.11 (SD) to 0.66±0.10. Observer volumes were larger after the training and miss of GTVexp was significantly reduced from 79.01±52.35 cc (SD) to 42.86±38.08 cc. Results are summarized in table 1. After further feedback and the webinar overall concordance indices for another 3 repetitive cases increased from 0.64±0.10 (SD) to 0.80±0.08. A reduction of GTVexp miss from 78.89±44.51 cc (SD) to 30.87±20.26 cc was observed.

Table 1. Comparison of results from contouring the GTV before and after the first training event, and before and after a complete training in use of a standardized delineation protocol. Mean of median concordance indices between the observed GTV and expert GTV.

<table>
<thead>
<tr>
<th>Contours before and after the three-day training course</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert Volume (cc)</td>
<td>288.38 ± 46.28</td>
<td>272.73 ± 42.43</td>
</tr>
<tr>
<td>Median Group Volume (cc ± 50)</td>
<td>84.91 ± 11.97</td>
<td>80.49 ± 12.33</td>
</tr>
<tr>
<td>Miss (cc ± SD)</td>
<td>0.64 ± 0.10</td>
<td>0.80 ± 0.08</td>
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Conclusions: Following a training intervention, PET/CT based TVD in NSCLC RTP using a standardized delineation protocol led to significant improvement in delineation performance. A greater improvement in TVD with the use of multiple training events as compared to a single training event was observed.

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PO-0684
Does the dose to heart affect survival in NSCLC patient treated with definitive Radiotherapy?

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Purpose or Objective: High radiotherapy dose to the heart increase the risk of cardiac morbidity and death in early stage breast cancer and lymphoma. Recent reports (1,2) have indicated that an association between overall survival and dose to heart (e.g. V5 for the heart) are observable after radiotherapy of NSCLC patients as well. The objective of this study was to evaluate if overall survival was affected by high V5 to the heart in NSCLC patients treated with definitive radiotherapy (RT).

Material and Methods: In a single institution, 297 NSCLC patients were treated consecutively with definitive RT from 2001-2007 with at least 60 Gy. Concomitant chemotherapy was not part of the standard treatment initially but became a treatment option later in the study period (weekly docetaxel). RT was delivered as 3D RT without elective nodal irradiation. No constraint on dose to the heart was applied during treatment planning. The heart was delineated retrospectively and heart doses were extracted from the treatment planning system (mean heart dose (MHD) and V5). Patients were stratified in two groups depending on their heart dose being above or below the median value. Survival test was performed using Kaplan Meyer and log-rank test. All patients were followed to death.

Results: Patient and treatment characteristics are summarized in table 1. Median follow-up was 127 months. The overall median survival was 19.1 months with 1, 2 and 5 year survival of 69%, 41%, and 17%, respectively. Median V5 for the heart was 49%. No association between survival and heart dose were observed (p=0.29 see Fig 1). The same was true when including smoking, gender, and concomitant chemotherapy as strata in the analyses. Median MHD was 14 Gy. Survival for patients with MHD ≥14 Gy or <14 Gy was 17% and 21%, respectively (p=0.83).

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Conclusion: This study did not show that heart V5 or MHD had a negative effect on survival for NSCLC patients treated with definitive radiotherapy. This study differs from recently reported studies by having a longer follow-up. On the other hand, concomitant chemotherapy was only used in 12% of the patients in this study. The main goal for NSCLC patients is still to achieve better loco-regional control. However, if dose escalation is performed with doses significant above those in the present study, strict dose constraints to the heart might still be advisable based on experience from patients with breast cancer.

PO-0685
Is PET imaging a reliable target for dose painting by numbers in lung cancer?

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Purpose or Objective: Since many years, PET has been foreseen as a promising candidate for dose painting. However, the lack of biological specificity of tracers together with the low spatial resolution could call PET into question as a reliable target for voxel-based dose prescription.

To address this issue, we analysed FDG (tumor burden) and FAZA (hypoxia) PET uptake distributions in lung tumors in terms of biological specificity, spatial resolution, and spatiotemporal evolution.

Material and Methods: Twelve patients with locally advanced lung carcinomas treated with concomitant chemo-radiation therapy were prospectively included. These patients underwent 4D PET/CT (FDG and FAZA) with audio coaching at 3 time-points: prior to radiotherapy, and in the second and the third weeks of treatment. All images were reconstructed in their time-weighted mid-position (MidP). At each time-point, CT-based rigid registration was performed between FDG and FAZA MidP PET/CT while CT-based deformable registration was performed between per- and pre-treatment images. In order to be compared with native FDG images, simulated PET images (PETsim) were created. To this end, tumors were segmented on FDG images (GTVFDG) using a gradient-based method relying on watershed and clustering. Subsequently, binary images were generated (uniform activity inside and null activity outside GTVFDG) and blurred using a Gaussian kernel of 8-mm FWHM. PET SUV within the GTV were pairwise compared on a voxel-by-voxel basis using Spearman’s correlation (rs) between:
- FDG and FAZA images, to assess their respective specificity
- FDG and PETsim images, to assess to which extent the blurring effect linked to the limited spatial resolution impacts the observed tracer distribution
- per- and pre-treatment images, to assess the spatiotemporal evolution of the uptake distribution during radiation therapy

Results: At each time point, FDG and FAZA SUVpeak showed high correlation (r = 0.78) (Fig. 1A). FDG and FAZA voxel-by-voxel comparison showed high correlation (rs = 0.78 ± 0.13). This correlation was even higher when the 50% more hypoxic tumours were considered (FAZA SUVpeak = 1.83 ± 0.32 ; rs = 0.80 ± 0.05), compared to the 50% less hypoxic (FAZA SUVpeak = 1.17 ± 0.22 ; rs = 0.69 ± 0.16) (Fig. 1B).

Similarly, high correlation was found between FDG and PETsim images (rs = 0.78 ± 0.14).

Finally, the uptake distribution was spatially stable through imaging sessions for both tracers (FDG: rs = 0.86 ± 0.09; FAZA: rs = 0.82 ± 0.11). All results were significant (p < 0.01).

Conclusion: FDG and FAZA PET images share similar uptake patterns, even more for hypoxic tumours. In addition, FDG and FAZA uptake distribution were stable over treatment time. Blurring caused by the limited spatial resolution seems to be the main driver of the observed uptake distributions, as...