PO-0786
Can we derive the radiation target volume for moving lesions from 3D-PET?
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Purpose/Objective: In the era of image-guided high-dose radiation therapy, accurate and precise definition of the target volume is indispensable. Besides computed tomography (CT) and magnetic resonance imaging (MRI), positron emission tomography (PET) using ¹⁸F-fluorodeoxyglucose (FDG) has found its way into routine clinical practice providing functional information, in particular for lung cancer [1]. With modern scanners, the acquisition of time-resolved, i.e., 4D-images is feasible. However, a comparative study of target volumes derived by 3D- versus 4D-FDG-PET/CT for early and locally advanced tumours subjected to internal motion (e.g., respiration in lung or liver) is thus far lacking. As a model for these moving lesions, we compared manually delineated and (semi-)automatically segmented 3D/4D-PET/CT-scans in 18 pulmonary lesions eligible for stereotactic ablative body radiotherapy (SABR).

Materials and Methods: For 11 patients, 12 FDG-PET/CT-scans with 18 pulmonary lesions were available. Using Artiview (Aquilab®) and Rover (ABX®) software, four observers independently delineated the gross tumour volume (GTV) on the 3D- and 4D-PET/CT scans, respectively, and the FDG-PET-scans were (semi-)automatically segmented using the Homburger method (HOM), the Rover algorithm (RO), and the threshold-based methods 15% and 40% of the SUVmax. By summation of the 4D-GTVs an ITV was created, and the ITV-CT contoured by at least 2 of the observers (ITV-CT-Ref) served as golden standard. Volumes and paired t-test index (KI) were calculated and compared using GraphPad Prism and R-software.

Results: The GTV on 3D-CT was statistically significantly smaller than the ITV-CT-Ref (5.3 cc vs 9.8 cc, p=0.0003). The automatically segmented 3D-GTV-PET volumes were, apart from 3D-GTV-PET-15%, statistically significantly smaller than the ITV-CT-Ref (p=0.0002). Conversely, the ITV-CT-PET-15% was statistically significantly larger than the ITV-CT-Ref (p=0.0002), whereas there was a statistically significant difference between ITV-CT-Ref and the average ITV-PTET-40% (7.0 cc), ITV-PET-HOM (8.2 cc), and ITV-PET-RO (7.4 cc). The ITV-CT-Ref and ITV-PET-Ref (6.5 cc) did not statistically significantly differ (p=0.0542).

The average KI for the individual observers was 0.78-0.92 for the ITV-CTs and 0.68-0.71 for the ITV-PETs. The average KI for the (semi-)automatically segmented ITV-PETs were: 0.65 (ITV-CT-PET-HOM), 0.63 (ITV-CT-PET-RO), 0.55 (ITV-PET-15%), and 0.67 (ITV-PTET-40%). These results were irrespective of the primary tumour volume, tumour motion and SUVmax.

Conclusions: For target volume delineation of moving lesions, an ITV based on a 3D-FDG-PET-scan is no surrogate for an ITV based on 4D-imaging. In addition to the standard use of 4D-CT-scans, the value of more advanced (semi-)automatic segmentation methods for accurate, observer-independent target volume definition on 4D-PET ought to be further elaborated.

Reference:

PO-0787
CT-based geometric dose escalation as an alternative to PET-based dose painting by numbers
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Purpose/Objective: To be relevant for clinical practice, PET-guided dose painting by numbers (DPBN) treatments should deliver dose distributions that are specific to the underlying biology. In this context, we investigated whether FDG or FAZA DPBN leads to dose distributions that differ significantly from a simple geometric dose escalation, starting from the contour of the GTV drawn on CT.

Materials and Methods: 8 patients with stage II-III lung carcinomas treated by concomitant chemo-radiation were included. Patients underwent 4D PET-CT (FDG and FAZA) prior to treatment (pre) and at week 2 (w2) and 3 (w3). All images were reconstructed in their time-weighted mid-position (MidP).

At each time point, MidP FDG and FAZA PET-CT were rigidly aligned, while per-treatment images were deformed to pre-treatment ones.

Image analysis
PET SUV values within GTV were pairwise compared on a voxel-by-voxel basis at each time point (FDG vs FAZA) and between time points (w2/w3 vs pre) using Spearman’s correlation (rs).

GTV were divided in 5 equidistant concentric rings, r1 (border) to r5 (center), and median SUV were compared between rings.

Adaptive planning
FDG and FAZA voxel-based DPBN treatment plans were generated by linearly increasing the dose from median (60Gy) to maximum SUV (80Gy) within GTV. Plan conformity was assessed by quality volume histogram (QVH) and quality factor (QF; target < 5%). Simultaneously, geometrically escalated plans were generated by linearly increasing the dose from the border to the center of the GTV.

Dose plans were compared at each time point (FDG/FAZA vs geometric) and between time points (w2/w3 vs pre) using cross...
QVH (one’s dose distribution being compared to the other’s dose prescription).

Results
Image analysis
At each time point, FDG vs FAZA voxel-by-voxel comparison showed high correlation (r, \(= 0.78 \) IQR [0.69-0.83]). Similarly, uptake distributions were spatially stable between imaging sessions for both tracers (FDG: \(= 0.90 \) [0.85-0.94]; FAZA: \(= 0.89 \) [0.75-0.91]).

FDG and FAZA median SUV increased linearly from r1 to r5. All results were significant (p < 0.01).

Adaptive planning
Conformity of FDG and FAZA DPBN plans was achieved (QF = 1.33 ± 0.19 %).

At each time point, cross QVH between FDG/FAZA DPBN prescriptions and geometric plans showed satisfactory QF (FDG: 2.99 ± 0.15 %; FAZA: 3.03 ± 0.21 %) meaning plans could be swapped.

Cross QVH between pre-treatment plans and per-treatment prescriptions had acceptable QF as well (FDG: 2.05 ± 0.82 %; FAZA: 2.39 ± 0.92 %).

Conclusions: FDG and FAZA did not clearly show different uptake patterns, nor significant temporal changes during RT. Notably, the linear increase of SUV towards the center of the GTV probably reflects the lack of tracer specificity and the typical blur of PET images. As a result, dose distributions were highly similar between DPBN and geometric plans. Therefore, a CT-based geometric dose escalation might be a simpler, as effective, alternative.

PO-0788
Do heart and lung distances correlate to DVH when irradiating with forward planned IMRT techniques in breast cancer?


Purpose/Objective: 10 year follow up after hypothesis fractionated radiation therapy in breast cancer has been reported as safe and effective. Maximum lung distance (LD) at mid slice (MS) and maximum heart distance (HD) MS or AS has traditionally been used to reduce pneumonitis or ischaemic cardiac effects post radiation. Improvements in planning with forward planned IMRT (FIMRT) often use shielding of heart and lung using mini segments to reduce irradiated heart/lungs. This study reports the dose volume (DV) correlates for whole breast and chest wall planning and analyses if traditional 2d distances (LD MS/AS or HD MS/AS) are relevant surrogates for use in the current era.

Materials and Methods: Plans for 496 consecutive patients who underwent FIMRT to the whole breast or chest wall (and/or supraclavicular fossa) to a dose of 4005 cGy in 15 fractions were analysed. All plans were accepted with target coverage between 95-107%. LD MS/AS, HD MS/AS were recorded. Mean heart dose(MHD), V2.5, V5 and V30 of heart (left sided cancers), mean lung dose (MLD), V5/V10/V20 of ipsilateral lung were analyzed from DV histograms (DVH). The DVH data was compared for correlation with 2d LD and HD, pearson correlation(r) calculated and significance analysed. Other DVH comparisons, left vs right, whole-breast (WBRT) vs chest wall irradiation (CWRT) were compared using the Independent samples T test.

Results: 290 and 206 patients underwent WBRT and CWRT, frequency of left vs right were 49.1%, 50.2% respectively. The mean of the LD-MS was 2.1 cm (range - 0.5 cm to 3.4 cm) and LD-AS was 2.3 cm (range - 0.80 to 3.7 cm). The MLD was 638.8 cGy (range - 14.6 cGy to 1115.3 cGy). Mean of V5, V10, V20 of ipsilateral lung were 21.7, 15.6 and 12.8 % respectively. Lung V5, V10, V20, MLD, were higher with right sided irradiation (p < 0.005). HD MS/AS were 0.6/1.9 cm respectively, AHD, V2.5, V5 and V30 in the left sided breast cancers were 396.0 cGy (range - 22.8 cGy to 858 cGy), 20.1, 11.3 and 6.0 % respectively. When comparing WBRT and CWRT, the mean LD-MS, LD-AS, V10 and V20 were significantly less (p <0.005) with WBRT although there weren't any different in heart DVH. LD-MS correlated strongly (p<0.005) with V5,V10, V20, MLD (r=0.6, 0.7, 0.7, 0.7) with Linear coefficient (R)ratio between 0.4-0.5. A significant reduction (range 22-46%) in V5/10/20 was seen with a 5mm 2dLD reduction. HD-AS correlated significantly (p<0.005) with V2.5, V5, V30, MHD (r=0.9 for all AND R2=0.8). A 2mm change above 1.7-2.1mm resulted significant DV heart changes.

Conclusions: Significant correlation existed between 2d LD and HD with the lung, heart dosimetric parameters reiterating their use as surrogate markers to predict lung and heart toxicities, even in the era of FIMRT. Significant DVH changes can occur with 5mm 2dLD and 2dHD changes, highlighting the benefit of segment shielding of heart and lungs in breast radiotherapy.

PO-0789
Trends in DVH metrics of OAR’s and tumor in 3 consecutive TPS for 270 HNC patients: an automated institutional analysis


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Purpose/Objective: Over the past years, treatment for Head and Neck Cancer (HNC) has evolved from relatively simple 3D conformal therapy to IMRT with static beams and more recently to volumetric modulated arc therapy (VMAT) techniques using rotational beams. Previous planning studies have shown benefits from these modern treatment planning systems (TPS) and techniques, but mainly in small and selected patient series. The purpose of the current study was to quantify the effects on dose-volume histogram (DVH) parameters for various treatment techniques and 3 different treatment planning systems (TPS’s). This was done on a large scale population basis using the actual treatment plans delivered in routine daily practice.

Materials and Methods: Between 2006 and 2013, a total of 270 patients with primary HNC underwent radiation therapy