PO-0927
Bone texture analysis as predictive of bone radiation damage in patients undergoing pelvic RT.
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Purpose or Objective: To assess the potential role for a CT-based, bone texture analysis as a predictive factor of bone radiation damage in patients undergoing radiotherapy (RT) for pelvic malignancies.

Material and Methods: We performed a retrospective analysis of suitable patients treated with RT for pelvic malignancies from January 2010 to December 2014. The DICOM CT data acquired for RT planning were collected, and used for a homemade ImageJ macro analysis. Two region of interest (ROI) were selected: the L5 vertebral body and the femoral heads. Typical texture analysis (TA) parameters were retrospectively evaluated: mean (M), standard deviation (SD), skewness (SK), kurtosis (K), entropy (E) and uniformity (U).

The patients who developed bone RT-related damages (i.e.: pelvic bone stress fracture, radiation osteitis, insufficiency fractures) during the follow-up constitute the study patients (SP) group. The TA data were collected for a comparative analysis also in a control group of patients (CP): 2:1 ratio, with respect to SP) not developing bone damages. The CPs were matched taking into account: age, sex, type of tumor, intent of postoperative treatment, comparable doses to the considered organs-at-risk. As for the statistical comparisons, we performed a univariate analysis (Pearson correlation) and a multivariate analysis (logistic regression) using the SPSS software 17.0.

Results: Twenty-four SPs and 48 CPs are the subject of this report. Out of SPs, postoperative RT was delivered for cancer of the digestive tract (anal or rectal) in thirteen patients (54%); of the female reproductive organs (endometrial or cervical) in 9 (37%); and of the excretory apparatus (prostate or bladder) in 3 patients (9%). In the comparison between SP and CP groups, the univariate analysis showed a significant correlation of the ROI parameters of L5: SD (p=0.012); K (p=0.001), E (p=0.001); U (p=0.008), and of the femoral head: M (p<0.001); SD (p=0.001), with the development of bone damage. The logistic regression highlighted a significant correlation with the ROI parameters of L5: E (p=0.004); U (p=0.014), and femoral head M (p=0.022); and SD (p=0.042), with an Overall Model Nagelkerke R Square of 0.590.

Conclusion: These results (with the limit of a small series) and those reported in previous related studies deserve some interest, since the knowledge of predictive factors of bone radiation damage might help in patients' selection for pelvic RT, and in identifying suitable dose constraints for the bony pelvis in RT planning for patients at risk.

PO-0928
Impact of fuzzy-thresholding of 18F-FDG PET images for cervical cancer recurrence prediction
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Purpose or Objective: In case of cervix cancer irradiation, parameters extracted from initial 18F-FDG-PET images can be used to predict recurrence. FDG PET parameters are classically computed among voxels binary selected in the segmentation step. We proposed the use of fuzzy-thresholding, providing tumor membership probability map, and present a generalization of the computation of FDG PET parameters by weighting each PET voxel by its tumor membership probability. The goal of the study was to evaluate the relevance of fuzzy-threshold based weighted parameters in prediction of tumor recurrence, in comparison with a “standard” fixed or hard threshold based parameters.

Material and Methods: This study included 53 patients treated for locally advanced cervical cancer by external beam radiation therapy with concurrent chemotherapy, followed by brachytherapy and ± surgery. All patient underwent 18F-FDG PET/CT exam before the treatment. Different tumor membership probability maps were extracted from 18F-FDG PET images using fuzzy-thresholding defined by a threshold Th and a level of fuzziness ΔTh (both expressed in % of the maximum uptake value) using a Zadeh’s standard function. Fuzzy-thresholding were tested with Th=41%, 50% and 70% and ΔTh from 0% to 40% (ΔTh=0% corresponding to hard-thresholding). Using the fuzzy-thresholding, we computed weighted analogous of four standard 18F-FDG PET parameters: the maximum uptake averaged by its 26 neighborhood (SUVpeak), the average SUV inside the tumor region (SUVmean), the metabolic tumor volume (MTV) and the total lesion glycolysis (TLG). The recurrence were defined based on clinical examination, MRI and PET imaging. Median follow-up was 49 months [range: 7-83]. A total of 16 patients developed disease recurrence. The predictive capability of the PET parameters to predict 3 year overall recurrence were evaluated using the area under the receiver operating characteristic curve (AUC) and the p-value of the logistic regression model.

Results: The figure shows the predictive values (AUC and p values) of the weighted parameters depending on the threshold Th and the fuzzy-level Δth used. SUVpeak and SUVmean were not predictive for any of the segmentations tested. TLG and MTV extracted through hard-thresholding (ΔTh=0%) were highly predictive with Th=41% (AUC=0.74, p=0.012) and Th=50% (AUC=0.77, p=0.006) but not with Th=70%. Weighted parameters were discriminative (p<0.05) at Th=41% with Δth = [0% - 22%], at Th=50% with Δth = [0% - 32%] and at Th=70% with Δth = [0% - 32%] indicating a lower sensitivity to the choice of threshold.

Conclusion: PET weighted parameters including voxels tumor membership probability can be used to predict tumor
recurrence in cervical cancer. Weighted PET parameters were less sensitive to the choice of threshold than standard parameters computed through hard-thresholding, all tested threshold TLG and MTV parameters becoming statistically predictive.

**PO-0929**

Dual Energy CT imaging of tumour vasculature in NSCLC: an intra-patient comparison with DCE-CT

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**Purpose or Objective:** Quantification of vasculature is frequently performed by dynamic contrast enhanced CT (DCE-CT) or MRI imaging. However, there are some limitations to this technique: DCE-CT requires a detailed kinetic fitting procedure, a prolonged acquisition time with increased dose to the patient, has a limited FOV and is not easy to implement in clinical routine. Dual Energy CT is an evolving field in CT image analysis that allows quantification of contrast material uptake using a single acquisition, making it easily implementable in a clinical workflow. Therefore we investigated the correlation between the DCE-CT derived vasculature parameters, blood flow and blood volume, with iodine related attenuation measured on a Dual Energy CT acquisition for non-small cell lung cancer patients.

**Material and Methods:** The same imaging protocol was followed for 13 patients on a Dual Energy CT scanner (Siemens Definition Flash). The protocol consisted of a Dual Energy CT scan (either 80/140kVp or 100/140kVp; 70 ml of iodine 300 mg/ml) of the entire thorax and a DCE-CT acquisition (65 ml of iodine 300 mg/ml; 33 frames @ 1.5sec for a total of 50 sec) in a 13 cm FOV centred around the primary tumour. Kinetic analysis was performed using commercial software (Siemens VPCT body) allowing the assessment of blood flow (unit: ml/100ml/min) and blood volume (unit: ml/100ml) in every voxel. Dual Energy CT images were analysed using in-house developed software for iodine contrast quantification. Iodine related attenuation was calculated by subtracting the Hounsfield units of the CT scan acquired at high energy from the scan acquired at low energy. A comparison was performed on 1) the entire tumour and 2) on a sub-volume level, defined by the upper 50% of the volume-of-interest. Correlation on tumour level was assessed by the Pearson correlation coefficient; overlap of sub-volumes with a DICE coefficient.

**Results:** There was a significant positive correlation between average contrast enhancement on Dual Energy CT and blood flow (r=0.615, p=0.025) and blood volume (average r=0.742, p=0.004) on a patient (i.e. tumour) level. Furthermore, the volumes defined by the highest 50% contrast enhanced uptake and 50% elevated perfusion coincided well (see Figure), with DICE scores of 0.72±0.10 (range 0.58-0.87) and 0.71±0.13 (range 0.50-0.91), for the blood flow and volume, respectively.

**PO-0930**

PET based response assessment of lung toxicity - assessment of two approaches for dose response

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**Purpose or Objective:** Patients with lung cancer given external radiotherapy are at risk of radiation induced lung toxicity (RILT). In many studies, mean density changes from CT (in Hounsfield units) have been used as a surrogate for radiation-induced alterations in the lung. However, a combination of mean density changes from CT scans with corresponding standard deviations has been shown to be a more sensitive method. In the current work, we explore whether such a combined approach is feasible for 18F-FDG PET data as well.

**Material and Methods:** 13 patients with advanced non-small cell lung cancer, participating in a phase II trial on combined radiation and erlotinib therapy, were included. The patients were examined by 18F-FDG-PET/CT at three sessions; prior to, one week into, and six weeks after fractionated radiotherapy (3 Gy × 10). For each patient, lung was delineated in the planning CT images. The RT dose matrix was co-registered with the PET image series. For each PET image series, mean (μ) and standard deviation (σ) map were calculated based on cubes in the lung (3×3×3 voxels) and were further used to quantify local structure (S). The spread in μ and σ was characterized by a local covariance ellipse (in pre-therapy PET series) in a sub-volume of 3×3×3 cubes. The distance of individual cube values to the origin of the ellipse is then calculated using Mahalanobis distance method to form S maps. ΔS and Δμ maps are derived by subtracting pre-therapy maps from maps of mid- and post-therapy. A detection threshold was calculated based on three patients with two sets of pre-therapy PET scans who were not included in the study.

**Results:** The structure difference maps (ΔS) identified new areas of interest in the lungs of individual patients compared to the mean difference maps (Δμ) (Figure 1 A). On a population level, both ΔS and Δμ were significantly different (P<0.05) from the respective threshold level, irrespective of dose (Figure 1 B). The inter-patient relative variation in ΔS and Δμ were 57% and 88%, respectively, indicating that the ΔS approach yielded less heterogeneous results. 18F-FDG dose response was analyzed up to total dose of 15 Gy by first order linear regression. The relative slopes of the regression lines were 0.036, 0.018, 0.052, and 0.061 for Δμ (mid-pre), ΔS (mid-pre), Δμ(mid-pre), and ΔS (post-pre), respectively. A significant dose response was only seen for the ΔS taken between post and pre-therapy PET.