were extracted (see image) at both timepoints from two sections of lung tissue - one that received the highest planned dose in healthy tissue and one that received low or no dose of RTx. Linear discriminant analysis (LDA) with 5-fold cross-validation and backward stepwise selection of variables was used to construct best classification models to separate irradiated from non-irradiated regions of the lung and differentiation of patients with RILT and without.

Results: LDA based on seven parameters allowed for differentiation (area under the ROC curve 0.86) of regions of healthy tissue and regions from tumor site. The 7 parameters were Wavelet-transform functions of different frequencies. However, despite those differences, CT-images from the 40Gy timepoints differed significantly depending on the received dose. An LDA model based on six parameters (3 autocorrelation functions, kurtosis and 2 wavelet function parameters) differentiated non-irradiated regions from irradiated ones - ROC AUC 0.89 (95%CI 0.75-1.00). Preliminary data from follow up showed that patients in whom RILT developed (N=7) could be differentiated from those free from complications (ROC 0.96 95%CI 0.89-1.00). However, parameters used in this LDA-based classifier relied on CT texture parameters extracted from both irradiated and non-irradiated ROIs, making ROI selection a crucial part of the texture analysis process.

Conclusion: Texture of CT-scans contains enough information to detect RTx-induced changes, although the method may be affected by pretreatment differences, which necessitates a robust placement of ROIs for analysis.

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Predictive factors based on textural features - reliability of patient classification
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Purpose or Objective: Textural analysis of lung tumors in PET or CT images is currently of interest in a number of publications e.g. to predict overall survival after radiotherapy. Given that tumor volume is a known independent predictor in radiotherapy of lung cancer, a textural feature must be volume independent to gain independent predictive power. Furthermore, the feature value should be stable against small variations in the delineated tumor volume. This study analyses how changes in PET based tumor volume and delineation affect different published textural features.

Material and Methods: PET delineated tumors for 158 NSCLC patients were used to calculate textural features as proposed by Amadasun et al [IEEE Trans. Syst., Man, Cybern., Syst. 1999]. Delineations of the tumors were made semi-automatically based on EANM guidelines for VOI41 and VOI50 (delineation at the 41% and 50% level of SUVmax). Additional smoothened delineations were made to resemble delineations made by humans. Furthermore, dilated versions of VOI41 were analyzed to determine the response of the textural features to large changes in delineation. Textural features are typically used to divide a patient population in two groups based on a given textural cut-value, e.g. the median value. Thus, the textural feature should preferably be stable towards small delineation variations in terms of patient classification. Such stability was tested using ROC curves, in which the initial delineation (VOI41) was used as ground truth classification based on the median value. Volume dependence of the textural features was assessed through the Spearman correlation coefficient.

Results: Coarseness, busyness, contrast, and complexity were all confirmed to have a significant correlation with volume (absolute Spearman > 0.58). The figure shows coarseness’ ability to classify the patients consistently for different delineations. The large area under the ROC curve (almost unity) between VOI41, VOI50, and the smoothed VOI, shows that the patient classification is almost independent of small variations of delineation. The figure also shows how successive dilations of tumor volume reduce the area under the curve. Similar findings were observed for the textures busyness and contrast. A mathematical examination of the textural features provided an easy way to correct for the volume dependence of coarseness and contrast. Neither of these modified versions was found to have volume dependence (absolute Spearman < 0.22); while at the same time having the same stability characteristic as their original versions.

Conclusion: All original textures had strong correlation with volume, which for PET delineation of lung tumors could be a confounding factor within a textural predictor. Through small changes to the original definition it is possible to make coarseness and contrast volume independent; a property which is needed for the features to be used as independent predictive factors.
Purpose or Objective: The purpose of this study was to prospectively evaluate the role of quantitative diffusion weighted imaging (DWI) and dynamic contrast enhanced (DCE) imaging used in combination for multi-parametric MRI prediction of treatment response in rectal cancer.

Material and Methods: This study used a voxel-by-voxel multi-parametric histogram analysis strategy to assess tumour heterogeneity and its changes in response to chemoradiotherapy (CRT). Twenty patients with locally advanced rectal cancer undergoing neoadjuvant CRT prospectively underwent MRI on a 3T wide bore Siemens Skyra at 3 time-points: Pre-CRT, week 3 CRT, and post-CRT. The study protocol consisted of: (i) T2-weighted images (ii) DWI using RESOLVE, which was previously shown to be robust with respect to geometrical distortions. Images were acquired with b-values 50 and 800s/mm² and 1 & 3 averages. ADC maps and calculated b=1400s/mm² images were produced as part of protocol (iii) DCE consisted of pre-contrast VIBE scans with flip angles 2° and 15° in order to calculate native T1, followed by gadoversetamide (0.1mM/kg) injection and 60 phases using TWIST with a 5s temporal resolution. ADC and Ktrans parameter maps were registered to T2-weighted images. Semi-automated segmentation was used to define the volume of interest from hyperintense tumour on the b-value=1400 images. A voxel-by-voxel technique was used to produce colour coded histograms of ADC and Ktrans, as well as combined scatterplots and difference histograms for each time-point. CRT response was defined according to histopathology tumour regression grade (TRG) (AJCC 7th Edition). A complete protocol and analysis strategy was successfully developed which has utilized commercial, in-house developed and works-in-progress (Siemens OncoTreat) software.

Results: Of 20 patients, 1 had clinical stage T2N2M0, 5 had T3N0M0, 4 had T3N1M0, 7 had T3N2M0, and 3 had T4N2M0. Eight patients had a good response (TRG0-1) and 11 patients had a poor response (TRG2-3) to CRT. Pathology for 1 patient set can be divided in two groups according to the time distance between the end of RT and the post-treatment DWI acquisition: A) patients with DWI acquired in acute phase (5 subjects, range of 6-15 days after the end of RT), B) patients with DWI acquired in non-acute phase (7 subjects, range of 76-179 days). Correlation of ADC variations with the contours of the penile bulb as delineated by a radiotherapist (on T2-weighted MRI images). Specifically, for each b-value, the mean signal intensity in the bulb was calculated and the exponential model was fitted to these averaged values using linear regression algorithm. The patient set can be divided in two groups according to the time distance between the end of RT and the post-treatment DWI acquisition: A) patients with DWI acquired in acute phase (5 subjects, range of 6-15 days after the end of RT), B) patients with DWI acquired in non-acute phase (7 subjects, range of 76-179 days). Correlation of ADC variations with timing of post-RT DWI and mean dose to the penile bulb (corrected for fractionation using the linear-quadratic model and alpha/beta=3Gy) were investigated with linear regression analysis.

Conclusion: Multi-parametric histogram analysis of ADC and Ktrans appears to be a promising and feasible method of assessing tumour heterogeneity and its changes in response to CRT in rectal cancer.

Purpose or Objective: Functional imaging is widely used to evaluate the response to radiotherapy (RT) in patients with prostate cancer. In particular, variations of Apparent Diffusion Coefficient (ADC) are normally evaluated in the prostate (benign and malignant zones), but organs at risk are usually not considered. The aim of our work was to investigate the changes of ADC values after RT and to correlate them to the dose in the penile bulb, as an organ which is considered to have an impact on sexual function toxicity.

Material and Methods: Twelve patients with prostate cancer treated with RT were considered. Diffusion-weighted MRI (DWI) images were acquired using four different b values (0, 150, 800 and 1000 s/mm²) at 1.5T before and after RT. A VOI-based approach was used to estimate ADC, considering the contours of the penile bulb as delineated by a radiotherapist (on T2-weighted MRI images). Specifically, for each b-value, the mean signal intensity in the bulb was calculated and the exponential model was fitted to these averaged values using linear regression algorithm. The patient set can be divided in two groups according to the time distance between the end of RT and the post-treatment DWI acquisition: A) patients with DWI acquired in acute phase (5 subjects, range of 6-15 days after the end of RT), B) patients with DWI acquired in non-acute phase (7 subjects, range of 76-179 days). Correlation of ADC variations with timing of post-RT DWI and mean dose to the penile bulb (corrected for fractionation using the linear-quadratic model and alpha/beta=3Gy) were investigated with linear regression analysis.