Material and Methods: An oropharynx cancer patient included in the ARTFIBIO project with a swollen node was selected. The pre-treatment imaging protocol was: MRI (DWMRI, DCEMRI) and PET/CT with FDG. Geometric distortion of DWMRI was corrected using the reversed gradient method (RGM) and the SPM8 software. DCEMRI analyses were performed using Dynamika® v4.0 (www.imageanalysis.org.uk). All the datasets were registered using ARTFIBIO tools.

The parameters for classifying subvolumes were (Figure A): Initial Rate Enhancement (IRE) from DCEMRI, that measures the initial slope of gadolinium concentration and related to vascularization, Apparent Diffusion Coefficient (ADC) from DWMRI, previously corrected by the RGM, related to tumour density, and SUV from PET/CT with FDG. Thus, three subvolumes have been delimited: node, hypoxic volume (low IRE) and necrotic volume (red region in DWMRI b0, high ADC, very low IRE).

Results: We have analysed the relationship between the three selected parameters (ADC, IRE and SUV) for the whole node and for the badly vascularized region excluding the necrotic region. When we considered the whole node (Figure B), we observe a complex relationship between these three parameters, but when we only consider the badly vascularized region (low IRE, low ADC), we observe a clear relationship between these parameters, that suggest that vascularization quantified by IRE must be related to oxygenation, as lowest vascularized dots (blue dots, figure C), correspond to high SUV for the same ADC, indicating an enhancement of the Pasteur effect in the badly vascularized region.

Conclusion: Several functional imaging techniques can be required to customize treatment, but an appropriate registration process must be applied. ADC maps can be used for tumour cell quantification, but distortion correction algorithm must be previously applied, RGM looks quite suitable. Oxygenation process can be estimated from DCEMRI in head and neck cancer, as vascularization is related to oxygenation in these cancers, and as our results suggest. PET/CT and MRI studies provide information about malignancy grade of the tumour, considering glucose metabolism, tumour cell density (from ADC maps) and oxygenation (DCEMRI). Supported by ISCIII Grant DTS14/00188.

EP-1874 Effective radiosensitivity maps of early tumour responsiveness based on repeated FDG PET scans

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Purpose or Objective: Identification of outcome predictive factors at an early stage of radiation therapy allows for adaptation and individualisation. Such predictive factors are crucial for advanced head and neck (H&N) cancer patients since the treatment failure is often caused by poor loco-regional control. An early treatment adaptation would allow a dose escalation in the most radioresistant tumour regions. The aim of this study was to early identify sub-regions in H&N tumours non-responding to the treatment. This was achieved by applying a previously developed method using [18F]-fluorodeoxy-D-glucose positron emission tomography (FDG PET) to evaluate the early responsiveness of lung tumours.

Material and Methods: Thirteen patients with advanced H&N cancer were imaged with FDG PET before the start and during the second week of concurrent chemoradiotherapy (after about 19 Gy of delivered dose to the primary gross tumour volume, GTVprim). The acquired PET images were coregistered to the planning CT and a systematic analysis was performed to calculate an operational parameter at voxel level, the effective radiosensitivity αeff which accounts for the accumulated dose distribution at the time of the second PET scan and variations in the FDG uptake. Volumetric maps of αeff values within GTVprim, as well as the average (a_αeff) and negative fractions (nf_αeff) of αeff values were determined. Patients were stratified in responders and non-responders to treatment based on previously determined criteria for overall survival at 2 years for concurrent chemoradiotherapy in lung cancer (a_αeff>0.004 Gy-1 and nf_αeff<30%). The spatial distribution of the αeff values was mapped for the non-responders to treatment for future adaptation strategies.

Results: The previously proposed method was feasible for H&N cancer patients and predicted good response in 54% of the patients having simultaneously a_αeff>0.004 Gy-1 and nf_αeff<30%. Figure 1a shows an example of the effective radiosensitivity map for a selected slice of the GTVprim in one of the H&N cancer patients. The corresponding binary image with threshold on the negative portion of the αeff distribution is presented in Figure 1b (white: αeff<0; black: αeff>0). Calculated volumetric maps of the effective radiosensitivity values showed that it was possible to segment confined sub-regions in the tumour which might indicate resistance to the treatment (Figure 1b).

Conclusion: Confined tumour sub-regions showing lack of metabolic response which might correlate to resistance to treatment could be identified at an early stage during the radiotherapy regime. Investigations on different dose boosting strategies are on-going to account for the quantitative information available from the αeff volumetric maps.
EP-1875
Correlation between MRI-based hyper-perfused areas and tumor recurrence in high-grade gliomas
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Purpose or Objective: Patients suffering from high-grade gliomas currently have a median survival time of 14 months despite treatment. Our purpose was to investigate whether MR perfusion and relative Cerebral Blood Volume (rCBV) maps could predict tumor recurrence areas and improve treatment planning.

Material and Methods: This retrospective study included 19 patients suffering from high-grade gliomas (3 and 4) who received standard radiotherapy [60 Gy, 2 Gy/fraction] and Temodal chemotherapy. Subjects underwent pre-treatment CT, gadolinium-enhanced T1-weighted, T2 FLAIR acquisitions and a DSC-MR scan. rCBV maps were calculated using READE View Advantage Workstation (GE) and normalized to the normal white matter perfusion value. The PLANET software (DOSIsoft) was used to register all MR images to the planning CT. A senior radiologist and a senior radiotherapist delineated Gross Tumor Volumes (GTV) on anatomical MR images. The Planning Target Volumes (PTV) were defined by a physicist. Threshold of 1.7 was applied to the rCBV maps to define hyper-perfused volumes (Vperf). Follow-up anatomical MR images were used to localize recurrence areas (GTV’). Correlations between all volumes were analyzed using several indexes. I1 is the percentage of Vperf not included in the GTV. I2, I3, and I5 are respectively the percentage of GTV’ included in Vperf, GTV, and PTV. I4 is the percentage of Vperf’ not included in the GTV which was predictive of tumor recurrence outside GTV. This index is meaningful only if GTV’ and GTV are different.

Results: Indexes obtained for each patient are presented in Table 1. For two patients, a threshold of 2 was applied to the rCBV maps at the physician request to facilitate the hyper-perfused area visualization. I1 values are in a range of 4 to 82% (mean = 43%) and are greater than 20% for almost 90% of the patients, indicating that hyper-perfused areas and GTV can be different. Hence, rCBV maps provide supplementary information. At least 40% of GTV’ is included in Vperf for 16 patients (I2 index). For 10 patients, GTV’ is not completely included in the GTV (I3 < 85%). In all these cases except one, the I4 index is greater than 20%, suggesting that a part of Vperf is predictive of the recurrence localization (Figure 1). I5 being almost always equal to 1 points out that all recurrence areas received the same dose as the GTV.

Conclusion: Our results suggest that rCBV perfusion maps can be predictive of recurrence localization. I1, I2 and I4 values are however entirely dependent on the threshold applied to rCBV maps and their evolution while the threshold increases will be studied. As recurrence areas are always included in the PTV, an improvement of treatment planning would consist in boosting hyper-perfused area rather than changing the GTV delineation. An in-depth analysis of the pre-treatment rCBV values observed in recurrence areas will be conducted to better describe potential boost areas.

EP-1876
An image-based method to quantify biomechanical properties of the rectum in RT of prostate cancer
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Table 1. Volume comparison indexes in 10 patients. The * sign indicates patients for whom a threshold of 2 was applied to rCBV maps at the request of the physicians. Yellow rows indicate patients for whom GTV is not entirely included in GTV. The ** sign indicates patients for whom at least 40% of GTV’ is included in Vperf.

Figure 1. Volume comparison on pre-treatment gadolinium-enhanced T1-weighted for patient 1. A large part of GTV’ (green) and Vperf (yellow) are included in GTV (red) in the left hemisphere. In the right hemisphere, the hyper-perfused area is predictive of tumour recurrence. GTV’ is completely included in PTV (pink).

Conclusion: Our results suggest that rCBV perfusion maps can be predictive of recurrence localization. I1, I2 and I4 values are however entirely dependent on the threshold applied to rCBV maps and their evolution while the threshold increases will be studied. As recurrence areas are always included in the PTV, an improvement of treatment planning would consist in boosting hyper-perfused area rather than changing the GTV delineation. An in-depth analysis of the pre-treatment rCBV values observed in recurrence areas will be conducted to better describe potential boost areas.