MULTIMODALITY FUNCTIONAL IMAGING IN RADIATION THERAPY: RELATIONSHIP BETWEEN FUNCTIONAL IMAGES OF HEAD AND NECK CANCER

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DocTIC

MOTIVATION AND OBJETIVES

In the modern era of adaptive RT, it has become vital to understand how different functional imaging techniques interact and link together in tumors. There is an urgent need to assess tumor response during treatment using functional imaging. Hence, in clinical settings it is extremely essential to accurately assess whether or not a tumor has been successfully treated and whether the tumor requires additional treatment. Quantitative Imaging Biomarkers (QIBs) may play a crucial role in deciphering treatment efficacy[1]. However, the implementation these functional techniques is one of the most challenging issues in RT. This work is part of a research project named "Adaptive Radiation and Prediction of Tumor Response based on Functional Studies of MRI and PET / CT in Head and Neck Cancer"' funded by a FIS (IP: PI11/02035) grant

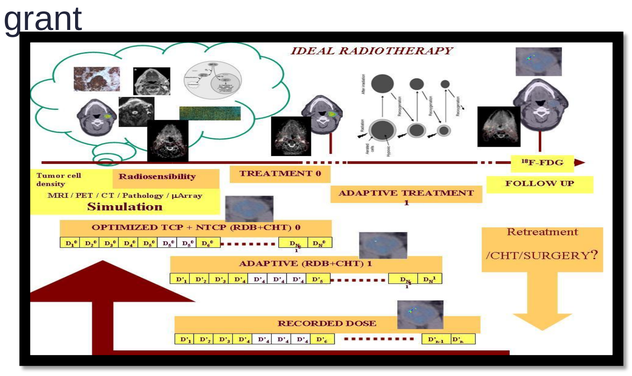


Fig. 1. Ideal Radiation: The radiation planning should be tailored to the individual patient's response to treatment, based on functional images.

The main objectives envisaged at the outset for the Ph.D programme are the following:

1.- Get and anatomically register functional images and extract all available information. It is a challenge to replicate the same position of the patient during the acquisition of the different modalities of images. The project developed a immobilization protocols and home-made software for register and extracts data from images

2. -Explore the relationships between different functional images. We will analyze the relationships between ADC, DCE-MRI and SUV parameters and evaluate their influence on the tumor response in a case study in which we have a necrotic volume, a hypoxic area and a heterogeneously vascularized tumor volume in the same section.

3. -Validate of registration software. A key aspect to be able to establish relationships between the different biomarkers is that they refer to the same sets of cells, to ensure this we will have to validate the co-registration of the software used by comparing different metrics with commercial software.

RESULTS

1 Get and anatomically register functional images

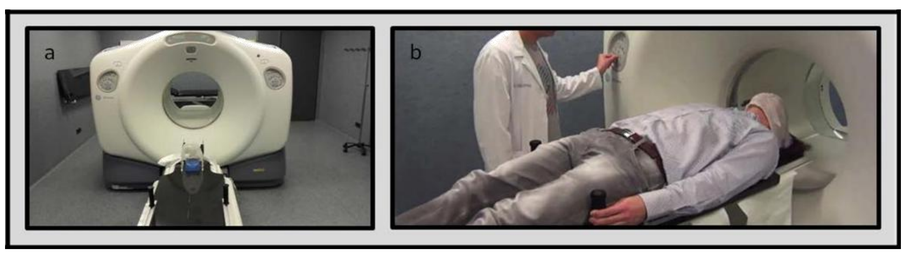


Fig. 2. a. Flat table with head support adapted to PET/CT requirements. **b.** Illustrates the patient positioning with the thermoplastic mask over the head support and flat table at the PET/CT

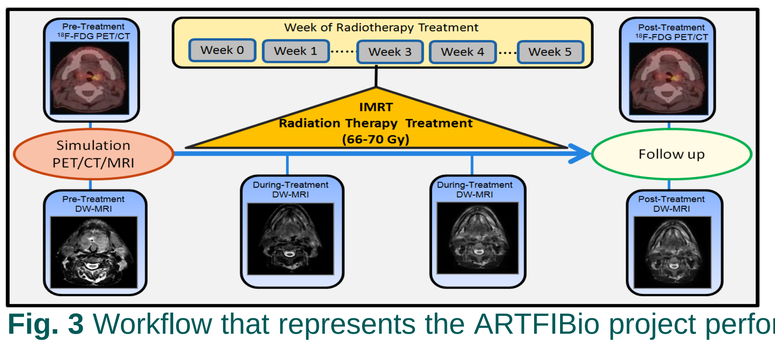


Fig. 3 Workflow that represents the ARTFIBio project performed in all the patients involved.

2 Explore the relationships between different functional images

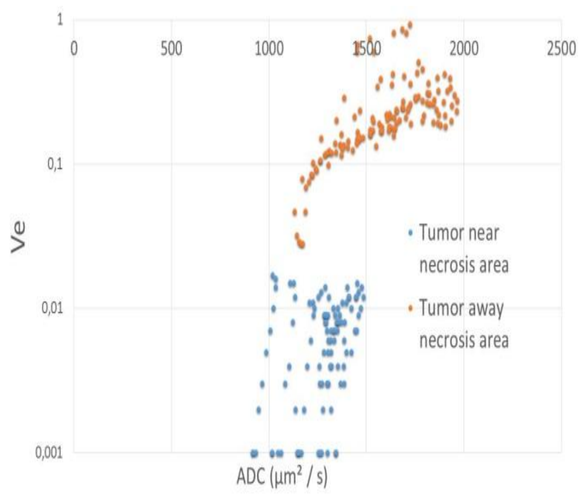
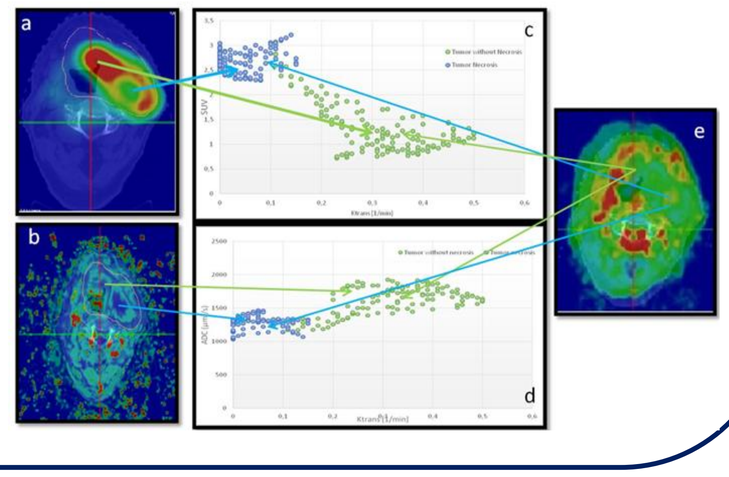


Fig. 4. v_e *vs*. ADC (µm² / s) for the selected slice of a patient. In well vascularized areas (red dots), a clear relationship can be found [2]

Fig.5 In this figure SUV versus Ktrans and ADC is represented. (a) PET/CT. (b) Ktrans map overlaped to simulation CT(c) In the hypoxic area (excluding necrotic area), high SUV values are obtained indepently for all low Ktrans values, because of the addition of the Warburg effect and the Pasteur effect. (d) In the well vascularized area, SUV values are decreasing with Ktrans, as expected, because a reduction in ADC implies an increase in tumour cell density. (e) ADC map overlaped to simulation CT.



3 Validate the registration of images

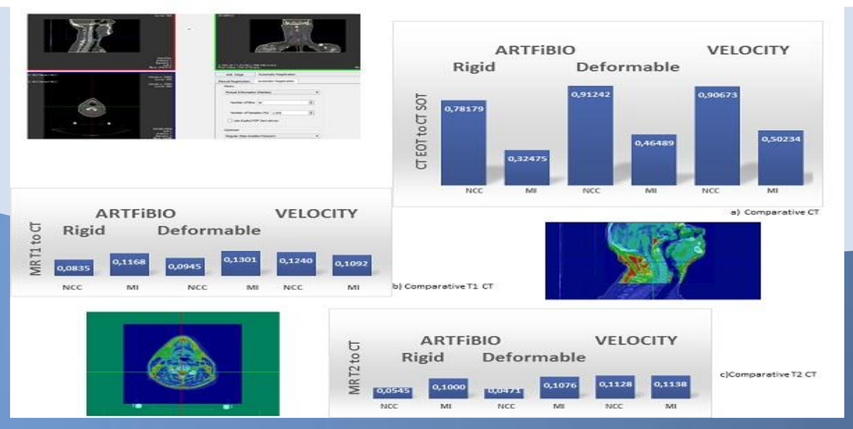


Fig.6 In this figure we compare the register between 2 X-ray CT (a), CT- MRI T1 (b) and CT-MRI T2 (c), made whit our home software (ARTFIBIO) versus commercial software Velocity©. For this we use NCC and Mutual Information metrics[3]

CONCLUSIONS

In order to the main objectives:

1.- With the immobilization protocols and the software developed in the ARTFIBio project [4] the requirements for the co-registration and extraction of functional image data are achieved.

2.- Multimodality imaging offers much more information about tumor behavior than the individual datasets on their own. The relationship between different types of images must be studied in detail in order to establish a minimum set of data required to personalize the radiotherapy treatment and to optimize the treatment for each patient. This could comprise not only a gradient of dose along the treatment, but also, different fractionation for each voxel.

3.- This software has been validated with commercial software, showing similar results. Real patients from the ARTFIBio database can be used to validate the registration software using different imaging modalities (MRI and CT).

RESEARCH PLAN

		2014		2015		2016		2017		2018	
TASK	DESCRIPTION	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1.	LITERATURE REVIEW										
2.	COLLECTING DATA										
3.	DATA ANALYSIS										
4.	SOFTWARE VALIDATION										
5.	PUBLICATION										
6.	THESIS										END

BIBLIOGRAPHY

[1] Jansen JF, Schöder H, Lee NY, Stambuk HE, Wang Y, Fury MG, Patel SG, Pfister DG, Shah JP, Koutcher JA, Shukla-Dave A. Tumor metabolism and perfusion in head and neck squamous cell carcinoma: pretreatment multimodality imaging with 1H magnetic resonance spectroscopy, dynamic contrast-enhanced MRI, and [18F]FDG-PET. Int J Radiat Oncol Biol Phys. 2012;82(1):299-307

[2] Mera Iglesias, M., Aramburu Núñez, D., del Olmo Claudio, J. L., López Medina, A., Landesa-Vázquez, I., Salvador Gómez, F., J.L.Alba, Muñoz, V. (2015). Multimodality functional imaging in radiation therapy planning: relationships between Dynamic Contrast-Enhanced MRI, Diffusion-Weighted MRI, and 18F-FDG PET. Computational and mathematical methods in medicine, 2015

[3] Mera Iglesias, M., Aramburu Núñez, D., del Olmo Claudio, J. L., López Medina, A., Landesa-Vázquez, I., J.L.Alba, Muñoz, V. (2015). Validation o f ARTFIBio registration software. Comparative with commercial software and shares dataset. Radiotherapy and Oncology, 115, S840-S841.

[4] Landesa-Vazquez, I., Alba-Castro, J. L., Mera-Iglesias, M., Aramburu-Nunez, D., Lopez-Medina, A., & Munoz-Garzon, V. (2014, June). ARTFIBio: A cross-platform image registration tool for tumor response quantification in head and neck cancer. In Biomedical and Health Informatics (BHI), 2014 IEEE-EMBS International Conference on (pp. 149-152). IEEE