



HAL
open science

Identifying a reliable radiomic signature from scarce data: illustration for 18F-FDOPA PET images in glioblastoma patients

Fanny Orlhac, Anne-Capucine Rollet, Irène Buvat, Jacques Darcourt, Véronique Bourg, Christophe Nioche, Charles Bouveyron, Nicholas Ayache, Olivier Humbert

► To cite this version:

Fanny Orlhac, Anne-Capucine Rollet, Irène Buvat, Jacques Darcourt, Véronique Bourg, et al.. Identifying a reliable radiomic signature from scarce data: illustration for 18F-FDOPA PET images in glioblastoma patients. EANM Annual Meeting - Annual Meeting of the European Association of Nuclear Medicine, Oct 2020, Virtual Meeting, Austria. inserm-02952445

HAL Id: inserm-02952445

<https://inserm.hal.science/inserm-02952445v1>

Submitted on 8 Oct 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Identifying a reliable radiomic signature from scarce data: illustration for 18F-FDOPA PET images in glioblastoma patients

Fanny Orlhac ^{1,2}, Anne-Capucine Rollet ³, Irène Buvat ¹, Jacques Darcourt ^{3,4}, Véronique Bourg ⁵, Christophe Nioche ¹, Charles Bouveyron ⁶, Nicholas Ayache ², Olivier Humbert ^{3,4}

¹Institut Curie, Inserm, U1288 LITO, Orsay, FRANCE, ²Université Côte d'Azur, Inria, Epione, Sophia-Antipolis, FRANCE, ³Université Côte d'Azur, Centre Antoine Lacassagne, Service de Médecine Nucléaire, Nice, FRANCE, ⁴Université Côte d'Azur, CEA, TIRO, Nice, FRANCE, ⁵Université Côte d'Azur, CHU Pasteur 2, Service de Neurologie, Nice, FRANCE, ⁶Université Côte d'Azur, Inria, MAASAI, Nice, FRANCE.

Abstract

Aim/Introduction: The design and validation of a reliable radiomic signature is challenging when few patients are available because the disease is rare, the imaging protocol is specific and/or the classes are unbalanced. In this context, we propose an approach to identify a signature and estimate its reliability.

Materials and Methods: 84 patients with a clinical and MRI suspicion of recurrent glioblastoma were retrospectively included. Each patient underwent a 18F-FDOPA PET-CT scan. For each patient, the suspicious lesion was segmented and 49 radiomic features were calculated using LIFEx [1]. Our goal was to distinguish between tumor recurrence and radiation-induced necrosis as confirmed on pathological data, or on a 3-month clinical/imaging follow-up. A screening procedure was developed to identify a signature using leave-one-out (LOO) cross-validation. The procedure involved: 1) selection of all features with a p-value of univariate Wilcoxon test lower than alpha varying from 0.005 to 0.10 for (N-1) learning patients, 2) based on these features, selection of only one feature among correlated features using a Pearson correlation cut-off R varying from 0.95 to 0.50, 3) building of a radiomic signature involving the resulting features using a linear discriminant analysis, 4) test of the model on the Nth patient, 5) characterization of the model performance using the Youden Index ($Y = \text{sensitivity} + \text{specificity} - 1$). The final model selection was based on the consistency of Y values as a function of alpha and R, on the consistency of selected features between the different models, and favored models involving a low number of features. To test the reliability of the selected signature, we repeated the process by excluding one patient using a jackknife procedure (ie, 84 LOO of 83 patients each). We compared the results with those obtained with the same alpha and R when randomly assigning a label to each patient (sham task).

Results: 61 patients had tumor recurrence and 23 had radiation necrosis. Visual interpretation yielded Y equal to 0.35 (Lizarraga scale, Se=100%, Sp=35%). Using LOO, 10/28 radiomic models had $Y > 0.35$. The largest Y ($Y = 0.49$, Se=62%, Sp=87%) were obtained with 4 features on average, reflecting the volume, sphericity and heterogeneity (GLCM_Correlation, GLCM_Contrast) of the lesion uptake. Using the jackknife procedure, Y was 0.47 ± 0.06 (range: [0.32;0.56]), significantly higher (Wilcoxon $p < 0.05$) than for the sham task ($Y = 0.06 \pm 0.18$, range: [-0.52;0.47]).

Conclusion: The proposed systematic screening procedure enabled the identification of a parsimonious radiomic signature from scarce data.

References: [1] Nioche et al. Cancer Res 2018.