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Abstract – Aim: *We studied whether the characterization of tumor texture in FDopa-PET/CT could assist in the identification of tumor grades in both primitive and recurrent gliomas.* ***Materials and Methods:*** *Eighty one patients with gliomas were studied, including 52 newly diagnosed tumors and 29 recurrent tumors. For each tumor, the SUVpeak and metabolic volume (MV) were measured, as well as 32 textural indices (TI). The ability of SUVpeak, MV and TI was investigated by using each index alone first (with ROC analyses), and then by using couples consisting of one TI with SUVpeak in a binomial model (with ROC analyses and a reclassification method). The pathological examination was assumed to provide the gold standard grade.* ***Results:*** *Neither SUVpeak nor MV could discriminate low-grade tumors (LG) from high-grade tumors (HG) in newly-diagnosed tumors, while SUVpeak alone could discriminate LG from HG in recurrent tumors (p=0.02). Combining a TI with SUVpeak led to a significant LG / HG discrimination for newly-diagnosed tumors (p = 0.01). Among all TI, entropy led to the best reclassification performance.* ***Conclusion:*** *The co-analysis of FDopa-PET/CT SUVpeak and well-selected TI (such as entropy) made it possible to improve the classification of newly-diagnosed gliomas.*

Index terms – Image Processing, Medical Physics, Nuclear imaging.

I. INTRODUCTION

In oncology, the coexistence in tumors of biological heterogeneity like the presence of necrosis, fibrosis or of specific receptors affects the evolution of cancer and the choice of therapy. Therefore, several groups have explored the interest of texture indices (TI) measured from PET images to characterize tumor heterogeneity for various types of cancer [1-2]. In addition, studies demonstrated that FDopa-PET/CT can distinguish between high-grade tumors (HG) and low-grade tumors (LG) in recurrent gliomas using Standardized Uptake Value (SUV) to characterize the tumor [3]. We studied whether the characterization of tumor texture in FDopa-PET/CT could assist in the identification of tumor grades in both primitive and recurrent gliomas.

II. MATERIALS AND METHODS

II.1. Patients and PET/CT protocol

Eighty one patients (age: 49±13) with gliomas were studied. Each patient underwent a 40 min dynamic FDopa-PET on a Philips Gemini TF scanner 3-min post injection without carbidopa premedication nor fasting. All patients underwent resection or biopsy and the pathological examination provided what was assumed to be the gold standard grade.

II.2. Volume of interest delineation and Texture analysis

Tumors were segmented using a thresholding method accounting for the background activity [4]. For each tumor, the SUVpeak and metabolic volume (MV) were measured, as well as 32 TI. Before calculating TI, voxel intensities were resampled between 0 and the maximum SUV of all tumors using 64 discrete values. After this step, we computed 3 texture matrices: co-occurrence matrix, gray-level run length matrix and gray-level zone length matrix. We extracted 32 TI: Homogeneity, Energy, Correlation, Contrast, Entropy, Dissimilarity, SRE, LRE, LGRE, HGRE, SRLGE, SRHGE, LRLGE, LRHGE, GLNUr, RLNU, RP, Coarseness, Contrast, Busyness, SZE, LZE, LGZE, HGZE, SZLGE, SZHGE, LZLGE, LZHGE, GLNUz, ZLNU, ZP, Sphericity [5].

II.3. Statistical analysis

The ability of SUVpeak, MV and TI to identify the tumor grade was investigated by using each index alone first (with p-value and ROC analyses) and by using couples consisting of one TI with SUVpeak in a binomial model (with ROC analyses and a reclassification method NRI [6]).

III. RESULTS

The 52 newly-diagnosed tumors consisted of 29 HG and 23 LG, while the 29 recurrent tumors included 21 HG and 8 LG. The results of ROC and NRI analysis are

summarized in Table 1. For HG/LG classification of newly-diagnosed tumors based on one significant index only, the AUC varied between 0.63 and 0.70. SUV peak and MV index did not allow a significant differentiation (pvalue>0.05, NS) unlike 8 TI (Homogeneity, Energy, Entropy, Dissimilarity, SRE, LRE, LRLGE, RP). Combining TI with SUVpeak improved the classification and yielded AUC up to 0.77 for entropy. Combining entropy with SUVpeak reclassified 3 LG and 5 HG tumors that were misclassified when using SUVpeak only, without modifying all the tumor classifications that were accurate based on SUVpeak only. In recurrent tumors, the discrimination between HG and LG tumor was better with an AUC between 0.75 and 0.92 based on one TI only (significant for Homogeneity, Energy, Contrast, Entropy, Dissimilarity, SRE, LRE, LGRE, HGRE, SRLGE, SRHGE, LRLGE, RP, SZE, LZE, LGZE, HGZE, SZHGE, Sphericity). Only the MV index was not significantly discriminant (NS, AUC=0.61). The impact of combining SUVpeak with TI was negligible for recurrent tumors.

IV. DISCUSSION – CONCLUSION

Neither SUVpeak nor MV could discriminate LG from HG in newly-diagnosed tumors, while SUVpeak alone could discriminate LG from HG in recurrent tumors (p=0.02). These results are perfectly consistent with what is known from the literature. Combining a TI (eg, homogeneity, entropy, or short-run emphasis SRE) with SUVpeak led to a significant LG/HG discrimination for newly-diagnosed tumors (p=0.01). Among all TI, entropy led to the best reclassification performance: by accounting for both SUVpeak and entropy, 67% of the newly-diagnosed tumors were assigned the correct grade vs 58% when using SUVpeak alone. Combining TI and SUVpeak did not significantly improve the classification of recurrent tumors (86% of properly classified tumors with SUVpeak only). The co-analysis of FDopa-PET/CT using SUVpeak and well-selected TI (such as entropy, homogeneity or SRE) made it possible to improve the classification of newly-diagnosed gliomas.

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newly diagnosed tumors	homogeneity	entropy	SRE	MV	SUVpeak
AUC±1SD for the index alone	0.70±0.07	0.69±0.07	0.70±0.07	0.59±0.08	0.64±0.08
AUC±1SD for the index combined with SUVpeak	0.76±0.07	0.77±0.07	0.74±0.07	---	---
net %LG reclassified	17.4	13	8.7	---	---
net %HG reclassified	10.3	13.8	17.2	---	---
recurrent tumors	homogeneity	entropy	SRE	MV	SUVpeak
AUC±1SD for the index alone	0.86±0.07	0.91±0.05	0.86±0.07	0.61±0.12	0.92±0.05
AUC±1SD for the index combined with SUVpeak	0.92±0.05	0.92±0.05	0.92±0.05	---	---
net %LG reclassified	0	0	0	---	---
net %HG reclassified	0	4.8	4.8	---	---

Table 1: Area under the ROC curve (AUC) for distinguishing between high-grade gliomas (HG) and low-grade gliomas (LG) for newly diagnosed tumors and recurrent tumors with one index only (2nd and 7th rows) or for the TI combined with SUVpeak (3rd and 8th rows). The net percentage of LG reclassified tumors corresponds to the number of LG tumors that were properly classified as LG only when combining the two indices minus the number of LG tumors that were improperly classified as HG when combining the two indices divided by the total number of LG tumors. Same for the HG tumors ; short-run emphasis index (SRE) ; metabolic volume (MV).