Textural analysis of pre-therapeutic [18F]-FET-PET and its correlation with tumor grade and patient survival in high-grade gliomas.

Abstract:
Amino acid positron emission tomography (PET) with [18F]-fluoroethyl-L-tyrosine (FET) is well established in the diagnostic work-up of malignant brain tumors. Analysis of FET-PET data using tumor-to-background ratios (TBR) has been shown to be highly valuable for the detection of viable hypermetabolic brain tumor tissue; however, it has not proven equally useful for tumor grading. Recently, textural features in 18-fluorodeoxyglucose-PET have been proposed as a method to quantify the heterogeneity of glucose metabolism in a variety of tumor entities. Herein we evaluate whether textural FET-PET features are of utility for grading and prognostication in patients with high-grade gliomas. One hundred thirteen patients (70 men, 43 women) with histologically proven high-grade gliomas were included in this retrospective study. All patients received static FET-PET scans prior to first-line therapy. TBR (max and mean), volumetric parameters and textural parameters based on gray-level neighborhood difference matrices were derived from static FET-PET images. Receiver operating characteristic (ROC) and discriminant function analyses were used to assess the value for tumor grading. Kaplan-Meier curves and univariate and multivariate Cox regression were employed for analysis of
progression-free and overall survival. All FET-PET textural parameters showed the ability to differentiate between World Health Organization (WHO) grade III and IV tumors (p< 0.001; AUC 0.775). Further improvement in discriminatory power was possible through a combination of texture and metabolic tumor volume, classifying 85 % of tumors correctly (AUC 0.830). TBR and volumetric parameters alone were correlated with tumor grade, but showed lower AUC values (0.644 and 0.710, respectively). Furthermore, a correlation of FET-PET texture but not TBR was shown with patient PFS and OS, proving significant in multivariate analysis as well. Volumetric parameters were predictive for OS, but this correlation did not hold in multivariate analysis. Determination of uptake heterogeneity in pre-therapeutic FET-PET using textural features proved valuable for the (sub-)grading of high-grade glioma as well as prediction of tumor progression and patient survival, and showed improved performance compared to standard parameters such as TBR and tumor volume. Our results underscore the importance of intratumoral heterogeneity in the biology of high-grade glial cell tumors and may contribute to individual therapy planning in the future, although they must be confirmed in prospective studies before incorporation into clinical routine.