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ORIGINAL ARTICLE

The diagnostic value of dual phase FDG PET CT in grading of gliomas

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KEYWORDS

FDG PET CT;
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Abstract *Objective:* The purpose of this study was to investigate the correlation between the FDG PET CT and histopathology in grading of gliomas.
Methods: 16 patients with clinically diagnosed glioma performed dual phase FDG PET CT of the brain for staging, and the staging was correlated to the histopathological classification in the surgical specimen.
Results: We found good correlation between the dual phase PET CT grading and the histopathological grading of gliomas, when a 23% increase was used as the cutoff for analysis of the difference in SUVmax of the lesion (L) versus normal gray matter (GM) over time, the sensitivity was 88.9%, the specificity was 85.7%, and the accuracy was 89.4% ($P = 0.003$; AUC = 0.94).
Conclusion: Dual phase FDG PET CT is a reliable predictor of proliferative activity of gliomas and could be used as a method of grading of the tumor.

1. Introduction

Preoperative assessment of tumor proliferative activity or malignancy has a potentially significant impact on the therapeutic strategy for patients with brain tumor. Positron emission tomography has been the method of choice for evaluating metabolism and malignancy (1).

The World Health Organization (WHO) classification of tumors of the central nervous system is a representative classification system for grading of a brain tumor, and is accepted and used worldwide (2).

Grading is based on the degree of nuclear atypia, mitosis, microvascular proliferation, and necrosis, with increasing anaplasia as tumor grade increases. The histologic features of the tumor and the age and performance status of the patient are major prognostic factors on outcome (3). Furthermore, PET has been introduced as an important tool in the definition of the tumor extent for therapy planning (4).

Dual-time-point 18F-FDG PET has significantly improved the diagnostic sensitivity and specificity for head and neck cancers, breast cancer, malignant lung lesions, and some others (5). Spence et al. (6) have introduced this methodology in

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neurooncology and have studied delayed images visually and quantitatively using volumes of interest (VOIs). They investigated the behavior of model-derived kinetic rate constants over time and concluded that 18F-FDG is dephosphorylated faster from normal tissue than from tumor, improving image contrast.

In this study, we correlated the results of the FDG PET CT of the brain glioma with the histopathological classification of the tumor specimen obtained at surgery.

2. Patients and methods

2.1. Study population

Sixteen patients with glioma, 9 men and 7 women, 24 to 60 years old (mean age, 40 years), were examined in the study during the period of July 2014 to March 2015. All patients performed dual phase FDG PET CT in a private center and subsequent surgery for subtotal or total tumor removal. The PET CT study was performed within 2 weeks prior to surgery. The results were correlated to the histological classification in all patients.

2.2. Dual phase PET CT protocol

Patients fasted for at least 8 h before F-18 FDG positron emission tomography with computed tomography (PET/CT). Mean fasting serum glucose of patients was 118–150 mg/dL, and 4 patients had a history of diabetes mellitus. The early PET/CT scans were started 40 to 45 min after the administration of 8–15 mCi F-18 FDG using an hybrid PET/CT system (Ingenuity, TF PET/CT /Philips, the Netherlands), and the delayed PET/CT scans were performed at 75 min after the early scan. The axes of both systems are mechanically aligned to coincide optimally. CT data were acquired first and the following parameters were used: tube rotation time, 0.5 s per revolution; 120 kV; 140 mAs; reconstructed slice thickness, 5 mm. No contrast medium was used for the CT examination. After the acquisition of CT data had been completed, the tabletop with the patient automatically advanced into the PET sensitive field of view and acquisition of PET data was started in
3-dimensional mode with the patient in exactly the same position on the table. Scanning was performed in one bed position for 3 min. The attenuation correction was automatically completed using corresponding CT data.

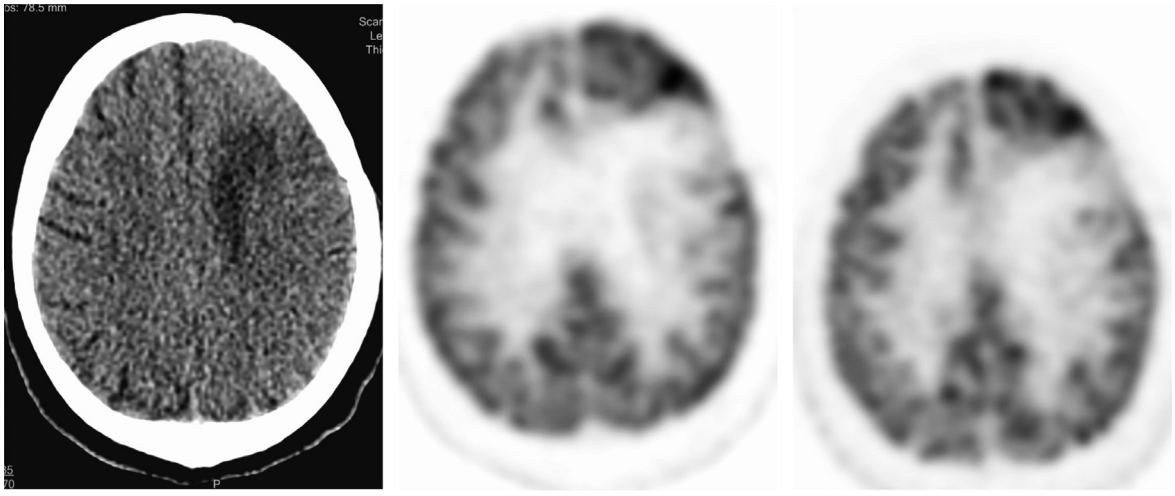
2.3. Data analysis

Semi-quantitative analysis of PET images was performed, and Maximum and mean standardized uptake values (SUVmax and SUVmean) of the lesion and normal gray matter were measured at early (1) and delayed (2)) imaging sessions. Circular regions of interest (0.5–1.0 cm, as appropriate) were used to determine the mean and max SUV of the lesion (L), and of the normal contralateral frontal gray matter (GM) at the level of the thalamus and the centrum semiovale (WM).

Ratios of L SUVmax to GM SUVmax at early and late time points (L1/GM1 and L2/GM2 respectively) were calculated individually, and the change between early and late L to GM ratios was calculated using the formula: [(L2/GM2 – L1/GM1)/(L1/GM1)]. Similar calculations were performed using GM SUVmean, WM SUVmean and WM SUVmax (Fig. 1).

2.4. Statistical analysis

The diagnostic accuracy of PET derived indices was calculated using Receiver Operating Curve (ROC) analysis. The cutoff values were determined automatically by the ROC analysis program. The optimal cutoff value for these variables was defined as the point on the ROC curve with minimal distance from



(a) (b) (c)

Fig. 1 50 years old patient with left frontal low grade glioma by noncontrast CT (a), early (b) and late (c) PET images showed, early SUVmax of the lesion = 6 and 4.7 in the late scan, difference of −21.7%, the GM early SUVmax was 7.8 and 5.9 in the late scan, difference of about −24.4%, and the ratio between the lesion and gray matter uptake was 0.77 in the early and 0.80 in the late phase with L/GM difference of 3.6%.