Case Report

Does increased 18FDG uptake reflect malignant transformation of a low-grade glioma? A diagnostic dilemma

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Benign gliomas of the brain show decreased uptake of 18F fluoro-deoxyglucose (FDG) on positron emission tomography (PET). Malignant transformation is usually manifested by an increase of 18FDG uptake. A 45-year-old female has been followed up since 1987 by means of 18FDG-PET for a right hemispheric World Health Organization Grade II oligoastrocytoma. In 1996, increased epileptic activity was accompanied by increased 18FDG uptake within the temporal part of the tumor. After surgery, the epileptic seizures diminished. Histological examination of the resected tumor showed no change in the pathology when compared with the first biopsy. Localized temporal increase of 18FDG uptake was not associated with malignant progression. The decrease of seizure frequency might shed light on a putative connection of hyperglycolysis and epileptic discharges.

Key Words: 18FDG-PET, malignant transformation, ictal scan, low-grade glioma.

Introduction

Benign gliomas of the brain appear as hypometabolic areas on 18F fluoro-deoxyglucose positron emission tomography (18FDG-PET). Malignant transformation and tumor progression results in an increased 18FDG uptake. We present a case of a World Health Organization (WHO) Grade II oligoastrocytoma with a total present length of 17 years’ survival time, despite indication – based on elevated 18FDG uptake - of malignant progression eight years previously (Table 1).

Case Report

A right frontal WHO Grade II oligoastrocytoma in a 28-year-old female was operated on in 1987. The patient stayed seizure-free until 1994, when an infiltrating recurrence was detected. 18FDG uptake was not elevated (Figure 1a). Partial temporal seizure activity became uncontrolable in 1996 with tumor extension towards the temporal lobe and the midline structures. The 18FDG-PET showed increased tracer uptake in the temporal region suggesting the possibility of malignant transformation (Figure 1b). The tumor then was repeatedly resected with evidence of residual parts in surgically inaccessible ganglionic structures. After surgery, the patient became seizure-free again. Histology of the second partial resection from the region of highest 18FDG uptake turned out to be the same WHO Grade II. oligoastrocytoma (GFAP positive gemistocytes and tumor cells with fried egg appearance, no necrosis, no atypia, slight endothelial proliferation and infrequent mitosis). The repeated post-operative 18FDG-PET revealed no elevated tracer uptake within the residual parts. Following recovery from surgery, conventional irradiation and PCV chemotherapy were administered. Eight years later, to date, the patient is in clinical remission. The follow-up 18FDG-PET scans have revealed gradual elevation of tracer uptake in the residual tumor, and thus a new cycle of PCV chemotherapy has been indicated (Figure 1c).

PET investigations

All static cerebral PET scans were performed using a GE 4096 Plus PET scanner (GE Medical Systems AB, Uppsala). The patient received 104 ± 44 iCi/kg (mean ± SD) 18FDG as an intravenous bolus injection in a dark, silent room 30 minutes prior to scanning. Axial scans with spatial resolution of 6.5 mm full width at half-maximum were obtained. Corrections for tissue attenuation were allowed by transmission measurements (25 min) performed before emission scans using a 68Ge source of 8 mCi activity. The tumor-to-white matter (T/WM) and tumor-to-frontal cortex (T/C) uptake ratios were used to substitute true 18FDG utilization (Table 1). The most accepted cut-off level in the differentiation of high-grade from low-grade tumors is 1.5 for T/WM and 0.6 for T/C ratios. The co-registered MRT (Shimadzu SM 100X, 1 Tesla) and PET images were merged (Register, McConnel Brain Imaging Center, Montreal Neurological Insti-
Figure 1a: Neuroradiological features in 1994. The corresponding axial slice of MRT (i), 18FDG-PET (ii) and the merged co-registered scans (iii) made after a diagnosis of the recurrent tumor. The $^{18}$FDG uptake of the whole tumor is less than the normal brain tissue's.

Figure 1b: Neuroradiological features in 1996. The corresponding axial slice of MRT (i), $^{18}$FDG-PET (ii) and the merged co-registered scans (iii) made before second operation in 1996 after nine years from discovery. The red arrow points out the right temporal region of elevated $^{18}$FDG uptake. The surrounding part of the tumor is hypometabolic.

Figure 1c: Neuroradiological features in 2003. The corresponding axial slice of MRT (i), $^{18}$FDG-PET (ii) and the merged co-registered scans (iii) made after 16 years of medical history. The tracer uptake of infiltrating right hemispheric tumor is elevated but does not approach the extent that was detected in 1996.
Discussion

18FDG-PET studies have shown good correlation between histological grade and tracer uptake that is intrinsically heterogeneous in gliomas.\textsuperscript{[1-3]} Regionally elevated tracer uptake is considered to be related to the presence of anaplasia, higher proliferation rate and cell density, hypervascularization, and inflammation.\textsuperscript{[2-3]} The temporal hypermetabolic region had been assumed to be a sign of malignant transformation but histology proved WHO Grade II, oligoastrocytoma. It occurred after a nine year long follow-up. In most cases of intracerebral tumors, resection results in decrease of seizure frequency and the regrowth often result in increase or recurrence of previously eliminated and temporarily absent fits, suggesting that the pacemaker area is mainly represented in the tumor and/or within a close vicinity.\textsuperscript{[4-5]} There was no preserved gray matter in the removed specimen, but the overlying cerebral cortex might have acted as a pacemaker since in case of epileptic activity the uptake rises because of excessive number of action potentials generated. The patient was not having seizures during the PET scans. EEG monitoring could help, but in focal seizure activity conventional scalp electrodes might not reveal spikes when the underlying tumor is expansive. In our case, after temporal resection, the seizures subsided, a fact that possibly implies that the elevated temporal 18FDG uptake might have been a result of continuous temporal epileptic activity.\textsuperscript{[6]}

Acknowledgement

The authors wish to express grateful appreciation for technical assistance to Irma Kari.

References


Accepted on 20.04.2004.