

## FDG PET in Dementia

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### Commentary

Positron emission tomography (PET) is a branch of Nuclear Medicine, a new novel way of functional imaging using radioisotopes, which has a significant role in all aspects of dementia-early diagnosis, differential diagnosis, and the assessment of drug treatment. [<sup>18</sup>F] Fluorodeoxyglucose (FDG) allows measurement of cerebral glucose metabolism both qualitatively and quantitatively. The metabolic activity of glucose in the brain can be assessed using FDG which is an analog of glucose. It is phosphorylated by a hexokinase into FDG-6 phosphate which cannot be metabolised further into the glycolytic pathways. It starts to accumulate proportionally to the rate of glycolysis in the cells. FDG reflects levels of cerebral glucose metabolism is the most commonly used and available PET agent, though many other newer PET agents are being developed to assess more specific cellular and neurotransmitter activities. PET MRI and Amyloid PET are still being evaluated for their clinical utility in diagnosis of Alzheimer's disease.

PET primarily images glucose metabolism at a cellular level. While SPECT focuses on perfusion, though both are essentially functional imaging when compared to CT or MRI which are primarily structural imaging modalities where the resolution of the images is much higher allowing better anatomic delineation. PET has better resolution and sensitivity to pick up more disease when compared to SPECT. <sup>18</sup>F-fluorodeoxyglucose-PET (FDG PET) provides an index of not only the synaptic integrity and also pattern of hypometabolism. Different and distinct spatial patterns of metabolism seen in the brain PET images guide the interpreting physicians make a reasonably accurate early diagnosis which helps the treating physicians in planning management and/or prognosticate disease in different types of dementia. It has been shown to provide key prognostic data in dementia and also predicts the disease progression to dementia. In dementia CT or MRI will usually demonstrate no-specific cortical atrophy. PET scans can demonstrate a pattern of hypo-metabolism which co-relates with different types of dementia's (sub-cortical or cortical).

In Amnesic Mild Cognitive Impairment (MCI), FDG PET brain scans initially shows a pattern of hypometabolism in the posterior cingulate and parahippocampal gyri, which later spreads to the bilateral temporal lobes (middle and inferior temporal gyri). As the disease progress to Alzheimer's disease involvement of the parietal lobes is seen often extending to the prefrontal cortex. Alzheimer's disease is characterized by hypometabolism in associative parietotemporal area, however the basal ganglia, thalamus, cerebellum, primary sensory motor cortex, and visual cortex are typically spared. As the disease advances further, the hypometabolism starts to extend to prefrontal cortex. The key differentiating factor is the sparing of primary neocortical areas, including the sensorimotor cortex, visual cortex, subcortical gray matter, basal ganglia, thalami, and cerebellum, which differentiates Alzheimer's disease from other subcortical causes

of dementia. Though progression to Alzheimer's' disease is seen only a small percentage of patients with Mild Cognitive Impairment, PET imaging can help identify patients in whom such a progression may progress. Early detection is the key in management of dementia, allowing prompt evaluation and treatment, particularly in cases of reversible or treatable causes of cognitive impairment (i.e., due to depression or insomnia). Sometimes vascular dementia and Alzheimer's disease may co-exist and also Alzheimer's disease can occur in conjunction with Parkinsonism and Lewy body disease. In Frontal Temporal Dementia, there is hypometabolism is predominately seen in the frontal anterior temporal lobes and sometimes in the subcortical structures. Picks disease shows frontal metabolic defects. Huntington's disease there is decreased metabolism in the caudate nucleus, not only in symptomatic patients but also in asymptomatic gene carriers. In Lewy Body Dementia, FDG PET shows a characteristic pattern of hypometabolism involving the occipital cortex, typically sparing the posterior cingulate cortex. In Vascular Dementia, show areas of focal cortical and subcortical hypometabolism are seen scattered on the FDG brain images.

Before the patient is subjected to the scan, a detailed dementia workup along with cognitive scales or neuropsychological testing, laboratory tests is done as a part of initial evaluation. It is very important to standardize the Imaging protocol to get images which are of good quality and consistency. The time between injection & imaging, taking all precautions in order to keep brain activity to a minimum, avoiding stress (of any sort including i.v. canula placement), and comfortable seating in a semi dark quiet room. No TV or reading or Video games or usage of mobile phone while waiting is allowed. Sedation may be needed occasionally. Images acquired in a comfortable position with a low-dose CT scan for attenuation correction purposes. All acquired data is processed images are digitally co registered and reconstructed in three orthogonal planes before interpretation.

A normal PET scan usually indicates that there has been no progression of cognitive impairment, usually for a follow-up period of 3 years. This is particularly important in to follow up patients with an initial presentation of cognitive symptoms of dementia. Many recent studies on large patient populations have been done, all of which indicate a sensitivity level of 93% to 95% in the diagnosis of Alzheimer's disease. Early diagnosis with such a high level of accuracy is the most important factor and has also been proven to be beneficial for patients who are being considered for pharmacologic and cognitive therapies. Although no definitive or curative treatment is available for Alzheimer's disease at this time; many different pharmacologic agents are available which can help treat symptomatic patients. For Eg, Cholinesterase inhibitors, Glutamate regulators & neuroprotective agents. Therefore, FDG PET helps diagnosing patients with a higher level of accuracy in early stages of disease, and can also provide specific

prognostic information prognosis remains an imperative factor in the management of dementias. This not only has several economic implications but also contributes positively towards a better quality of life for the patients.