Dementia syndromes are a leading cause of morbidity and mortality in the elderly population. Unfortunately, there are limited treatment options, especially in advanced cases. This creates a diagnostic dilemma, as the dementia syndromes often overlap in clinical presentation early in the disease process. 18F-FDG has been utilized to help differentiate between the various causes of dementia based upon differing areas of altered brain metabolism, allowing for an appropriate treatment regimen to be initiated.

18F-FDG can also be used to identify confirm cases of suspected dementia early in the disease process, such that the few treatment options available may actually impact the patient. Interpretation of 18F-FDG brain PET scans based upon visual analysis is very subjective and can be challenging. Utilizing software that allows for quantitative analysis of brain metabolism with respect to a normal population, such as MIM Neuro by MIM Software (Cleveland, OH), can lead to improved diagnostic accuracy. For example, this software highlights statistically significant anatomic regions of altered brain metabolism leading to increased confidence in the interpretation of these scans.

![PET images](image)

Figure 1: Axial, Coronal and Sagittal PET images demonstrate an advanced case of AD with decreased metabolism within the posterior parietotemporal lobes, precuneus, posterior cingulate gyrus and within the frontal lobes to a lesser degree. Note the preservation of activity within the occipital lobes and the primary sensoriomotor cortex. Statistical parametric images confirm findings of severe hypometabolism in these regions. Z-score: Light blue -2 SDs, Dark blue -2.5 SDs, Purple -3 SDs.
Alzheimer’s disease (AD) is the leading cause of dementia characterized clinically by memory loss and cognitive impairment. Classically, patients will demonstrate symmetric, decreased metabolism within the posterior cingulate gyrus, precuneus and within the posterior parietotemporal lobes/parietotemporal association cortices (Figure 1). Specifically, hypometabolism within the posterior cingulate gyrus and the precuneus are hallmarks for dementia of the Alzheimer type. In advanced stages, hypometabolism can extend to the frontal lobes. However, metabolism within the primary motor cortex, primary sensory cortex, occipital lobes and cerebellum remain preserved throughout the disease process, another hallmark of AD. Mild cognitive impairment (MCI) is a heterogeneous clinical entity, typically seen as an intermediate stage between normal aging and dementia (usually AD). Clinically, patients present with evidence of mild cognitive decline, such as mildly decreased scores on the Mini-Mental State Exam. On imaging, these patients typically demonstrate hypometabolism solely within the posterior cingulate gyrus. This is contradistinction to individuals with early AD, where hypometabolism is seen within the posterior cingulate gyrus, precuneus and the posterior parietotemporal lobes. Identifying other areas of hypometabolism can be used to identify patients who clinically present with MCI who are at increased likelihood of progressing to AD. Subtle cases may be difficult to detect visually and can only be made using software that allows for quantitative analysis.

Lewy Body Dementia (LBD) is the second most common dementia syndrome with patients presenting with visual hallucinations, fluctuating cognition and Parkinsonian symptoms. This can be differentiated from dementia secondary to Parkinson’s disease (PD) based upon the onset of Parkinsonian symptoms, which is seen greater than 1 year prior to cognitive decline in PD, although histopathologically, both entities are similar. Metabolic imaging is useful in this patient population to differentiate from AD, which can present similarly based upon clinical evaluation, especially early in the disease process. LBD presents as hypometabolism within the posterior parietotemporal lobe and posterior cingular gyrus, similar to AD. However, in many cases, there is also hypometabolism within the occipital cortices in LBD (Figure 3), which is spared in AD. This is most commonly used to suggest the diagnosis of LBD if it is present.
Figure 3: Axial CT image with a statistical map overlay from a F18-FDG brain PET scan and parametric statistical maps demonstrate hypometabolism within the posterior parietal lobes and the occipital lobes, which is characteristic for LBD. Z-score: Light blue -2 SDs, Dark blue -2.5 SDs, Purple -3 SDs.

Frontotemporal dementia (FTD) is a leading cause of dementia in patients slightly younger than those seen in AD or LBD. FTD is a heterogenous group of disorders used as a broad category clinically to classify patients with symptoms involving the frontal or temporal lobes. These patients typically demonstrate hypometabolism involving the frontal lobes and anterior temporal lobes, including the anterior cingulate gyrus (Figure 4). There can be variation in the patterns of hypometabolism, such as frontal predominant disease or temporal predominant disease (semantic dementia). The distinction between the various subtypes of FTD is less important, as no pharmacologic therapies are currently available for these patients.

Figure 4: Axial brain PET image and parametric statistical maps demonstrate marked hypometabolism of the frontal lobes and to a lesser degree the anterior temporal lobes, including the anterior cingulate gyrus, compatible with frontotemporal dementia. Z-score: Light blue -2 SDs, Dark blue -2.5 SDs, Purple -3 SDs.

F18-FDG is an excellent test to help distinguish between the many causes of dementia earlier in the disease process. The use of software with statistical analysis can improve diagnostic confidence, especially in subtle cases. Nevertheless, the various patterns of dementia have significant overlap and can be confusing. In indeterminate cases, further workup with amyloid imaging (F18-Florbetapir) or I-123 Ioflupane (DaT scan) should be considered.

References:
1. Ishii, K. PET Approaches for Diagnosis of Dementia. AJNR 2014, 35: 2030-38.

