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REVIEW ARTICLE

POSITRON-EMISSION TOMOGRAPHY (PET) AND SINGLE-PHOTON-EMISSION COMPUTED TOMOGRAPHY: DIAGNOSIS OF NEUROLOGICAL DISORDERS

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Abstract:
Functional neuroimaging is a major tool in the study of neurological illnesses. It plays a role in diagnosis, therapy, and surgical planning. It can aid in the identification and understanding of functional movement impairments, as well as their differentiation from other diseases. It can also aid in detecting co-morbid organic illnesses. Positron-emission tomography (PET) and single-photon-emission computed tomography (SPECT) are well-known nuclear-medicine imaging techniques utilized in current neurological diagnostics. PET (Positron Emission Tomography) and SPECT (Single Photon Emission Computed Tomography) are two imaging procedures that use radioactive tracers to analyze the brain and other organs. They are essential in both clinical research and treatment development, and can aid in the early detection and treatment of neurological diseases. So, the combination of PET with 18F-fluorodeoxyglucose (FDG) and SPECT with a 111 In-labeled ligand provides clinicians with information an other kind of neurological disorders.

Keywords: *Positron-emission tomography, PET, Single-photon-emission computed tomography, SPECT, Diagnosis of Neurological disorders*

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Introduction:

Functional neuroimaging is the use of neuroimaging technology to assess a specific element of brain function, generally in order to better understand the relationship between activity in certain brain areas and specific cognitive functions.[1] Common approaches of functional neuroimaging include: Single photon emission computed tomography (SPECT), Positron Emission Tomography (PET), Functional magnetic resonance imaging (fMRI), Electroencephalography (EEG), Magnetoencephalography (MEG), Functional Near-Infrared Spectroscopy (fNIRS) and Functional Ultrasound Imaging (fUS).[1,2]

PET (positron emission tomography) and SPECT (single photon emission computed tomography) scans are two medical imaging procedures that use radioactive tracers to provide 3D images of the body's interior functioning.[3] PET scans employ radiotracers to emit positrons, whereas SPECT scans use radiotracers to release gamma rays. PET provides superior spatial resolution than SPECT. PET scans offer higher resolution than SPECT scans, with pictures averaging 5 mm against 10-20 mm for SPECT. PET has a better sensitivity, which means it can detect smaller levels than SPECT. [4]

In general, SPECT radioisotopes may be measured for hours to days, whereas PET radioisotopes can be measured for minutes to hours. PET provides superior spatial resolution than SPECT PET devices require an on-site cyclotron to supply radioisotopes, whereas SPECT machines are more generally available. PET scans are effective for cancer diagnosis and brain

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imaging, whereas SPECT scans are commonly utilized for bone scans and heart/blood flow imaging.[5]

Both scans use very small amounts of radioactive tracers that are quickly removed by the body, and radiation exposure is negligible and comparable between the two. A single photon emission computed tomography (SPECT) scan is an imaging technique that reveals how blood flows to tissues and organs. It may be used to diagnose seizures, strokes, stress fractures, infections, and spinal malignancies. [4]

Positron Emission Tomography (PET) Imaging:

Introduction:

Positron Emission Tomography (PET) is a non-invasive imaging method that produces three-dimensional (3D) images of the interior of the body using radioactive tracers.[5] It is frequently employed to evaluate blood flow, metabolic activity, and chemical composition of organs and tissues. Using radioactive isotopes, this imaging method can examine a range of chemical or functional characteristics in both healthy and diseased brains that are not available with other imaging techniques. A biological tracer is identified by a positron-emitting radionuclide in positron emission tomography (PET) imaging.[6] A positron is a positively charged electron (Fig.-1).

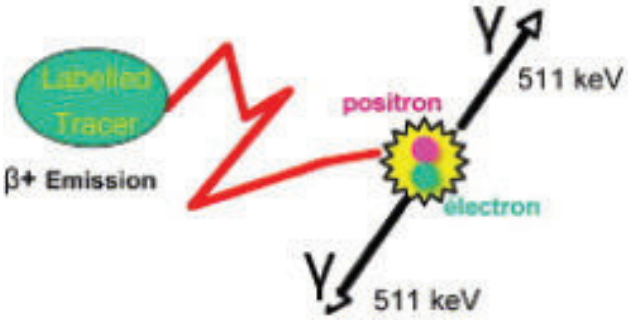

Fig.-1: *A positron is a positively charged electron*

Source: semnuclmed.2011.11.003. doi: 10.1053/j. PMCID: PMC3586419.

PET scans of the brain are used to identify or highlight tumors and diseased tissue, measure blood flow, measure cellular and/or tissue metabolism, assess patients with seizure disorders that do not improve with medication, assess patients with specific memory disorders, and identify changes in the brain after trauma or drug abuse. It is clinically proven that brain metabolism can be visualized indirectly through perfusion directly utilizing PET and [F-18] fluorodeoxyglucose (FDG). [7]

In vivo measurements of cerebral blood flow and metabolism have been made possible using radio-isotopes like [15O] or [18F] deoxyglucose (Figure: 1). The tracer is administered by gaseous inhalation or intravenous injection, and tomographic images show where it is distributed throughout the brain. PET studies that assess receptor binding, such as those that examine dopaminergic receptors in extrapyramidal disorders, also include radioisotope labels.[8]

Advantages:

PET studies have shed a great deal of light on the pathophysiology and pathogenesis of diseases as well as elements of normal brain activity. Important information has been gathered about the different anatomical patterns of altered flow and metabolism in a variety of neurodegenerative illnesses, as well as the patterns of flow and oxygen use in infarcts and the ischemic penumbra that surrounds them. Figure 5 shows amyloid PET in Alzheimer's Disease and Frontal Lobe Dementia.[9]

Disadvantages:

It is an expensive tool, requires immediate access to a cyclotron. The opportunity for serial examinations is limited by the constraints of radiation exposure.[10]

Limitations of Positron emission tomography (PET) scans:

PET scans can generate erroneous results if a patient's chemical balance is abnormal. Patients with diabetes, for example, or those who ate within a few hours of the scan, may have inaccurate results. The radioactive chemical used in PET scans decays quickly, so be on time for your appointment. PET scans may not have the same image resolution as CT or MRI scans. Patients may need to fast for a few hours prior to the scan. PET and CT scans have difficulty detecting cancers less than one centimeter in diameter. PET scans have limits in certain types of cancer, such as breast and thyroid cancer. Patients who suffer from claustrophobia or anxiety may struggle to complete the scan.[11]

PET in Dementias:

Positron Emission Tomography (PET) scans are used to determine the levels of specific chemicals in the brain. There are several distinct types of PET scans. An amyloid-PET scan detects the accumulation of aberrant amyloid protein in the brain, which is one of

the hallmarks of Alzheimer's disease. An ^{18}F]fluorodeoxyglucose, FDG) ; FDG-PET scan assesses the concentration of glucose in the brain, demonstrating how the brain uses energy(Fig.-2). ^{18}FDG PET scan, reveals areas of the brain where nutrients are not being used effectively for energy. A brain with Alzheimer's disease exhibits a loss of red color and an increase in yellow, blue, and green colors, indicating diminished metabolic activity.[12] Several other PET tracers have also been created to investigate the neuropathology and changes in neurotransmitter systems that underpin dementia, to further our understanding of the pathophysiology of dementia, and to improve diagnostic accuracy (Table:1).

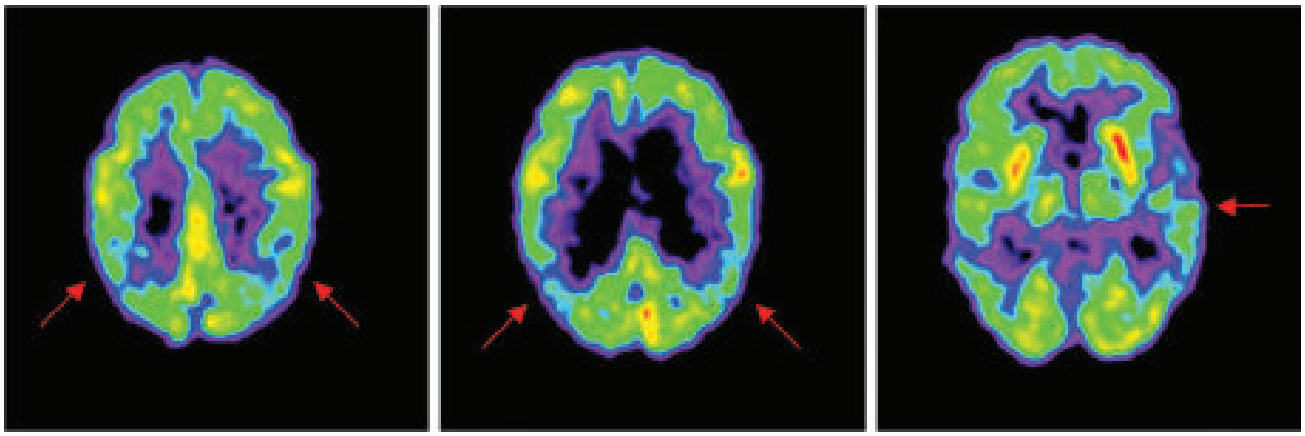

Fig.-2: *8F-FDG PET images of early AD. Early Alzheimer's typically affects the parietal, temporal, and posterior cingulate cortices. Brain images of this 80-y-old woman demonstrate hypometabolism of the parietal cortex, bilaterally (left and middle), with relative sparing of the primary visual cortex, sensorimotor cortex, thalamus, and basal ganglia. In the early stages of AD, deficits often appear asymmetrically, as evidenced here by mild hypometabolism of the left temporal cortex (right). In later stages of the disease, degeneration will be apparent bilaterally.*

Source: Daniel H.S. Silverman ; Journal of Nuclear Medicine April 2004, 45 (4) 594-607;

Table I

Major findings in dementia for PET tracers mainly used in clinical practice

Disease	[18F]FDG	[11C]PiB/[18F]FDDNP	Dopaminergic system tracers
AD	Parietotemporal, posterior cingulate, medial temporal hypometabolism, accompanied by frontal hypometabolism in advanced disease	high cortical uptake, mostly in frontal, parietal, and temporal association cortices	Normal
FTLD	Frontal lobe hypometabolism, accompanied by temporal and subcortical hypometabolism in advanced stages; SD: temporal hypometabolism, associated with frontal hypometabolism; PNFA: left frontotemporal hypometabolism	Low cortical [11C] PIB retention; high [18F] FDDNP uptake in frontal and prefrontal regions	Normal
LBD	Widespread hypometabolism with marked metabolic reductions in occipital cortex	DLB: high cortical [11C]PiB retention; PDD: low cortical [11C] PiB retention	Marked reduction in striatum, more prominent in putamen

PET scans in Parkinson's Disease:

The brain's dopamine-producing neurons' capacity to generate dopamine is reflected in 18F-DOPA absorption. Research has indicated that elevated bradykinesia and rigidity, but not tremor, are associated with 18F-DOPA uptake.[13]

PET tracers like 18F-DOPA and radiolabeled tracers tailored for dopamine transporters (DaT) and vesicular monoamine transporters (VMAT) can be used to evaluate motor dysfunction. At the synapse—the junction of two nerve cells or a nerve cell and a muscle cell—both DaT and VMAT are membrane-embedded proteins that aid in the uptake of monoamine neurotransmitters like dopamine. PET can detect abnormal activity of these transporters, which is used to diagnose Parkinson's disease early.[14]

Additionally, PET can be used to distinguish Parkinson's disease from other movement diseases. As an illustration, 18F-DOPA PET has been used to distinguish between idiopathic Parkinson's disease and drug-induced Parkinson's disease(Fig.-3). Taking antipsychotics can cause drug-induced Parkinsonism, a reversible illness. In contrast to idiopathic Parkinson's patients, who have diminished DaT activity even in the early stages of the disease, drug-induced Parkinson's patients' brains do not exhibit any changes in presynaptic DaT activity.[15]

Since the uptake of 18F-FDG in the brains of patients with multiple striatal atrophy (MSA) is low and that of people with Parkinson's disease is either normal or elevated, PET with this tracer can be utilized to distinguish between patients with MSA and those with Parkinson's disease.[16]

Dementia, linked to alterations in the brain's cortical region, affects about 40% of patients with Parkinson's disease. Due to their low cortical area activity, people with dementia can be distinguished from those without dementia using PET tests using 18F-FDG, even in the early stages of Parkinson's disease. Research also revealed that individuals with dementia from Parkinson's disease have lower glucose metabolism, as measured by the uptake of 18F-FDG in the frontal, temporal, and parietal regions of the brain, as compared to those without dementia.[16,17]

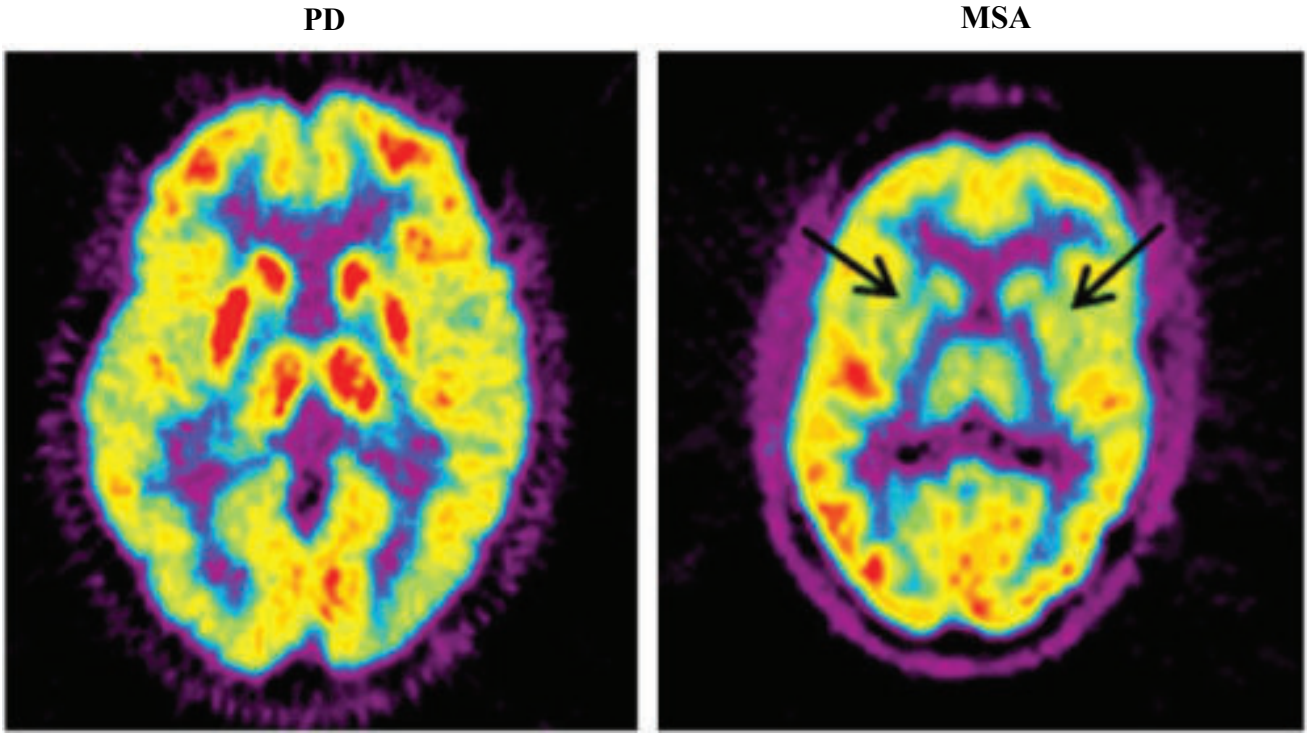

Fig.-3 *F-18-FDG PET in Parkinson's disease (PD) & Multiple-system atrophy(MSA). 18 F-FDG PET images of PD and multiplesystem atrophy patient. Multiple-system atrophy patient shows significant striatal reduction of glucose metabolism. MSA multiple-system atrophy.*

Source: Journal of Nuclear Medicine ;2010;51(4):596-609. DOI:10.2967/jnumed.108.059998

PET in Multiple Sclerosis:

Neurodegeneration results from inflammation and demyelination in the central nervous system (CNS), which are linked to the pathology of multiple sclerosis (MS). These processes have been imaged using a variety of positron emission tomography (PET) tracers. Neuro-inflammation has been measured using PET tracers for 18-kD translocator protein (TSPO) receptors, which are overexpressed on activated microglia, macrophages, and astrocytes. Increased activation of inflammatory cells was shown by PET imaging of TSPO expression in normal appearing white matter (NAWM), grey matter (GM), and MS lesions (Fig. 4). One of the key factors influencing the effectiveness of treatment was found to be a decrease in inflammation in MS lesions. Recently, myelin visualization with PET has advanced.[18]

First clinical trials using PET to visualize myelin yield encouraging findings. When evaluating neuronal damage in various neurodegenerative illnesses, [18F] FDG remains the primary PET tracer. PET's current clinical use in MS are primarily limited to supporting differential diagnosis or assessing the effectiveness of immune-suppressive therapies. The initial metabolic and structural alterations in MS neurons can be found by PET imaging of the mitochondria and synaptic vesicles. In clinical trials of medications intended to postpone or stop neurodegeneration in multiple sclerosis, PET imaging of pathological processes may offer reliable outcome markers.[19]

PET scan in brain tumor:

A positron emission tomography (PET) scan is a type of brain imaging examination used to detect tumors of the brain A PET scan employs a radioactive tracer that binds to brain tumor cells, making them visible on the image (Fig.-5). PET scans are very efficient at detecting rapidly growing brain cancers like glioblastomas and some oligodendrogliomas. However, they are less effective at detecting slow-growing brain tumors, which are more common in benign tumors. So, to produce even more detail three dimensional images for highly exact diagnosis, the scans can be merged in a PET-MRI scan or a PET-CT scan.[20]

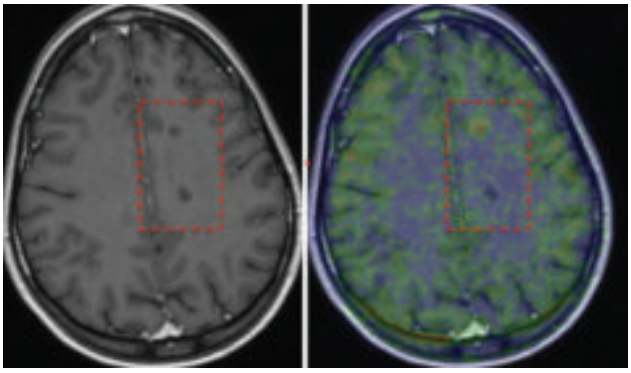

Fig.-4: *TSPO-PET imaging for neuroinflammation in multiple sclerosis. Chronic T1 lesions were differentiated in vivo using TSPO-PET. The left image shows a T1-weighted MRI image with two T1 black holes that appear comparable (no gadolinium enhancement). TSPO-PET (on the right) demonstrates that in the upper lesion, there is microglial activation, confirming this lesion as a chronic active lesion, but in the lower lesion, there is no radioligand uptake, confirming this lesion as a chronic inactive lesion.*

Source: Frontiers in Neurology, *9*, 341831. https://doi.org/10.3389/fneur.2018.00181

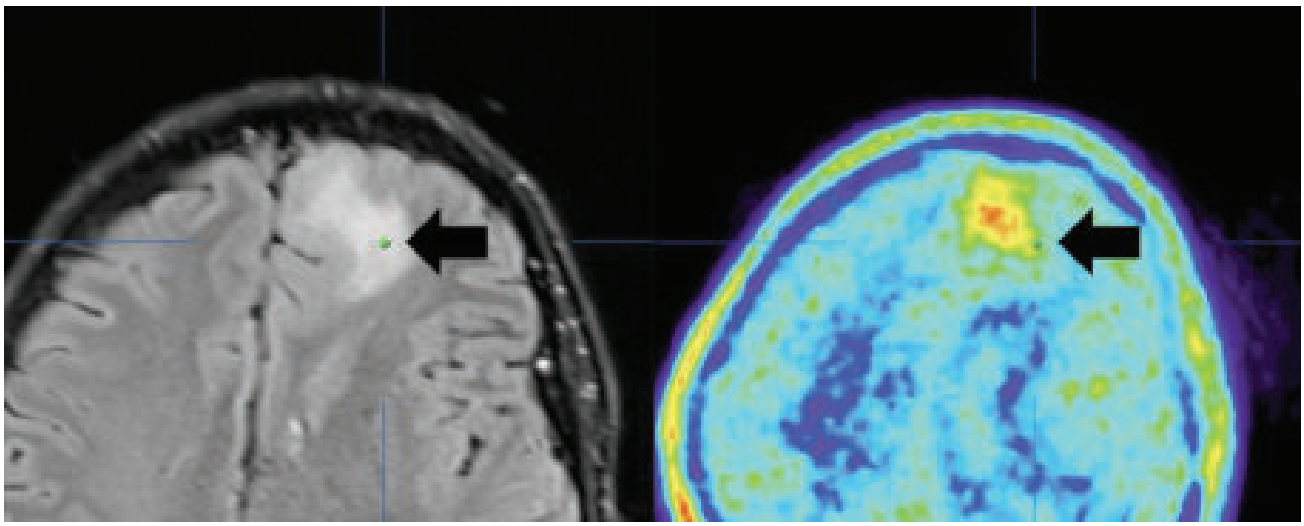

Fig.-5: *On the left, an image of the brain obtained using magnetic resonance imaging; on the right, using a new tyrosine PET procedure. The location of the tumor is indicated by the arrow.*

Source: Franciszek Lukaszczyk Oncology Center; Harat et al., Nature Communications 2023 (CC BY 4.0)

Single Photon Emission Computed Tomography (SPECT) Scan:

A single photon emission computed tomography (SPECT) scan is a functional nuclear imaging method used to assess regional cerebral perfusion. Because cerebral blood flow is directly related to neuronal activity, the activity distribution is thought to reflect neuronal activity levels in various parts of the brain. Although structural magnetic resonance imaging (MRI) and computed tomography (CT) provide fine anatomical detail, SPECT offers additional functional information. Frequently, brain pathology manifests as functional abnormalities before physical changes may be seen.[21] SPECT has clinical applications in diagnosis, therapeutic treatment, and patient follow-up. A basic discussion of the clinical utility of this technology is followed by pertinent information on cerebral physiology and pathology for accurate interpretation of brain SPECT pictures.[22]

Clinical applications of SPECT:

Cerebral disorders can be diagnosed and monitored using a SPECT scan, including strokes, seizures, and neurodegenerative diseases such as Alzheimer's. It can also aid in diagnosing vascular brain illnesses such as moyamoya disease. A SPECT scan can assist in assessing memory loss. Detecting changed blood flow: A SPECT scan can reveal which parts of the brain are the most and least active. It can assist pinpoint epileptic foci prior to surgery and map cerebral perfusion during surgical procedures. It can assist measure vascular spasm following a subarachnoid hemorrhage and assist predict the prognosis of patients who have had a stroke. It scan can support the clinical diagnosis of brain death.[23]

Limitations of SPECT:

The major limitation of brain SPECT study is the attenuation by the skull. The commonly used Chang method of attenuation correction is based on a simple mathematical formula, which is susceptible to technical variation. In diagnosis of dementia with SPECT, it can be difficult to separate the real defect from the attenuation artifact. SPECT is technically less sophisticated and demanding when compared with positron emission tomography (PET), but provides lower-resolution images. It can be used to evaluate regional variations in blood flow, but its role in everyday clinical practice is, like that of PET, a small one.[24]

SPECT in Epilepsy:

Patients with intractable focal epilepsy who are candidates for surgical excision of the epileptogenic focus may benefit from SPECT imaging (12-13). MRI is also important in the care of these individuals, albeit not all epileptogenic foci can be precisely localized using this modality, and not all anatomical foci are the source of a patient's seizures. As a result, SPECT can correctly pinpoint the epileptogenic focus, which is useful for neurosurgical procedures. (Fig.-6).

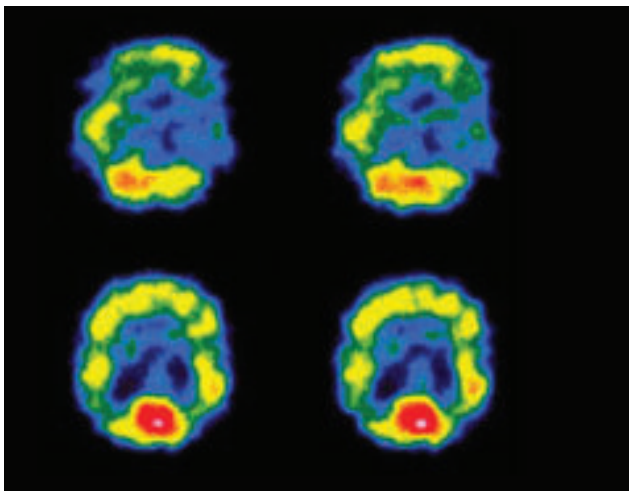

Fig.-6: *A SPECT scan of a patient with uncontrolled complex partial seizures. The temporal lobe on the left side of the brain shows less blood flow than the right, confirming for the surgeon the nonfunctioning area of the brain causing seizures.*

Source: Dinesh, E. et al. "Instinctive classification of Alzheimer's disease using FMRI, pet and SPECT images." 2013 7th International Conference on Intelligent Systems and Control (ISCO): 405-409.

SPECT in Dementias:

Anatomical imaging in dementia patients often indicates little or no change. However, employing SPECT scans to identify functional involvement patterns allows for more reliable distinction of these forms of dementia (Fig. 7).[26] Regional cerebral blood flow is reduced in Alzheimer's disease, particularly in the bilateral temporal lobes (Fig. 7A). The posterior parietal lobes may also exhibit hypometabolism. These changes can arise early in the disease process and may serve to identify AD from other types of dementia. In vascular dementia, many asymmetrical lesions impact the anterior and posterior cortex, as well as the right striatum (Fig. 7B), and in frontotemporal dementia, there is frontal hypoperfusion. (Fig. 7C).

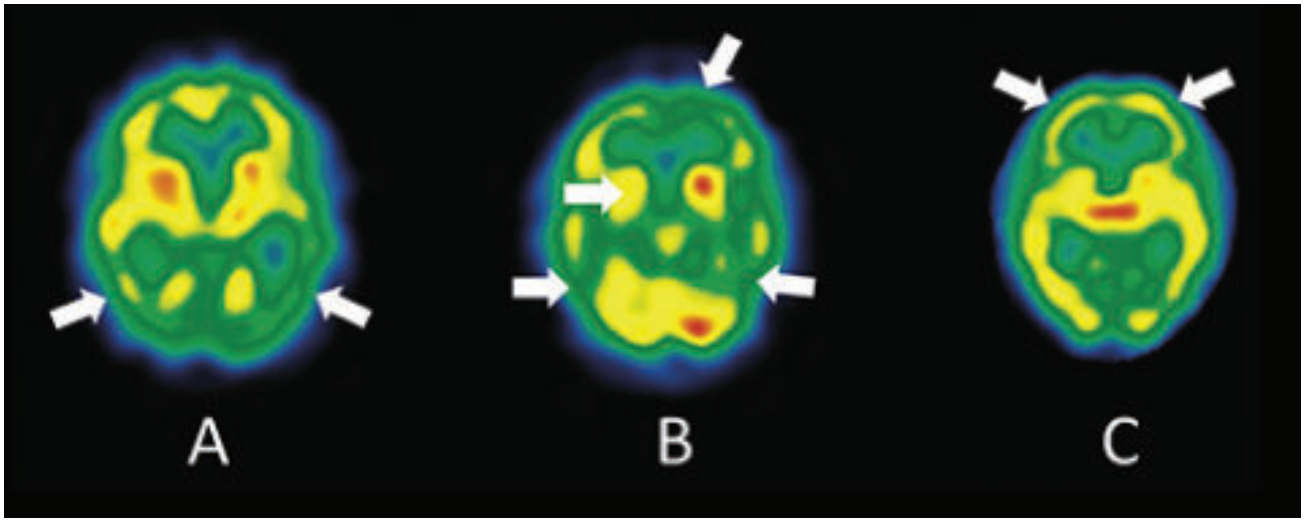

Fig.-7: *Tc-99m HMPAO SPECT scans in 3 patients with dementia showing perfusion patterns suggestive of Alzheimer's disease, with bilateral temporo-parietal hypoperfusion (A), vascular dementia with multiple asymmetrical lesions affecting the anterior and posterior cortex and right striatum (B) and fronto-temporal dementia with frontal hypoperfusion (C).*

Source: Warwick, J. "Brain imaging with SPECT and PET." Continuing Medical Education "2013; 31.8: 307-309.

SPECT in Stroke:

SPECT tests can determine the position and degree of lesions caused by blood supply abnormalities. This approach is more sensitive than CT in determining the existence and size of myocardial infarction [27] (Fig: 8&9). SPECT was found to be positive in 90% of cases within the first 8 hours following a stroke, with sensitivity of 61%-74% and specificity of 88%-98% reported 13. Within 6 hours of symptom onset, transient ischemic episodes can be distinguished from ischemic strokes by SPECT counting rate densities of 70% when compared to the contralateral side (perfusion in stroke tissue 35%-60% of contralateral values).[28]

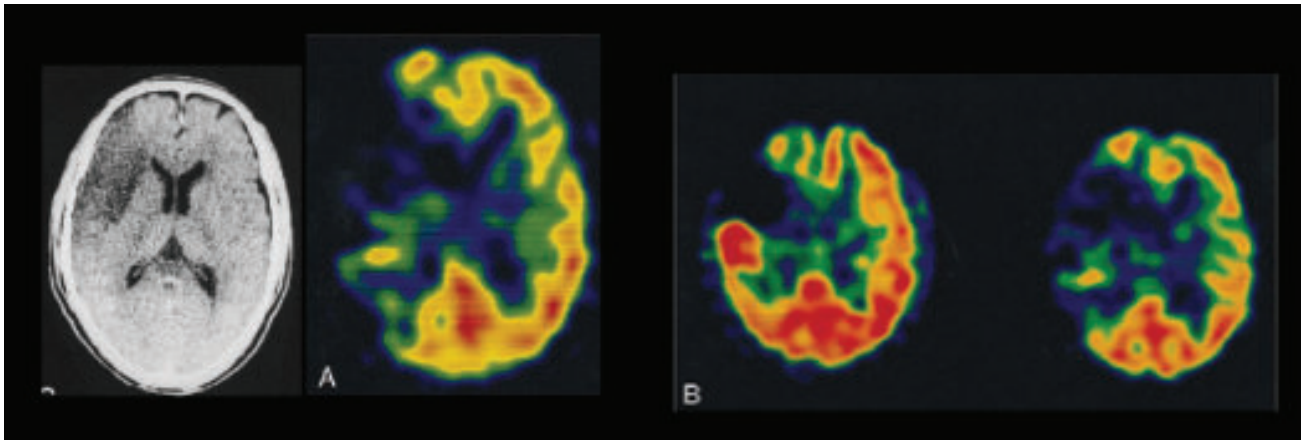

Fig.-8: *54-year-old man with atrial fibrillation and sudden onset of left-sided hemiparesis. Figure (A) CT scan of brain and 99mTc-HMPAO SPECT image 4.5 hours after the onset of stroke shows hypoactivity in the right frontal and temporal lobes. (B) 99mTc-HMPAO SPECT image (left) obtained 12 hours after the initial study shows hyperactivity in the right temporal lobe; a 99mTcECD SPECT image (right) shows hypoactivity in the same area.*

Source: Ogasawara, K., Mizoi, K., Fujiwara, S., & Yoshimoto, T. (1999). 99mTc-bicisate and 99mTc-HMPAO SPECT imaging in early spontaneous reperfusion of cerebral embolism. AJNR., 20 4, 626-8.

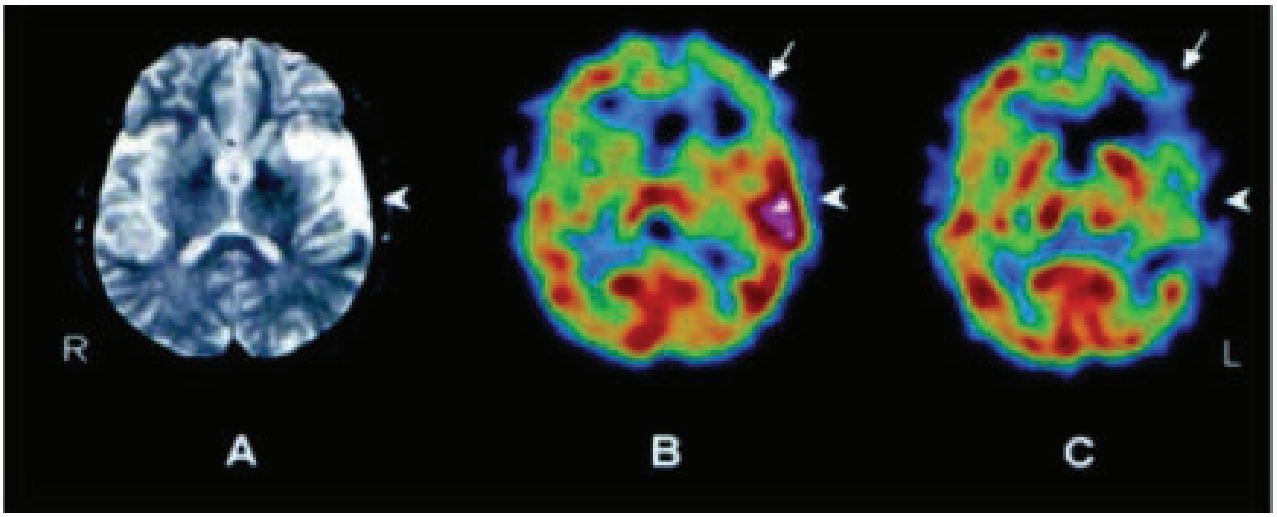

Fig.-9: (*A) MRI (T2-weighted) at admission shows hyperintensity at site of infarction (arrowhead). (B) 99mTc-HMPAO SPECT image obtained 1 wk after stroke shows increased tracer uptake (hyperperfusion) in left temporal lobe caused by luxury perfusion (arrowhead). Hypoperfusion is also seen in left frontal cortex (arrow), intrepreted as ischemia in anatomically preserved region. (C) 99mTc-HMPAO SPECT image obtained 1 mo after stroke shows left temporal lobe hypoperfusion (arrowhead) corresponding to initial MR image of ischemia. Perfusion changes in left frontal lobe are also seen: improvement in anterior and mesial aspects caused by recovery of ischemia, as well as perfusion impairment in lateral aspect caused by extension of the infarction (arrow).*

Source: Ana M. Catafau "Brain SPECT in Clinical Practice. Part I: Perfusion" J Nucl Med 2001; 42:259–271

SPECT in Traumatic Brain Injury:

SPECT scans reveal more abnormalities in traumatic brain injury (TBI) patients than MRI and CT scans.[29]Hypoperfusion is most common in the frontal and parietal lobes (Fig. 10), although it can also impact the basal ganglia, occipital, parietal, and cerebellar areas. SPECT has a high sensitivity and negative predictive value for TBI, and a normal study predicts a good recovery.[30] However, due to its low specificity, SPECT alone is insufficient to diagnose TBI.

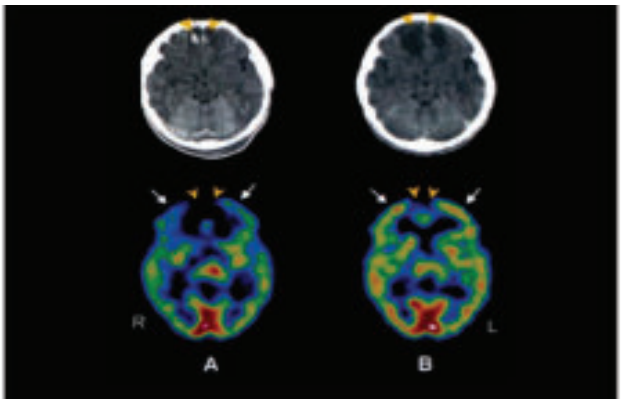

Fig.-10. *CT (top) and 99mTc-HMPAO SPECT (bottom) images from 16-y-old patient with traumatic brain injury after traffic accident. (A) CT at time of admission shows subarachnoid hemorrhage with small contusional hemorrhagic foci in both frontal lobes (orange arrowheads). SPECT was subsequently performed and shows absence of tracer uptake (cold areas) in anteromedial aspect of both frontal lobes corresponding to hemorrhagic lesions, in addition to global hypoperfusion, more marked in both frontal cortices (white arrows). (B) CT and SPECT images obtained 1 mo later at time of discharge after clinical recovery. Hypodense images in both frontal lobes can be seen on CT as consequence of hematoma's resolution. Corresponding cold areas persist on SPECT image (orange arrowheads) but show improvement in global cerebral perfusion, particularly in both frontal lobes (white arrows).* Source: Ana M. Catafau "Brain SPECT in Clinical Practice. Part I: Perfusion" J Nucl Med 2001; 42:259–271

SPECT in Parkinsonism:

SPECT is routinely used to diagnose Parkinson's disease.[31] 123I-Ioflupane-SPECT imaging offers information based on the local binding of presynaptic dopamine transporters (DaTs) with 123I-Ioflupane, which has been demonstrated to be highly linked with Parkinson's disease progression.[31,32] This binding metric is quantitative and measures the geographic distribution of dopamine transporters. Furthermore, 123I-Ioflupane-SPECT is an imaging technique that can differentiate between Parkinson's disease and essential tremor.[33] SPECT imaging can help identify PD from drug-induced Parkinsonism. [34,34] However, any condition that causes the loss of presynaptic dopamine neurons would appear aberrant when compared to normal controls (NCs)24. Thus, SPECT cannot distinguish between Parkinson's disease, progressive supranuclear palsy, multiple system atrophy, and other neurodegenerative illnesses that

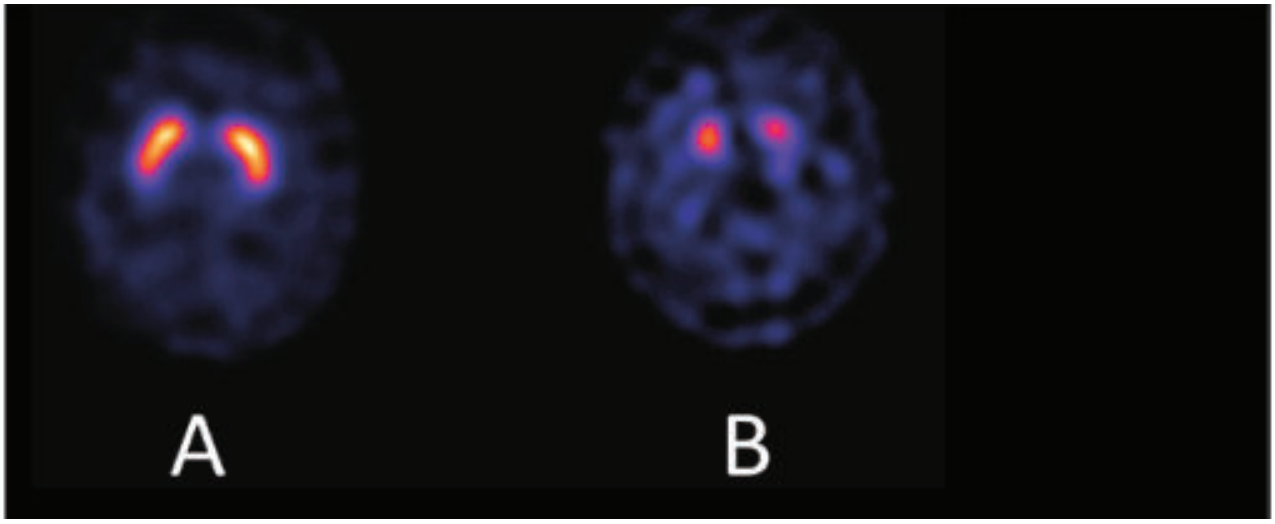

Fig.-11: *Scans of two patients with parkinsonism. In one case, DaT SPECT shows normal striatal DaT density, virtually ruling out Parkinson's disease or other causes of presynaptic dopaminergic neuron degeneration (A). The second scan shows a patient with Parkinson's disease with marked loss of striatal uptake, particularly in the putamen, and a high level of background activity (B).*

Source: Warwick, J. "Brain imaging with SPECT and PET." Continuing Medical Education, 2013; 31.8:307-309.

damage dopamine neurons.[35] The majority of 123I-Ioflupane-SPECT studies have focused on the striatum (putamen and caudate) [36-38]. Researchers found that Parkinson's disease reduces DaT levels in the striatum, which are linked to disease progression and clinical scores. [39.40] DaT imaging shows reduced presynaptic neuronal degeneration in PD and kindred parkinsonian syndromes, even when clinical symptoms are mild, whereas essential tremor has normal striatal DaT density29 (Fig. 11).

SPECT in Brain tumour:

SPECT is used in brain tumor patients to assess tumor aggressiveness, distinguish between therapy-induced necrosis and tumor recurrence, evaluate treatment response, and estimate prognosis.[41] It also implies that it has a high sensitivity and specificity for localizing ICSOLs and can be employed in patients who are unable to undergo CECT/CEMR due to contraindications or long waiting lists. The most commonly used SPECT radiopharmaceuticals are Tc-99m diethlyenetriaminepentaacetic acid (DTPA) and Tc-99m glucoheptonate (Tc-99m GHA), which are well-known renal radiopharmaceuticals that lack the drawbacks of Tc-99m pertechnetate.

Tc-99m GHA SPECT can discriminate between high- and low-grade gliomas, as well as metastases.[42] Similarly, thallium-201, Tc-99m tetrofosmin, and Tc-99m sestamibi were discovered to delineate brain tumors through multiple mechanisms of uptake other than blood-brain barrier (BBB) disruption; however, their high cost and the availability of morphological imaging techniques put these modalities on the back burner (Fig.12).[43] SPECT has also been used to diagnose brain cancers and assess tumor response to radiation therapy using the radioactively labeled amino acid 3-(123I) iodo-a-methyl-L-tyrosine.

Comparison of PET and SPECT:

PET (Positron Emission Tomography) and SPECT (Single Photon Emission Computed Tomography) scans are two imaging procedures that use radioactive tracers to produce 3D images of the body's interior functioning. The primary distinction between the two is the type of radiotracer utilized and the ensuing resolution and sensitivity. PET scans use radiotracers to produce positrons, whereas SPECT scans detect gamma rays.[44]

PET scans provide more spatial resolution than SPECT scans. For example, a heart PET scan has a resolution of 5 to 7 mm, whereas a cardiac SPECT scan has a resolution of 12 to 15 mm. PET scans have more sensitivity than SPECT scans, allowing them to detect lower amounts. SPECT scans are typically cheaper than PET scans.[45]

PET scans are frequently used to assess the function of organs like the heart and brain, diagnose cancer, and assess the effectiveness of cancer treatment. SPECT scans can reveal bone malignancy, brain activity, and cardiac blood flow, among other indicators of organ function. MRI scans are frequently coupled with PET and SPECT scans. When combined, the

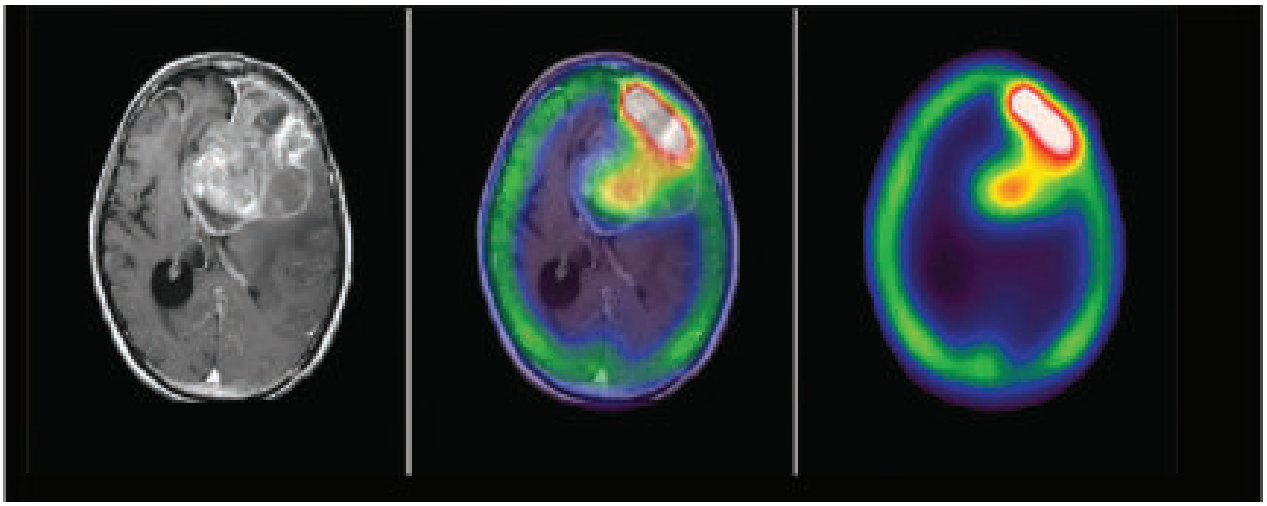

Fig.-12: *Tc-99m GHA SPECT (Tc-99m glucoheptonate) shows anaplastic oligodendroglioma of the left prefrontal region.*

Source: Alam S.S, Junaid S., Ahmed S.M" Evaluation of Technetium-99m glucoheptonate single photon emission computed tomography for brain tumor grading"Asian J Neurosurg. 2016 Apr-Jun; 11(2): 118–128.

information from these scans can yield more precise diagnoses. PET can measure radioisotopes in a matter of minutes to a few hours, while SPECT can measure them in a matter of hours to days.[46]

Conclusion:

Functional imaging such as SPECT or PET, which is used to diagnose metabolic diseases and lesions on a finer scale (such as dementia, PD etc.), and also for neurological and cognitive-psychology research. SPECT is technically less sophisticated and demanding when compared with positron emission tomography (PET), but provides lower-resolution images. SPECT can be used to assess regional differences in blood flow, but its utility in ordinary clinical practice is limited, as are PET's. PET provides more spatial resolution than SPECT. PET has a better sensitivity, which means it can detect smaller levels than SPECT. In general, SPECT radioisotopes may be measured for hours to days, whereas PET radioisotopes can be measured in minutes to hours.

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