EDITORIAL

The Necessity of Development and Manufacturing of Dedicated Brain PET Scanners

Peyman Sheikhzadeh [1,2*], **Mohammadreza Ay** [1,3]

[1] *Department of Medical Physics and Biomedical Engineering, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran*

[2] *Department of Nuclear Medicine, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran*

[3] *Research Center for Molecular and Cellular Imaging, Advanced Medical Technologies and Equipment Institute, Tehran University of Medical Sciences, Tehran, Iran*

*Corresponding Author: Peyman Sheikhzadeh
Email: psh82@yahoo.com

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Although Positron Emission Tomography (PET) imaging has always been associated with oncology, and almost ninety percent of procedures are allocated for oncology applications, a very broad perspective for PET for use in neurology, psychology, and cognitive science applications can be envisioned. The reason for this progress can be examined in several ways. The first is the development of new radiopharmaceuticals, as well as the facilitation of their production so that these radiopharmaceuticals can explore different functions of the brain. The ability of PET in the demonstration of the metabolism, physiology, and biochemistry of the brain is so high that it is always beyond the capabilities of other modalities such as Magnetic Resonance Imaging (MRI). Also, the ability of neurotransmitter imaging in PET allows for complex studies in cognitive science. PET inherently is a very sensitive modality, so it can detect even the smallest changes in the brain metabolism. Dynamic imaging by PET, which is one of the important capabilities of PET, can explore the new findings and solve a complex question of the brain function in addition to the static imaging [1].

Conventional PET scanners, which are generally used in whole-body imaging, always have a large ring diameter that can cover the patient's body, and also the patient bed inside the scanner is always lying down.

These scanners are equipped with Computed Tomography (CT) or MRI to perform attenuation and scatter corrections, and therefore these hybrid modalities always limit studies because of their large and non-removable volume. The design and development of a dedicated brain scanner proportional to the head size, with smaller bore diameter, increases geometrical efficiency, so can provide a highly sensitive and efficient scanner than conventional PET. This increase in sensitivity reduces the patient's injection dose, improves image quality, and allows for better dynamic studies. In dedicated brain PETs, unlike the conventional PET scanners, there is no serious need for CT or MRI. Due to the spherical shape of the head, simple analytical and software methods can be used for attenuation and scatter correction; therefore, we can manufacture a PET stand-alone system without a second modality for brain imaging. The small size of PET stand-alone systems certainly reduces the patient dose and also greatly facilitates studies and also even allows screening studies [2].

In some brain studies, we need to examine the brain while the patient is moving or talking, or when performing various behaviors, which is possible with dedicated brain scanners. PET scanners like helmets can detect brain function in real situations.

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In brain scanners, the patients will have no fear of tunnel phobias and the studies will be much easier. Also for the patients with open eyes can be easily displayed of various images to assess their behavior of the brain [3].

A recent attempt that may be revolutionary in brain imaging is the use of multiple modalities and simultaneous imaging of the brain, in which dedicated PETs can play a valuable role, such as the use of PET-inserts inside MRI as well as the connection of Electroencephalogram (EEG) and Near-Infrared (NIR) electrodes to the brain. Brain assessment using different modalities simultaneously offers new dimensions to understanding the complexities of the brain. In addition to cognitive studies, neurodegenerative diseases such as Alzheimer's have grown rapidly in recent years and have involved many medical organizations in the world. PET has always been the gold standard for Alzheimer's diagnosis, so assigning a general whole-body PET to it can be costly and reduce the efficiency of an imaging center. One of the best suggestions in this regard, which provides both high-quality and lower cost, is to assign a brain PET to diagnose Alzheimer's. Early detection of Alzheimer's at a lower cost and affordable will start initial treatments and prevent staggering future treatment costs.

Although the design and manufacture of dedicated scanners began in the last two decades, it has not received much attention in the clinic and has become more focused on research. However, diagnosing and evaluating neurological and psychological diseases such as Alzheimer’s, epilepsy, obsessive-compulsive disorder, addiction, schizophrenia, fear and anxiety, and finding appropriate treatment for these diseases may highlight the clinical aspects of these scanners. However, advances in these scanners and the presentations of higher quality images than general-purpose scanners will make clinical systems more enthusiastic. Concept design with specific geometries that fit the head, such as the shape of a helmet or headphones [4,5], can provide higher sensitivity and image quality for the scanner. Using new and multi-layered crystals with depth-of-interaction capability can produce very good spatial resolution and uniformity entire the field of view. The use of fast scintillators, time of flight and new resolution recovery and noise controlling algorithms can go a step further and create a unique resolution of the brain that improves the diagnosis and prognosis and also artificial intelligence, it can make these scanners much more prominent. Recently our team is working on the design and development of a dedicated brain PET scanner based on Silicon Photomultipliers (SiPM) technology to offer high sensitivity and super spatial resolution to a researcher in the field of brain mapping.

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