PRECLINICAL IMAGING

Preclinical PET Imaging

Past, present, and future

What is PET imaging?

Positron emission tomography (PET) uses small amounts of radioactive tracers to image important cellular and molecular processes in living subjects. Popular in both clinical diagnostics and preclinical research, PET provides functional imaging, which shows the spatial distribution of biomolecular activity in living tissues. This molecular insight allows clinicians to characterize disease progression and enables researchers to develop therapeutics that target early stages of disease.

A brief history of PET

1932

Concept of the **positron** was postulated by Carl Anderson, winning him the 1936 Nobel Prize in Physics

1936

First **cyclotron** developed at University of California, Berkley

1940-1950

Invention of the **scintillator detector** and development of radionuclides ^{11}C, ^{13}N, ^{15}O, and ^{18}F

1962-1963

Development of **early positron scanners** with a ring of scintillation detectors and tomographic imaging

1970

Scintillator, crystal bismuth germanate (**BGO**) emerged

1973

Researchers from Washington University built "**PETT II**" that used annihilation coincidence detection to generate **reconstructed transaxial tomographs**, which provided the foundations for the evolution of PET tomographs

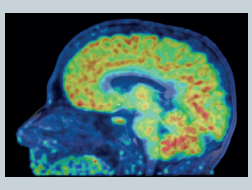
1974

Filtered back projection (FBP) **reconstruction algorithms** developed

Prototypical PETT II expanded to **clinically applicable "PET III"**

1975

First radiotracer, ^{14}C labeled 2-deoxyglucose, developed for human use



1977

Iterative reconstruction method, MLEM, introduced

1978

^{18}F-FDG was synthesized

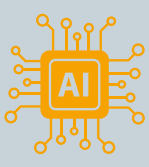
1980-1990

Time-of-flight (TOF) PET explored in clinical imaging

Kinetic modeling image analysis methods developed

1993

Potential of **AI and neural network–based technologies** recognized in nuclear medicine for image processing



1996

Preclinical PET/MR first explored in oncology and neurology

Scintillator crystal **lutetium oxyorthosilicate (LSO)** developed

1998

Development of **clinical PET/CT** scanners

First commercial **small animal PET scanner** (microPET, Concorde Microsystems) launched

2000

Standard uptake value (SUV) image analysis methods developed

2006

Commercialization of **simultaneous clinical PET/MR imaging**

2010

Silicon photomultiplier (SiPM) photodetector emerged which enabled full compatibility with MRI

Installation of first **whole-body clinical PET/MR scanner**

2010-2020

Acceleration of **nuclear theranostics**, from preclinical to clinical studies

PET IMAGING TODAY

PET, PET/MR and PET/CT scanners are now available with an unparalleled combination of high sensitivity and high spatial and temporal resolution, and powerful image reconstruction and analysis technologies.

Together with ongoing development of novel radiotracers and imaging agents, PET technology is today an integral part of translational oncology, neurology, and pharmaceutical research.

Modern stand alone and multimodality imaging technologies

PET is often combined with other imaging technologies, such as magnetic resonance imaging (MRI) and computed tomography (CT) scanning, to complement functional images with anatomical information. Advanced hardware and software now enables seamless PET/MR, PET/CT, and PET/SPECT/CT either as modular stand alone systems or combined in a single instrument with automatic image co-registration.

Current trends in preclinical research

Oncology

Immuno-oncology is a rapidly evolving field involving more precise treatment that utilizes the patient's immune system to tackle the tumor. Monoclonal antibodies (mAbs) are now being radiolabeled for immuno-PET to detect cancer and assess therapeutic responses.

Neurology

The growth in neurodegenerative disease research is driving the development of novel PET tracers. These tracers target relevant proteins such as amyloid, tau, and synaptic vesicle2A (SV2A) protein.

Pharma

The non-invasive, sensitive and quantitative nature of PET imaging is valuable in pharma research, for example in receptor occupancy studies. By quantitatively measuring receptor availability, pharma researchers can calculate meaningful dose scaling for new drugs, saving time and money in clinical trials.

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