

Short Communication

Peering Into the Living Brain: Advances, Applications, and Future Directions in Neuroimaging Techniques,

Lindseth D, Reeves E, Romano S, Wiederhold F, Nimmon

Institute of Neurology and Neurosurgery, Switzerland

***Corresponding Author:** Reeves E, Institute of Neurology and Neurosurgery, Switzerland

Citation: Reeves E, Peering Into the Living Brain: Advances, Applications, and Future Directions in Neuroimaging Techniques V2 (2),2026

Copyright: ©2026 Reeves E, Peering into the Living Brain: Advances, Applications, and Future Directions in Neuroimaging Techniques V2 (2),2026

Received date: September 10, 2026: **Accepted date:** September 25, 2026: **Published date:** September 29,2026

Keywords: neuroimaging, mri, fmri, pet, ct, dti, eeg, meg, brain connectivity, artificial intelligence

Abstract Neuroimaging has transformed neuroscience and clinical medicine by enabling researchers and clinicians to visualize brain structure, function, connectivity, metabolism, and molecular processes in living individuals. Modern neuroimaging encompasses a broad spectrum of techniques, including computed tomography (CT), magnetic resonance imaging (MRI), functional MRI (fMRI), diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), positron emission tomography (PET), single-photon emission computed tomography (SPECT), electroencephalography (EEG), magnetoencephalography (MEG), and emerging hybrid imaging approaches. Each technique provides distinct information and presents specific advantages and limitations regarding spatial resolution, temporal resolution, invasiveness, cost, and clinical accessibility. Structural imaging is particularly valuable for identifying anatomical abnormalities, whereas functional and molecular imaging can reveal changes in neural activity, cerebral metabolism, neurotransmitter systems, and brain connectivity. The integration of multimodal neuroimaging with artificial intelligence, machine learning, and advanced computational analysis is creating new opportunities for early diagnosis, disease monitoring, personalized treatment, and neuroscience research. This article reviews major neuroimaging techniques, their underlying principles, applications, advantages, limitations, and emerging developments, emphasizing their growing importance in understanding neurological and psychiatric disorders.

Introduction

The human brain is one of the most complex biological systems, containing billions of neurons and an intricate network of interconnected regions. Understanding its

structure and function requires technologies capable of examining the brain without causing significant damage to its delicate tissues. Neuroimaging has emerged as one of the most important technological developments for achieving this objective.

Neuroimaging refers to a collection of techniques used to visualize the anatomy, physiology, function, metabolism, and molecular characteristics of the nervous system. Initially, brain imaging primarily focused on detecting structural abnormalities. The development of MRI, PET, fMRI, DTI, and other advanced technologies has expanded neuroimaging from anatomical visualization to the investigation of neural activity and brain networks.

Major Neuroimaging Techniques

Computed Tomography

Computed tomography (CT) uses X-rays and computer-based reconstruction to generate cross-sectional images of the brain.

CT is particularly useful in emergency medicine because it is rapid and widely available. It is commonly used to detect

- Intracranial hemorrhage
- Acute ischemic stroke-related abnormalities
- Skull fractures
- Brain edema
- Hydrocephalus
- Mass lesions

Journal of Neuroscience and Neurodevelopmental Disorders (JNDD)

- Traumatic brain injuries

Advantages

CT provides rapid image acquisition and is relatively accessible. It is also less susceptible to motion than some MRI examinations

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) uses a strong magnetic field and radiofrequency energy to produce detailed images of brain structures.

MRI is one of the most important neuroimaging modalities because it provides excellent soft-tissue contrast without exposing patients to ionizing radiation.

Different MRI sequences can provide different types of information, including:

- T1-weighted imaging
- T2-weighted imaging
- Fluid-attenuated inversion recovery (FLAIR)
- Susceptibility-weighted imaging (SWI)
- Diffusion-weighted imaging
- Perfusion imaging

Positron Emission Tomography

Positron emission tomography (PET) is a molecular imaging technique that uses radiotracers to investigate physiological and biochemical processes.

Different radiotracers can target different biological processes. Depending on the tracer, PET can provide information about:

- Glucose metabolism
- Cerebral blood flow
- Neurotransmitter systems
- Amyloid deposition
- Tau pathology
- Receptor distribution

Conclusion

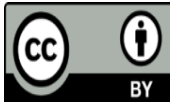
Neuroimaging has fundamentally changed the study of the human brain. From conventional CT and structural MRI to functional MRI, diffusion imaging, PET, EEG, MEG, and fNIRS, each technique provides a distinct perspective on brain anatomy or physiology. Their applications extend from emergency diagnosis and surgical planning to the investigation of cognition, neurological disease, neurodegeneration, and brain connectivity.

The future of neuroimaging will increasingly depend on multimodal integration, quantitative analysis, artificial intelligence, and molecular characterization. Although challenges related to cost, accessibility, interpretation, data complexity, and privacy remain, continued technological development is likely to make neuroimaging an increasingly powerful component of neuroscience and personalized medicine.

References

1. Frisoni GB, Fox NC, Jack CR Jr, et al. The clinical use of structural MRI in Alzheimer disease. *Nature Reviews Neurology*. 2010;6:67–77.
2. Heeger DJ, Ress D. What does fMRI tell us about neuronal activity? *Nature Reviews Neuroscience*. 2002;3:142–151.
3. Le Bihan D, Breton E, Lallemand D, et al. MR imaging of intravoxel incoherent motions: application to diffusion and perfusion in neurologic disorders. *Radiology*. 1986;161:401–407.
4. Cabeza R, Nyberg L, Park DC, eds. *Cognitive Neuroscience: The Psychology of the Human Brain*. Oxford University Press; 2016.

Journal of Neuroscience and Neurodevelopmental Disorders (JNDD)



This work is licensed under Creative Commons Attribution 4.0 License
DOI:10/JNDD/2026/025

Your next submission with

Olites Publishers will reach you the below assets

- We follow principles of publication led by the Committee on Publication Ethics (COPE).
- Double blinded peer review process which is just as well as constructive.
- Permanent archiving of your article on our website
- Quality Editorial service
- Manuscript accessibility in different formats (PDF, Full Text)
- authors retain copyrights
- unique DOI for all articles
- immediate, unrestricted online access

Learn more: [Journal of Neuroscience and Neurodevelopmental Disorders Olites Publishers \(olitespublishing.org\)](https://olitespublishing.org)

