Bioimaging is in the forefront of medicine for the diagnosis and treatment of neurodegenerative disease. Conventional magnetic resonance imaging (MRI) uses interactive external magnetic fields and resonant frequencies of protons from water molecules. However, newer sequences, such as magnetization-prepared rapid acquisition gradient echo (MPRAGE), are able to seek higher levels of anatomic resolution by allowing more rapid temporal imaging. Magnetic resonance spectroscopy (MRS) images metabolic changes, enabling underlying pathophysiologic dysfunction in neurodegeneration to be deciphered. Neurochemicals visible with proton 1H MRS include N-acetyl aspartate (NAA), creatine/phosphocreatine (Cr), and choline (Cho). NAA is considered to act as an in vivo marker for neuronal loss and/or neuronal dysfunction. By extending imaging to the study of elements such as iron—elevated in several neurodegenerative diseases—laser microprobe studies have become extremely useful, followed by X-ray absorption fine-structure experiments.

Positron emission tomography (PET) and single-photon emission tomography (SPECT) have become important tools in the differential diagnosis of neurodegenerative diseases by allowing imaging of metabolism and cerebral blood flow. PET studies of cerebral glucose metabolism use the glucose analog [18F] fluorodeoxyglucose ([18F]FDG) and radioactive water (H215O) and SPECT tracers use 99mTc-hexamethylpropylene amine oxime (HMPAO), and 99mTc-ethylcysteinate dimer (99mTc-ECD).

Moreover, direct imaging of the nigrostriatal pathway with 6-[18F]-fluoro-1-3,4-dihydroxyphenylalanine ([18F]FDOPA) in combination with PET technology, may be more effective at differentiating neurodegenerative diseases than PET or SPECT alone. Radioactive cocaine and the tropane analogs directly measure dopamine (DA) transporter binding sites and 99mTc-TRODAT-1 is a new tracer that could move imaging of the DA neuronal circuitry from the research environment to the clinic. 11C-flumazenil (FMZ PET), has found utility in the detection of epileptic foci in patients with partial epilepsies, and yet normal structural imaging is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Positron emission tomography (PET) and single-photon emission tomography (SPECT) have become important tools in the differential diagnosis of neurodegenerative diseases by allowing imaging of metabolism and cerebral blood flow. PET studies of cerebral glucose metabolism use the glucose analog [18F] fluorodeoxyglucose ([18F]FDG) and radioactive water (H215O) and SPECT tracers use 99mTc-hexamethylpropylene amine oxime (HMPAO), and 99mTc-ethylcysteinate dimer (99mTc-ECD).

Moreover, direct imaging of the nigrostriatal pathway with 6-[18F]-fluoro-1-3,4-dihydroxyphenylalanine ([18F]FDOPA) in combination with PET technology, may be more effective at differentiating neurodegenerative diseases than PET or SPECT alone. Radioactive cocaine and the tropane analogs directly measure dopamine (DA) transporter binding sites and 99mTc-TRODAT-1 is a new tracer that could move imaging of the DA neuronal circuitry from the research environment to the clinic. 11C-flumazenil (FMZ PET), has found utility in the detection of epileptic foci in patients with partial epilepsies, and yet normal structural imaging is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Diagnosis of neocortical epilepsy has been significantly advanced by IOS or intrinsic optical signal imaging. IOS has its basis in the light absorption properties of electrophysiologically active neural tissue, activity caused by focal alterations in blood flow, oxygenation of hemoglobin, and scattering of light. IOS can map interictal spikes, onsets and offsets, and horizontal propagation lines. Thus, IOS is useful for diagnosing “spreading epileptiform depression.” As with NMI, IOS holds promise for intraoperative cortical mapping wherein ictal and interictal margins can be more clearly defined. As does intraoperative MRI (sMRI) with neuronavigation, these technologies provide what is called “guided neurosurgery.”

Correlative imaging of general neurophysiology is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Diagnosis of neocortical epilepsy has been significantly advanced by IOS or intrinsic optical signal imaging. IOS has its basis in the light absorption properties of electrophysiologically active neural tissue, activity caused by focal alterations in blood flow, oxygenation of hemoglobin, and scattering of light. IOS can map interictal spikes, onsets and offsets, and horizontal propagation lines. Thus, IOS is useful for diagnosing “spreading epileptiform depression.” As with NMI, IOS holds promise for intraoperative cortical mapping wherein ictal and interictal margins can be more clearly defined. As does intraoperative MRI (sMRI) with neuronavigation, these technologies provide what is called “guided neurosurgery.”

Correlative imaging of general neurophysiology is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Diagnosis of neocortical epilepsy has been significantly advanced by IOS or intrinsic optical signal imaging. IOS has its basis in the light absorption properties of electrophysiologically active neural tissue, activity caused by focal alterations in blood flow, oxygenation of hemoglobin, and scattering of light. IOS can map interictal spikes, onsets and offsets, and horizontal propagation lines. Thus, IOS is useful for diagnosing “spreading epileptiform depression.” As with NMI, IOS holds promise for intraoperative cortical mapping wherein ictal and interictal margins can be more clearly defined. As does intraoperative MRI (sMRI) with neuronavigation, these technologies provide what is called “guided neurosurgery.”

Correlative imaging of general neurophysiology is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Diagnosis of neocortical epilepsy has been significantly advanced by IOS or intrinsic optical signal imaging. IOS has its basis in the light absorption properties of electrophysiologically active neural tissue, activity caused by focal alterations in blood flow, oxygenation of hemoglobin, and scattering of light. IOS can map interictal spikes, onsets and offsets, and horizontal propagation lines. Thus, IOS is useful for diagnosing “spreading epileptiform depression.” As with NMI, IOS holds promise for intraoperative cortical mapping wherein ictal and interictal margins can be more clearly defined. As does intraoperative MRI (sMRI) with neuronavigation, these technologies provide what is called “guided neurosurgery.”

Correlative imaging of general neurophysiology is observed. Another new 5-HT1A tracer for PET imaging in abnormal dysplastic tissue is a carboxamide compound called [18F]FCWAY. Diagnosis of neocortical epilepsy has been significantly advanced by IOS or intrinsic optical signal imaging. IOS has its basis in the light absorption properties of electrophysiologically active neural tissue, activity caused by focal alterations in blood flow, oxygenation of hemoglobin, and scattering of light. IOS can map interictal spikes, onsets and offsets, and horizontal propagation lines. Thus, IOS is useful for diagnosing “spreading epileptiform depression.” As with NMI, IOS holds promise for intraoperative cortical mapping wherein ictal and interictal margins can be more clearly defined. As does intraoperative MRI (sMRI) with neuronavigation, these technologies provide what is called “guided neurosurgery.”
NMI and MRI also enable the differential detection of white matter versus gray matter in discrete neuroanatomic substrates in brain, detection which is critical to both the epilepsies and the leukodystrophies. Although NMI is in its early stage in this arena, the immediate and distinct waveforms that distinguish white from gray matter are impressive. Moreover, the early finding of a leukodystrophy by MRI, particularly relevant for metachromatic leukodystrophy (MLD), Krabbe’s disease (KD), and X-linked adrenoleukodystrophy (ALD), allows clinicians therapeutic interventions before overt symptoms are exhibited. Imaging technologies, pathologies, clinical features, and treatments for these and other leukodystrophies, including peroxisomal disorders and leukodystrophies with macrocrania (Canavan’s disease and Alexander’s disease), are presented here in precise detail. The van der Knaap syndrome is a recently described leukodystrophy in vacuolating megalencephalic leukoencephalopathy (VMI). This vanishing white matter disease highlights the potential of MRS imaging, which was used in its identification.

Thus, Bioimaging in Neurodegeneration fulfills the current need to bring together neurodegeneration with bio- and neuroimaging technologies that actually enable diagnosis and treatment. Professionals in neurology, psychiatry, pharmacology, radiology, and surgery are among many who will greatly benefit.

Neurodegenerative disease is divided into four areas, i.e., Parkinson’s disease, Alzheimer’s disease, the epilepsies, and the leukodystrophies. Chapter authors were selected for their formidable expertise in each field of medicine, their expertise in imaging technologies, and their scholarly contributions to medicine and science. Our appreciation is extended to them, and their staffs, for their fine research. We thank the editors and staff at Humana Press for their excellent assistance and support.

Patricia A. Broderick, PhD
David N. Rahni, PhD
Edwin H. Kolodny, MD
Bioimaging in Neurodegeneration
Broderick, P.A.; Rahni, D.N.; Kolodny, E.H. (Eds.)
ISBN: 978-1-58829-391-6
A product of Humana Press