Picture-Perfect: The Center for Imaging Research Enhances Biomedical Research

Jing-Huei Lee, PhD

As Scientific Director of the Center for Imaging Research (CIR), Dr. Jing-Huei Lee uses state-of-the-art equipment to study human anatomy and physiology. Equipped with a 4.0 Tesla Varian Unity INOVA Whole Body MRI/MRS system, the CIR specializes in human neuroscience investigation, particularly focusing on brain metabolism and function in patients with cognitive impairment, Parkinson’s Disease, drug abuse, ADHD, anxiety, bipolar disorder, schizophrenia, and depression. As a core facility at UC, the CIR aims to provide imaging research capabilities to scientific investigators across disciplines at the University of Cincinnati.

The MRI and MRS System

Central to the CIR’s operation is the 4.0 Tesla MRI/MRS system. A strong magnetic field—measured in units of Tesla—is crucial for MRI. This machine produces highly detailed images of the human body through the magnetic properties of hydrogen and its interaction with a strong external field and radio waves. From these images, researchers can non-invasively visualize human anatomy, and measure organ function and tissue chemistry in human subjects.

The 4.0 Tesla system is dedicated for research only. “It is more powerful than most hospital MRI systems (typically 1.5 and/or 3 Tesla), and about 80,000-times stronger than the earth’s magnetic field, depending on where you live.” Lee said. It is one of only a handful of such machines in the United States.

The CIR is also equipped with a micro imaging system for animal testing, a 9.4 Tesla Bruker Ascend™ Animal MRI/MRS system, installed in 2013. Animal tests allow for complementary data with human testing, in addition to other capabilities. Together, these two machines allow Dr. Lee, the CIR personnel, and researchers across campus to perform detailed analyses of anatomy and physiology, specifically focused on psychiatric diseases and other researches (e.g. cancer research).
Imaging Research Techniques

Dr. Lee has also been working with many other MRI techniques for decades. Magnetic Resonance Spectroscopy (MRS), for instance, creates a chemical fingerprint of the molecules in the brain that can reveal chemical imbalances. In addition, the CIR has been using Functional Magnetic Resonance Imaging (fMRI), a technique that measures brain activity in nearly real-time. Using fMRI, researchers may ask subjects to perform certain tasks (such as looking at pictures, pressing buttons or remembering words), and they scan the brain to determine brain activities that respond to tasks. Then, they use these brain scans to compare healthy subjects with patients with certain pathology. The combination of MRI, MRS, and fMRI techniques, according to Dr. Lee, allows researchers to “better understand the mechanisms underlying the abnormal brain.”

Psychiatric Disease Research

One of the primary focuses at the CIR is psychiatric research. Using imaging techniques, CIR researchers explore a range of topics, including adolescent mania, bipolar disorder, schizophrenia, cognitive impairment, and neuropathic changes in football players, among others. Their comprehensive techniques and longitudinal treatment follow-up make it easier to compare the differences between healthy and pathological brains allowing for improved diagnoses and treatment.

Cancer Research

In addition, the CIR has delved extensively into cancer research through a so-called Smart Contrast Agent. “Smart Contrast Agents can target a specific cancer cell, such as a breast cancer cell, and the compound will read it. Then it will “light up” in the images so that we can see where the cancer or tumor is,” Dr. Lee said. After better identifying cancer cells, doctors can then send a vehicle (i.e. using the same compound that carries drug instead of contrast agent) into the body to target those cells and deliver treatment. Such approaches allow for a more accurate and less invasive study and treatment of cancer.

More About Dr. Jing-Huei Lee

In addition to serving as Scientific Director of the CIR, Dr. Lee is a Professor and the Graduate Program Director of Biomedical Engineering. After seven years at Brookhaven National Laboratory in Upton, NY, Lee was recruited to UC in 2002. He is a graduate of National Taiwan University and earned his PhD in Physical Chemistry from the State University of New York at Stony Brook (a.k.a. Stony Brook University). Dr. Lee’s current research interests focus on development of magnetic resonance imaging (MRI)/Spectroscopy (MRS) methodologies and the utilization of these methodologies for studying physiology, metabolism, bioenergetics, and function of the brain and other organs noninvasively.