New Imaging Approaches Unveiled

Techniques Reveal Clues to Body's Biochemistry

Tracy Hampton, PhD

WHILE MAGNETIC RESONANCE imaging (MRI) has been used since the mid-1980s to detect anatomical changes caused by disease, the technique has lacked the ability to detect the earliest molecular hallmarks of illness—alterations in the biochemical processes that are at the heart of cell function.

But advances in MRI technology may someday remove this limitation, according to researchers studying new, highly sensitive MRI devices to look at the metabolic intricacies of normal and disease states. Their hope, they say, is that such advances will improve diagnoses and allow physicians to monitor response to therapies.

MOST POWERFUL MRI

Current MRIs work by contrasting water within tissues, which gives information about anatomical changes.

"These are relatively insensitive signs and relatively late signs in disease processes," said Keith Thulborn, MD, PhD, director of the University of Illinois at Chicago's Center for Magnetic Resonance Research. "What you'd really like to do is . . . to look at the disease process itself—the disruption of the normal biochemistry that supports normal tissue function," he added.

Thulborn and colleagues designed a new MRI device that uses a powerful 9.4-tesla magnet—3 times more powerful than current clinical MRI magnets—that renders the machine sensitive enough to detect the metabolic building blocks of cells: sodium, phosphorous, carbon, oxygen, and nitrogen.

With the increased magnetic field of the 9.4-tesla MRI, built to Thulborn's specifications by engineers at GE Healthcare, based in Waukesha, Wis, researchers could potentially detect the metabolic changes that occur during processes such as tumorigenesis or neurological degeneration, said Thulborn. He also suspects the technology will be able to teach scientists more about how diseases arise and progress.

"I'm hoping that we're going to get a comprehensive description of the disease process at a metabolic level," said Thulborn, who predicts the device will have a variety of applications in the clinic within 1 to 2 years.

In collaboration with GE Healthcare, Thulborn is using the 9.4-tesla MRI to study the metabolic reactions that occur within brain cells. "By having access to these biochemical signals, we hope that we can actually look at the formation of thought," he said. With such information, physicians might be better able to observe and treat cognitive learning disorders such as attention deficit disorder and to identify and monitor conditions such as Alzheimer disease and autism.

Pacific Northwest National Laboratory

A mouse goes for a spin in a new imaging device that researchers hope to use in humans to see tissues and biological processes invisible to today's medical imaging machines.

GOING FOR A SPIN

Another innovation in imaging technology, slow-magic-angle spinning magnetic resonance spectroscopy, or slow MAS, uses a rotating magnetic field rather than a bigger magnet to achieve the sensitivity needed to measure metabolic processes.

In experiments with mice, Robert Wind, PhD, of the Department of Energy's Pacific Northwest National Laboratory, in Richland, Wash, places an anaesthetized animal in a tube, which spins at about one rotation per second inside of a magnetic field. The reason for the dizzying ride for the rodents goes back more than a half-century ago, when researchers discovered that they could get better spectral resolution if they spun a sample.

Wind, who holds two US patents for the device, conceded that such spinning would likely be a problem in the clinic. "I doubt if you could do that with patients, but a possibility is to rotate the magnetic field instead of the patient," he said, noting that it will take years to develop such technology.

While today's MRI techniques can locate tumors or other lesions within the body, slow MAS, like the 9.4-tesla MRI, could potentially determine what sorts of metabolic processes are occurring within these cells—information that could be useful for evaluating a variety of conditions, said Wind. "So a possibility is to image a person, localize a lesion or tumor, and then take spectral information in order to be able to say what it is—whether it is malignant, benign, or something else," he said.

The technique has potential as a tool "to diagnose diseases and assess the body's response to drugs and even to observe the working physiology of living cells," he added. □