Griswold and Team Close in on "Holy Grail" of Medical Imaging

New type of MRI can do virtual biopsy

by Kate Rein

A cool hand on a warmer-than-normal forehead can mean fever. But is it 100 degrees—or 103 or 105? Taking a temperature and knowing the number can be the difference between prescribing fluids and bed rest or handling a medical emergency.

Modern-day magnetic resonance imaging (MRI) has long been like a hand on a forehead. MRI scans show when something in a person's soft tissue isn't right. But what that "something" is and how "not right" is another story.

Mark Griswold, PhD, professor of radiology and director of MRI research at Case Western Reserve University School of Medicine, stands to change that. After more than a decade in the lab, Griswold and his team of researchers are about to make MRIs more quantitative. That is, MRIs will take more measurements more quickly, recording more numbers—numbers that can actually help diagnose a disease.

Searching Since 2003

"It's been the holy grail of medical imaging for some time," says Griswold about quantitative MRI.

Researchers have been actively searching for it since the 1980s. Griswold along with Case Western Reserve's Vikas Gulani, MD, PhD, assistant professor of radiology, took up the search in 2003, when they were both at the University of Würzburg, Germany.

Griswold had earned his PhD in physics at the University of Würzburg in 2002. That, complemented by his undergrad work in electrical engineering at the University of Illinois, set him on course for a career in medical imaging. He served as director of the radiofrequency coil lab at Harvard's Beth Israel Deaconess Medical Center before joining Case Western Reserve's MRI research group in 2005.

Since then, Griswold and Gulani have teamed with Nicole Seiberlich, PhD, assistant professor of biomedical engineering, **Jeffrey Duerk, PhD [GRS '87]**, dean of Case School of Engineering, **Jeffrey Sunshine, MD, PhD [MED'90]**, professor of radiology, neurology and neurosurgery at the School of Medicine and radiologist and chief medical officer at University Hospitals Case Medical Center, and others, to get one step closer to the holy grail—one giant step.

Fingerprinting Diseases

Over the last three years, they've developed technology that can take a multi-dimensional measurement of a patient's tissue in one, quick MRI scan. In minutes, it can even tell the difference between tissue types, such as gray matter, white matter, fat and muscle. Using today's MRIs, it would take up to four times longer to identify the same array of characteristics.

The next step will be linking these characteristics to certain diseases, making MRIs a type of virtual biopsy.

"Instead of just seeing a bright spot or dark spot on an MRI of a patient's brain, for example, we'll be able to tell if the spot is a multiple sclerosis lesion or small stroke or something else," says Griswold.

In other words, characteristics seen on the MRI will create a unique "fingerprint"

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of a disease, hence the name "magnetic resonance fingerprinting" (MRF). Much like running an actual fingerprint through a police database to identify a person, medical professionals will run MRFs through a database of characteristics to identify disease states.

Building the MRF database is what Griswold's team is working on now.

"We've been able to characterize up to 500,000 tissue states so far. We'll have about 25 million when we're done," Griswold says matter-of-factly.

He's not saying it to impress. If anything, Griswold's quiet demeanor downplays his achievements. Even with an overbooked schedule and occasional obstacle in the lab, he is calm and measured. Griswold is a patient teacher and a master of metaphor, using the familiar to teach the complex. And he's careful to credit all of his students' contributions.

"Our lab is like a spider web," says Griswold. "All of us have strengths that anchor us to the wall around us, but I intentionally make assignments that get people to collaborate and create the web. There are 15 or 16 people in the lab on any given day. I've learned that if I keep them happy, with a challenging yet supportive environment, they do good work."

Replacing Other Diagnostics

That good work could potentially change medical diagnosis as we know it as well as provide early identification of some cancers, multiple sclerosis, heart disease and more. Griswold foresees MRF replacing not just conventional MRI but other imaging diagnostic tools, including X-rays.

"Right now, MRIs are problem-solving tools, used after a patient has had rounds of other tests," says Griswold. "If we can get the cost down yet still give a definitive diagnosis, MRF could become a first-line tool, allowing patients and physicians to skip the initial tests."

How quickly could MRF be available to patients? As early as three years from now, estimates Griswold.

"MRF will make diagnosing disease more systematic," says Griswold. "Today, when you get your blood sugar checked, there's a range of normal and abnormal. It's straightforward. We want to have that for tissue, too."

Magnetic resonance fingerprinting (MRF) is intended to identify whether tissue is healthy or diseased, how badly and by what. In one quick scan, researchers simultaneously vary different parts of the input electromagnetic fields that probe tissues. These variations make the received signal sensitive to multiple physical properties that vary from tissue to tissue.