New MRI Method Fingerprints Tissues and Diseases

Case Western Reserve University

A new method of magnetic resonance imaging (MRI) could routinely spot specific cancers, multiple sclerosis, heart disease and other maladies early, when they're most treatable, researchers at Case Western Reserve University and University Hospitals (UH) Case Medical Center suggest in the journal *Nature*.

Each body tissue and disease has a unique fingerprint that can be used to quickly diagnose problems, the scientists say.

By using new MRI technologies to scan for different physical properties simultaneously, the team differentiated white matter from gray matter from cerebrospinal fluid in the brain in about 12 seconds, with the promise of doing this much faster in the near future.

The technology has the potential to make an MRI scan standard procedure in annual check-ups, the authors believe. A full-body scan lasting just minutes would provide far more information and require no radiologist to interpret the data, making diagnostics cheap, compared to today's scans, they contend.

"The overall goal is to specifically identify individual tissues and diseases, to hopefully see things and quantify things before they become a problem," said Mark Griswold, a radiology professor at Case Western Reserve School of Medicine and UH Case Medical Center. "But to try to get there, we've had to give up everything we knew about the MRI and start over."

Griswold has been working on this goal with Case Western Reserve's Vikas Gulani, MD, an assistant professor of radiology, and Nicole Seiberlich, assistant professor of biomedical engineering, for a decade. During the last three years, they developed the technology and proved the concept with graduate student Dan Ma; Kecheng Liu, PhD, collaborations manager from Siemens Medical Solutions Inc.; Jeffrey L. Sunshine, MD, professor of radiology and a radiologist at UH Case Medical Center; and Jeffrey L. Duerk, dean of Case School of Engineering and professor of biomedical engineering.

A magnetic resonance imager uses a magnetic field and pulses of radio waves to create images of the body's tissues and structures. Magnetic resonance fingerprinting, MRF for short, can obtain much more information with each measurement than a traditional MRI.

Griswold likens the difference in technologies to a pair of choirs.

"In the traditional MRI, everyone is singing the same song and you can tell who is

singing louder, who is off-pitch, who is singing softer," he said. "But that's about it."

The louder, softer and off-pitch singing is represented by dark, light or bright spots in the scan that a radiologist must interpret. For example, an MRI would show swelling as a bright area in an image. But brightness doesn't necessarily equate with severity or cause.

"With an MRF," Griswold said, "we hope that with one step we can tell the severity and exactly what's happening in that area."

The fingerprint of each tissue, each disease and each material inside the body is therefore a different song. In an MRF, each member of the choir sings a different song simultaneously, Griswold said. "What it sounds like in total is a randomized mess."

The researchers generate unique songs by simultaneously varying different parts of the input electromagnetic fields that probe the tissues. These variations make the received signal sensitive to four physical properties that vary from tissue to tissue. These differences—the different notes and lyrics of their songs—become evident when applying pattern recognition programs using the same math in facial recognition software.

The patterns are then charted. Instead of looking at relative measurements from an image, Griswold said quantitative estimates told one tissue from another. As the technology progresses, these results will determine whether tissue is healthy or diseased, how badly and by what.

The scientists believe that they will be able to interrogate a total of eight or nine physical properties which will allow them to elicit the songs from a vast array of tissues, diseases and materials.

For a patient, an MRF would seem like a quick MRI. When the scan is done, all of the patient's songs would be compared with the songbook, which will provide doctors with a suite of diagnostic information.

"If colon cancer is 'Happy Birthday' and we don't hear 'Happy Birthday,' the patient doesn't have colon cancer," Griswold said.

Other researchers have tried to use multiple parameters in MRI's, but this group was able to scan fast and with higher sensitivity than in previous attempts, he continued. "This research gives us hope. We can see that it's possible the MRI can see all sorts of things."

The group expects to reduce scanning time and continue to build the songbook, or library of fingerprints, over the next few years.

For more information visit www.case.edu [1].

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