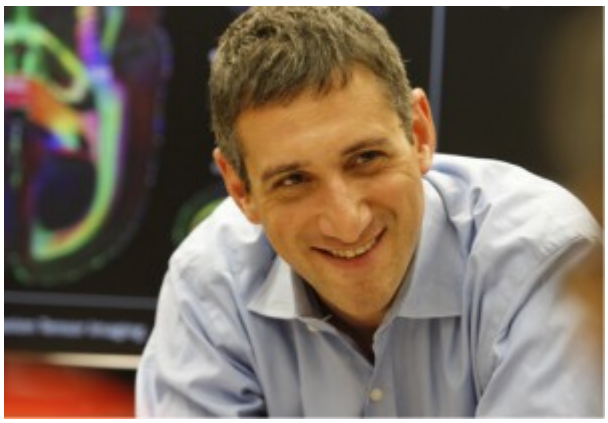
Demystifying MRIs

This technology, commonly used in MS care, can provide us with increasingly useful information. But it also has its limitations.

by Susan Worley

Since 1981, physicians and researchers have used magnetic resonance imaging (MRI) to look inside the brains and spinal cords of people with multiple sclerosis and detect damage to the central nervous system without the risk of injuring patients.



MRIs provide important information, but they do not tell the whole story, points out Dr. Daniel Reich of the National Institutes of Health. For

example, the plaques that show up on MRIs do not always correspond with MS relapses or symptoms. And it is difficult to know from the MRIs exactly what is happening in the plaques. Photo courtesy of Dr. Daniel Reich

While this technology has revolutionized many aspects of diagnosing and treating MS, the information it provides is not yet perfect. Understanding some of the limitations of MRI and the challenges that experts face when interpreting images can give individuals with MS greater insight into the role that MRI plays in helping clinicians to monitor the disease.

What is MRI?

To create pictures of the brain and spinal cord, MRI uses the combined power of a large magnetic field and radio wave energy. For a clear idea of how it works, it's important to understand that the atoms that make up our cells and tissues are in constant movement.

"Our cells are mostly made of water. Whenever you place biological tissues inside a very powerful magnet [such as the MRI tube], the hydrogen atoms in that water, which are all spinning around really fast, will start spinning at the same speed, and they'll all point in the same direction," says Dr. Daniel Reich, chief of the Translational Neuroradiology Unit at the National Institute of Neurological Disorders and Stroke, in Bethesda, Maryland, part of the National Institutes of Health (NIH). "During an MRI scan, we can temporarily force those hydrogen atoms to stop spinning together using a pulse of radiofrequency energy. Because they're still in the magnet, the atoms will begin to align again, but at different rates, which tells us whether we're looking at gray matter, white matter or MS lesions."

A contrast-enhancing agent, such as gadolinium, is injected into a vein in the arm. The agent travels through the bloodstream to get to the brain, where it can provide doctors with more detailed information. For example, if someone develops a new MS plaque, the blood vessels within that plaque often become leaky. "When that happens, gadolinium can leak out of the blood vessels into the plaque. That's how we know that the plaque is new," says Dr. Reich. "In our lab, we have also discovered that gadolinium can sometimes leak out into the layers of cells and fibers that cover the brain, called the meninges, and that this leakage also indicates that inflammation is going on."

[mri_images]

These MRI images of the brain of a 34-year-old woman with relapsing-remitting MS were collected at the first clinic visit (top row) and two months later (bottom row). The images in the left column, taken without a contrast agent, show MS lesions, both new and old, which are visible as white spots. The images in the right column were taken after gadolinium administration. They highlight one new lesion, with leaky blood vessels, in the first scan (bright spot, top right). In the second scan, the blood vessels are no longer leaky, but the lesion remains visible on the non-contrast scan

(bottom left). The lesion has also shrunk slightly, probably because of decreased swelling and inflammation. Photo courtesy of Dr. Daniel Reich

Challenges in interpreting MRIs

One challenge with MRI images is linking them to the clinical manifestation of the disease, such as a relapse or symptom. For instance, new lesions, or plaques, appear on MRI scans about 10 times more frequently than when clinical relapses with symptoms occur. Therefore, many of the plaques that are seen on MRI are "clinically silent," which means that they don't result in new symptoms.

About gadolinium

Last summer, the Food and Drug Administration (FDA) issued a Safety Communication about gadolinium-based contrast agents. Research indicates that these agents might not be completely eliminated from the body. While there is currently no indication that these deposits are harmful, the FDA has indicated its intention to investigate this issue as a possible safety risk. View more information about potential risks of gadolinium.

"Sometimes," says Dr. Reich, "you can pick up the effect of one of these new plaques with very sensitive neurological testing. But for the majority of them, it's not possible to identify any corresponding physical symptoms."

What's more, says Dr. Reich, it can be very difficult for experts to predict the outcome of new lesions. Some lesions—whether or not they produce symptoms—will repair themselves, which Dr. Reich says is part of the reason people recover from relapses.

"Whenever there is new inflammation in the body, there tends to be a lot of swelling," which causes more water than usual between the cells of the brain," Dr. Reich says. "Because of the way MRI works, we see water really, really well—so, when there is a lot of water surrounding new plaques, it can dominate the picture, and make it difficult to obtain information about other things that are going on in the plaques—for example, how much of the myelin and how many of the nerve cells have been damaged," he adds.

To make interpretations and predictions regarding plaques, experts need to rely not only on the images they see, but also on all of the scientific knowledge currently available regarding lesions. For instance, studies have shown that lesions in older people generally repair less well than those that develop in younger people. Doctors also must pay close attention to each individual patient's history because of the great deal of variation in the way that individual plaques look and behave over time.

Key definitions

- Lesion: an area that is inflamed or has damaged myelin, the protective sheath around nerves that is damaged in MS. Lesions are also sometimes called plaques.
- PET (positron emission tomography) imaging: an imaging technique that produces three-dimensional images showing blood flow to different parts of the brain.
- OCT (optical coherence tomography) imaging: a noninvasive imaging technique that produces high-resolution, three-dimensional images of the retina, which can provide information about damage to the optic nerve.

“MS is one of the most variable brain disorders,” says Dr. Reich. “It literally does not affect two people in the same way. Moreover, there are mysteries that experts still don’t understand—for example, in some individuals with progressive MS and rapidly increasing disability, it sometimes can be difficult to detect any corresponding significant changes on MRI. For t
hose reasons, it can be very challenging to draw from information gained in clinical trials to make decisions about the care of a particular individual. This is why we at NIH have imaged the brains of people with MS over many years and why we’re especially grateful to those who donate their brains to research; it enables us to understand how an MRI result relates to what is happening with the person’s MS.”

Talking with your neurologist

People with MS may feel less frustrated by imaging results that aren’t straightforward if they actively discuss these results with their doctors. Dr. Lily Jung Henson, chief of neurology for Piedmont Healthcare in Atlanta, says that it’s important to let your neurologist know when there is something you don’t quite understand.

Ask the following questions, she suggests: “Is there evidence of active disease? Do you see any new scars? Do you see any evidence of permanent nerve cell loss?”

Dr. Lily Jung

Henson

Dr. Jung Henson says, “It’s also good to ask about any changes that may have occurred on MRI, even when you may not be experiencing a change in symptoms, because these could still lead to disability. An affirmative answer to any of these questions should prompt you and your neurologist to have a discussion about whether your current therapy is keeping your MS under control.”

She adds that it’s also important for people with MS to be aware that disease activity can occur even in the absence of new lesions.

“Even when no new scarring is apparent, the scars that have occurred in the past are still there, and there could be activity occurring underneath the surface,” she explains. “Perhaps most important, the absence of new lesions doesn’t mean that a patient can start thinking about discontinuing his or her medications. Previous activity may be under control because of the disease-modifying agent a patient is taking.”

The future of imaging

Despite some of the challenges associated with imaging, MRI has proven to have enormous value. In addition to helping neurologists track MS progression and make important treatment decisions, MRI also enables new treatments to be tested much more quickly in clinical trials. Dr. Reich adds that researchers also are using MRI to study MS at very early stages of the disease.

“We are using MRI to study individuals who, because of genetics or certain risk factors, might be likely to develop MS. Our hope is that one day we’ll be able to treat or prevent the disease from occurring in the first place.”

As imaging techniques continue to improve, he says, experts will have access to better, higher-resolution pictures. And increasingly, experts will incorporate information from other imaging techniques, such as PET (positron emission tomography) and OCT (optical coherence tomography), to gain a better understanding of disease activity.

Susan Worley is a freelance medical writer in Bryn Mawr, Pennsylvania.

Learn more about the work of the National Institute of Neurological Disorders and Stroke, or to participate in its studies, call 301-496-3825.