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Understanding

If you have multiple sclerosis (MS) or your healthcare provider suspects MS, you will undoubtedly be scheduled for a magnetic resonance imaging (MRI) scan. An MRI is one of the best tools doctors and nurses have to assist in diagnosing and managing MS, and since the 1980s, when the first MRI of the brain was performed, these scanning techniques have changed quite a lot.

Many patients with MS are very interested in hearing about their MRI results and what they mean for their health and the effectiveness of the therapy they are taking. In this article, we talk to two MRI experts about the basics of MRIs and the questions you should be asking about your MRI tests.

What Is an MRI?

An MRI is an imaging technique that uses radiowaves and a powerful magnet to take detailed pictures of your brain and spinal cord from many different angles. It's a painless test, but some people feel uncomfortable during an MRI because you have to lie still for about half an hour on a table in a tube-like structure that houses the magnet while the pictures are taken. The machine is also quite noisy while it's taking the images. The pictures are then translated by a computer into thin, slice-by-slice images of the brain and spinal cord that are reviewed by a radiologist and your MS team.

MRI scans can show lesions (also called plaques or white spots) in the brain and spinal cord that are inflamed or damaged, which can signal MS is present. These lesions are visible because there is a disruption in the blood vessels of the brain, which allows inflammatory cells and fluid into the brain and spinal cord.

"Lots of diseases can cause white spots on an MRI scan," says Guy Buckle, MD, Director of Neuroimaging Research at the Andrew C. Carlos MS Institute at Shepherd Center in Atlanta, Georgia, "but not all white spots indicate MS. They can also be caused by normal aging, migraine headaches, or high blood pressure. So in order to make a diagnosis of MS, the MRI results must be matched with physical symptoms that suggest MS." These symptoms include things like numbness and tingling in the legs and temporary loss of vision in one eye (a condition known as optic neuritis).

Types of MRI Images

Two types of MRI pictures are especially useful in MS:

- **A T1-weighted MRI scan with or without the contrast agent gadolinium.** The contrast dye is injected into your veins to "light up" areas of active inflammation. It reveals new or reactivated old plaques, which show up as bright spots that last for several weeks and then fade. These plaques may

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Your MRI Results

help clinicians make a diagnosis of MS and can be a strong indicator of active disease. On a T1-weighted MRI scan where no contrast is used, chronic inactive plaques may show up as "black holes," and indicate more severe tissue damage.

- **A T2-weighted MRI scan.** This type of scan can show your clinician both the number and size of lesions in your brain and spinal cord. Changes in T2 lesions are often used to follow patients with MS to see if their disease is progressing. "Lesions that appear more noticeable or intense than the rest of the brain, due to inflammation, swelling, or fluid that has replaced tissue, can be seen on T2-weighted sequences," explains Matilde Inglese, MD, PhD, Associate Professor in the Departments of Neurology, Radiology, and Neuroscience at The Mount Sinai School of Medicine in New York City.

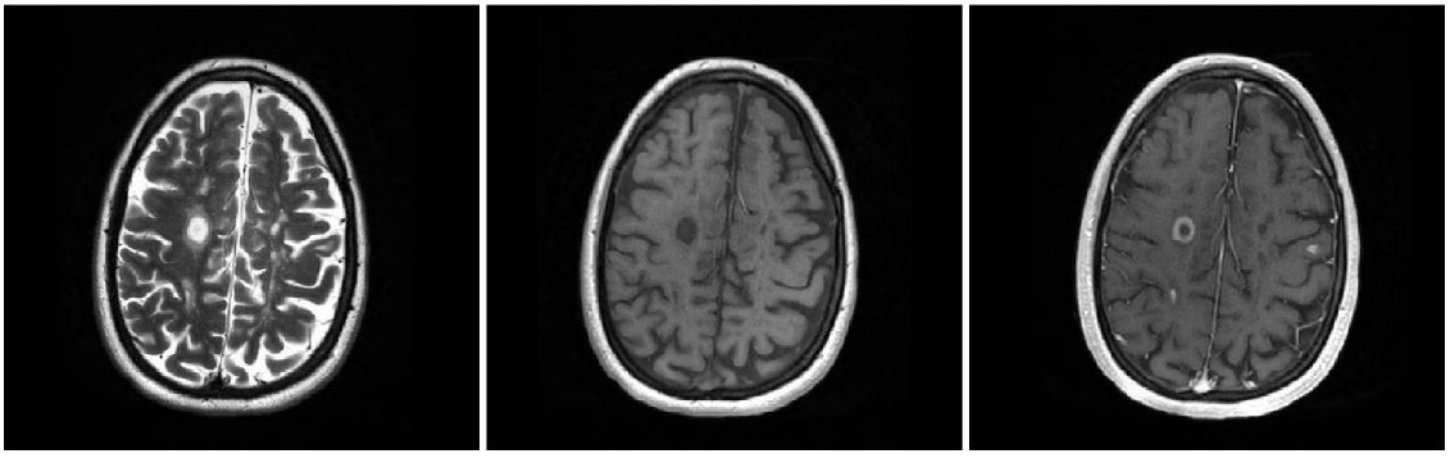
Changes in Space and Time

Healthcare providers also look for dissemination (changes) in space (DIS) and time (DIT) when reading MRI scans. "Dissemination in space means we are looking for the presence of lesions in different areas of the brain and spinal cord. Dissemination in time means we are looking for lesions that build up over time—that is, new lesions that were not present on older MRI scans," says Dr. Inglese.

MRI Guidelines

The Consortium of MS Centers (CMSC) has developed guidelines for when MRIs should be performed. Most healthcare providers use these guidelines in caring for people with MS.

- The guidelines state that a brain MRI with gadolinium should be performed to confirm the diagnosis of MS.
- An MRI of the spinal cord is recommended if the brain MRI doesn't clearly indicate MS or if your symptoms suggest MS lesions in your spinal cord.
- The CMSC recommends that an MRI be performed every 6 months to 2 years if you have relapsing MS. Your healthcare team will recommend the best schedule for you depending on your health status and your drug therapy. "Some providers may do an MRI every 3 months to 1 year," says Dr. Inglese. In



MRI images from a 36-year-old woman with MS

In this series of panels, you can see a T2-weighted image of the brain (first panel on the left), a T1-weighted image in the middle, and then a T1-weighted image after the administration of the contrast agent gadolinium. The MS lesions appear very bright (hyperintense) in the T2-weighted image. Some of them are dark (hypointense) in the T1-weight image in the middle, and then show enhancement after administration of the contrast agent.

Images courtesy of Matilda Inglese, MD.

addition, Dr. Buckle says that if you are diagnosed with a clinically isolated syndrome (CIS), which is a first neurological episode that suggests MS, MRIs may be performed every 3 months if not more often until a diagnosis is made.

- Follow-up brain MRIs are recommended during treatment to determine if new lesions have developed or if lesions are inflamed (in which case they will "light up" with the gadolinium). These kinds of changes on the MRI scan may prompt a change in therapy.
- The guidelines also advise a follow-up scan if you have new or worsening symptoms and when you are starting on a new drug therapy. "It's very important to have an MRI scan when you start or switch medications and then another one at 6 months," says Dr. Buckle. "You need a baseline scan to compare the 6-month results to in order to tell if the medication is working for you."

New MRI Techniques Used in Research

Routine MRIs are very important for the diagnosis of MS and for monitoring treatment, but there is much more going on in the brain and spinal cord than is currently evident to the eye on T1- and T2-weighted scans. "Studies have shown that there are microscopic brain tissue abnormalities in the white matter of the brain," says Dr. Inglese, "which contains the nerve fibers that send messages to and from the brain and rely on the myelin, the fatty coating that covers nerves and that is damaged and destroyed by MS." There is also often damage to the gray matter of the brain, which makes up the outer surface of the brain and contains nerve cells. Until recently, there was no way to see this damage. "Today, however, we are using new sequences such as MR double inversion recovery (DIR), which uses pulses of energy to better distinguish between white and gray matter tissue and detect these finer changes," reports Dr. Inglese. DIR and other new techniques, such as diffusion tensor imaging, which detects the motion of water molecules in tissue, and magnetization transfer imaging, which uses pulses of radiofrequency energy to get pictures of small vessels, are being used in research studies, but in the future may make it to clinical practice, she expects.

Dr. Buckle notes that measurement of brain volume is also increasingly being looked at on MRI brain scans. "We know that the brains of people with MS shrink faster over time than in people without the disease, and we are testing new disease-modifying therapies to see if they are effective in preventing loss of brain volume," he says. Currently, brain volume reports aren't part of the standard and routine MRI testing protocol, but healthcare providers can request them if the software is available in their practice setting.

Questions to Ask Your Clinician About Your MRI Scans

- Why do you suggest frequent MRIs?
- Has my MRI changed over time?
- Do I have any new lesions or active lesions?
- What do enlarging white spots mean?
- Why do some lesions appear darker than others?
- Do my MRI results indicate the drug I'm taking is working?
- How does the number of lesions seen on a scan influence the choice of treatment?
- Does the location of lesions influence the choice of treatment?