MS EMPOWERMENT SERIES

SHARED DECISION MAKING IN MULTIPLE SCLEROSIS

UNDERSTANDING MY MRI

Tips for Preparing for an MRI

What the Results Mean for People With MS

IOMSN
International Organization of Multiple Sclerosis Nurses

An educational series for people with multiple sclerosis (MS) developed in partnership with the International Organization of MS Nurses (IOMSN).

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UNDERSTANDING MY MRI

Magnetic resonance imaging (MRI) scans are a fact of life for anyone who has multiple sclerosis (MS) or is going through the diagnostic steps. Some people take the MRI procedure in stride, but many struggle with the prolonged, noisy experience of being "in the tube." In addition, it is common for people with MS to be worried or concerned about what their MRI result might show. MS nurses often provide valuable support before and after the MRI scan. To get updated information on what to expect during an MRI, how to prepare, and what the results might mean, we talked with MS nurse specialist Amy Perrin Ross, APN, MSN, CNRN, MSCN. In addition to being Neuroscience Program Coordinator at Loyola University Medical Center in Maywood, IL, Ms. Perrin Ross has held leadership roles in many MS organizations. These include the National Multiple Sclerosis Society, the Multiple Sclerosis Association of America, and the Consortium of Multiple Sclerosis Centers.

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IOMSN International Organization of Multiple Sclerosis Nurses

Developed by Delaware Media Group in partnership with the International Organization of MS Nurses (IOMSN)

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What should a person with MS know before having an MRI?

If this is the person's first-ever MRI, it helps to have a little background on what MRI is and how it works (see page 5, What is an MRI?). It's important for people to understand that having an MRI does not expose you to radiation, unlike an x-ray or CT scan. They will also need to decide where to have the MRI. Costs of these tests often vary, and some insurance companies may limit where the test can be done. However, we do need to ensure that the MRI facility is equipped to use the correct protocols for MS. MS lesions in brain tissue are very small, so if the scan is done incorrectly, at a lower resolution, or in the wrong areas, critical information may be missed.

How can a person with MS be sure their MRI meets the correct standards?

This year, the Consortium of Multiple Sclerosis Centers (CMSC) cooperated with other organizations to release international guidelines for using MRI in MS diagnosis and management. This guideline covers brain and spinal cord MRI

for MS with very specific and clear instructions. There is even a wallet card that can be downloaded from the CMSC website or clipped from this brochure on pages 9 and 10. The main types of MRI images used in MS are shown in the Infographic on page 7.

What are some of the questions people have about that guideline?

The stronger the magnet, the clearer the detail on the MRI images. A 3 Tesla (3T) magnet strength is preferred when possible. If 3T is really not available, a 1.5 Tesla MRI is acceptable but it will not show the same degree of clarity. Some facilities are able to do scans for MS on open MRI scanners or larger machines that do not feel as cramped. However, if the choice is between an open MRI with 1.5T magnet strength or a closed MRI with 3T, I would urge the person to go for the 3T.

Another question is whether or not a contrast medium (gadolinium) should be used. Gadolinium is a metallic element which has had some of the metals removed to make it safe to inject. In an MRI, the gadolinium enhances the quality of the pictures by showing a clear distinction of areas in the body where the dye has collected.

How safe is gadolinium?

In people with MS we no longer use gadolinium on every MRI scan. Some research has looked into whether gadolinium buildup, over a period of many years, might be harmful. We

What is an MRI?

Magnetic resonance imaging (MRI) is an imaging technique that uses a magnetic field along with computer-generated radio waves to create detailed images of the organs and tissues in the body. The magnetic field temporarily realigns water molecules in the body. Radio waves cause these aligned atoms to produce faint signals, which are used to create cross-sectional MRI images. The tissue images are kind of like slices in a loaf of bread. The thinner the slice, the more detail can be seen. MRIs can also produce 3D images that can be viewed from different angles. MRI is one of the safest imaging technologies. The examination causes no pain and the magnetic field produces no known tissue damage. MRIs do not expose a person to radiation, unlike an x-ray or CT scan.

don't know the answers yet. As a precaution, it is better to limit gadolinium to initial scans and other times when it is medically necessary.

Gadolinium may be used when we are looking to see if there are new lesions in the brain. New inflammatory lesions can occur even if the person has no symptoms or changes in their MS. The gadolinium-enhancing lesions may indicate silent disease activity and could suggest that a change in treatment may be needed. We also use gadolinium enhancement when a person is just starting out on a new therapy, so we can better detect any changes while the person is on the new medication.

How is gadolinium administered?

The patient will first be placed in the tube to have some images collected without contrast. They will then come out to have the dye injected into a vein. This is a small needle and is not painful, but some people may notice a cold sensation in the arm during the injection. The person then re-enters the scanner for a new series of images. The dye that has circulated will highlight areas of tissue damage. Most of the gadolinium leaves the body via the urine within 24 hours.

How do you help patients prepare for an MRI if they are anxious or claustrophobic?

It is very common for people to be given a mild sedative like diazepam (Valium) about 30 min-

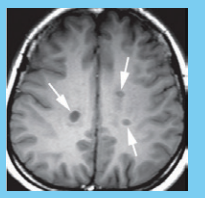
TYPES OF MRI IMAGES

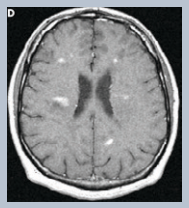
in multiple sclerosis

MRI imaging uses non-ionizing magnets to create detailed images of soft tissues in the body. Images are created using a magnetic field, radio waves, and a computer. Views on MRI are shown in layers or "slices" and a picture is taken of each slice.

T1-WEIGHTED IMAGES WITHOUT GADOLINIUM

On a T1-weighted image, lesions show up as dark areas (hypointensities, or "black holes") that indicate areas of permanent nerve damage.
In people with MS, T1 black holes depict chronic destruction of the brain's white matter and loss of axons (threadlike parts of the nerve cells).



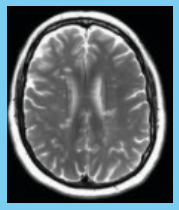


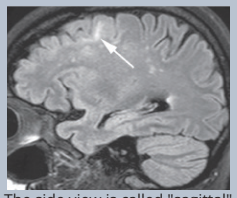
T1-WEIGHTED IMAGES WITH GADOLINIUM (CONTRAST)

Gadolinium is a contrast agent that is injected into the patient prior to or during an MRI scan. T1-weighted images with gadolinium show bright areas (enhancing lesions) indicating areas of active inflammation.

T2-WEIGHTED IMAGES

In a person with MS, T2-weighted MRI images show overall disease burden or lesion load (the total number of lesions, both old and new).





The side view is called "sagittal"

FLAIR (FLUID-ATTENUATED INVERSION RECOVERY)

This type of brain imaging reduces interference from the spinal fluid. On FLAIR images, brain tissue appears similar to T2 weighted images. Grey matter appears brighter than white matter, but the spinal fluid shows up as dark instead of bright.

WHAT IS TESLA STRENGTH?

The Tesla (symbol T) represents the strength of the MRI's magnetic field. Higher numbers mean stronger magnets and clearer MRI images. While MRIs can be done at 1.5T, a 3T scan is highly recommended for MS. Higher magnet strengths (6T or 9T) are used in research settings.

utes before having the MRI scan. Anyone who is feeling nervous about the procedure should feel free to mention this to the MS clinician in advance, to make sure that the drug is ordered and administered before the test. Another dose can be administered 30 minutes later if needed.

Another tip that my patients find helpful is to close their eyes before they go into the scanner and keep them closed during the procedure. The visual image of being pulled into a closed space can create anxiety even in people who usually aren't claustrophobic. Closing your eyes wipes out those visual cues. It also helps to use a cloth eye mask such as those used on overnight flights.

It may help to use the same MRI facility for repeat tests. This can help increase the person's comfort about what to expect.

Why are MRIs so noisy?

During an MRI the patient needs to lie very still during the whole exam. Some people find the noises to be troubling. The loud clicking and banging sounds are due to the switching of electromagnetic currents which causes the coils in the machine to expand. These sounds vary depending on the sequences being used. The patient may be allowed to wear plastic ear buds to listen to music or other calming audio. The MRI technician can assist with that and will make sure the headset is safe to bring into the machine.

About the International MRI Guidelines

The International MRI Guidelines represent a collaboration between three major medical organizations. The full guideline statement is highly detailed and available online. A card with abbreviated guidelines is shown below and also can be downloaded from the CMSC website at https://www.mscare.org/page/ MRI_protocol. This card can be taken to an MRI facility to ensure that the correct procedure is used on MRI scans for MS.

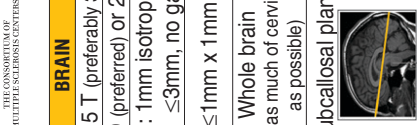
2021 MAGNIMS-CMSC-NAIMS STANDARDIZED MRI PROTOCOL

Lancet Neurology 2021 Aug;20(8):653-670

Magnims

CMSC THE CONSORTIUM OF MULTIPLE SCLEROSIS CENTERS

NAIMS North American Imaging in MS Cooperative

	BRAIN	SPINAL CORD	OPTIC NERVE
FIELD STRENGTH	≥1.5 T (preferably 3T)	≥1.5 T	≥1.5 T
ACQUISITION	3D (preferred) or 2D	2D or 3D	2D or 3D
SLICE THICKNESS	3D: 1mm isotropic[1] 2D: ≤3mm, no gap[2]	Sagittal ≤3mm, no gap Axial ≤5mm, no gap	≤2-3mm, no gap
IN-PLANE RESOLUTION	≤1mm x 1mm	≤1mm x 1mm	≤1mm x 1mm
COVERAGE	Whole brain (include as much of cervical cord as possible)	Whole cord (cervical, thoracolumbar including conus)	Optic nerve & chiasm
AXIAL SCAN ORIENTATION (2D ACQUISITION OR 3D RECONSTRUCTION)	Subcallosal plane 	Perpendicular to sagittal axis of cord	Align to optic nerve/ chiasm orientation

T = tesla; 3D = 3 dimensional; 2D = 2 dimensional

1 Isotropic preferred; if over-contiguous (through-plane and in-plane), not > 1.5 mm with 0.75 mm overlap

2 Diffusion-weighted imaging: slice thickness should be ≤ 5mm with no more than a 10–30% slice gap

How often should a person with MS have an MRI?

An initial MRI for MS should look at the brain and cervical spine, with and without contrast. This gives us a baseline, or starting point. If the MRI shows enhancing lesions, the person will most likely receive IV steroids to reduce the inflammation. After that, a disease-modifying therapy (DMT) should be started if MS lesions are found.

For a new patient, we usually recommend a repeat MRI after six months, even if there are no new symptoms. Going forward, a younger person with MS should usually have an MRI annually if the disease is relatively stable. Those with more active MS, or who have changed their DMT, may need more frequent MRIs.

An older person whose MS has been stable for many years might go to 2 or 3 years between MRI scans. I rarely recommend going beyond 3 years, because we might overlook changes in the disease activity.

On the Web: Many resources about MRI testing and procedures can be found on the National Library of Medicine website, MedlinePlus (https://medlineplus.gov/mriscans.html).

Brain	Dx	Fm	Sm
Axial T_2		±	±
Sagittal & axial FLAIR (or 3D)			
Post-Gd axial (or 3D) T_1			
Diffusion-weighted imaging		DDx	
DIR or PSIR			
High-resolution 3D T_1 (brain volume assessment)			
Susceptibility-weighted imaging			
Optic Nerve	**Dx**	**Fm**	**Sm**
Axial & coronal fat-suppressed T_2 or STIR			
Post-Gd[3] axial & coronal fat-suppressed T_1			
Spinal Cord	**Dx**	**Fm**	**Sm**
Sagittal at least 2 of T_2, PD or STIR			
Sagittal 3D T_1 (PSIR, MPRAGE)[4] cervical only			
Axial T_2 or T_2^*			
Pre-Gd Sagittal T_1			
Post-Gd[3] Sagittal T_1			
Post-Gd[3] axial T_1			

Recommended	Optional	Not Required

Dx Diagnosis of MS
Fm Follow-up monitoring of disease activity and effectiveness of disease modifying treatment (DMT)
Sm Safety monitoring for DMT e.g., screening for risk of progressive multifocal encephalopathy (PML)

T_2 (TSE/FSE, turbo/fast spin echo)
± Axial T_2 optional if 3D FLAIR with sagittal/axial reconstructions are available
Gd macrocyclic agent, 0.1mm/kg body weight, minimum delay 5-10 minutes
T_1 (TSE/FSE)
DDx For differential diagnosis

FLAIR (fluid-attenuated inversion recovery), with optional fat suppression
DIR (double inversion recovery)
PSIR (phase-sensitive inversion recovery)

High resolution 3D T_1 (e.g. MPRAGE/MP2RAGE magnetization-prepared rapid acquisition of gradient echoes; IR-SPGR, inversion recovery prepared spoiled gradient; TFE, turbo field-echo)

STIR (short tau inversion recovery)
PD (proton-density, TSE/FSE)
T_2^* (T_2 gradient recalled echo)

[3] No additional Gd necessary if immediately following Post-Gd brain examination
[4] Could substitute for one of T_2, PD or STIR

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