



PROPOSED 2017 REVISED GUIDELINES

CONSORTIUM OF MS CENTERS MRI PROTOCOL FOR THE DIAGNOSIS AND FOLLOW-UP OF MS

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PURPOSE

MRI is widely used for the early and accurate diagnosis of multiple sclerosis (MS) and is used increasingly in patient follow-up. Guidelines for a standardized brain and spinal cord MRI protocol had been previously proposed in 2001, 2003, and 2009. More recently, revised recommendations were published (AJNR 2016;37:394-401. doi: 10.3174/ajnr.A4539) and subsequently, a letter to the editor addressing concerns regarding the use of gadolinium was published (AJNR online: 10.3174/ajnr.A4943). A follow-up consensus meeting was convened in January 2017 to review and update the guidelines with particular attention to the use of gadolinium. The proposed 2017 revised guidelines incorporates new clinical information and imaging techniques that will benefit patients and will be useful for physicians and health care providers.

METHODS

Sponsored by the Consortium of MS Centers, an international group of neurologists, radiologists, and imaging scientists with an expertise in MS from North America and Europe met in Newark, NJ, US, January 11-12, 2017 to revise and update the guidelines and indications for standardized brain and spinal cord MRI for MS including attention to the use of gadolinium, based on new data, survey results and expert opinion. The expert taskforce included representatives of the American Academy of Neurology, the Radiological Society of North America, the American Society of Neuroradiology, the National Institutes of Health and the North American Imaging in Multiple Sclerosis Cooperative. The update reviewed the four imaging protocols: routine brain, progressive multifocal leukoencephalopathy (PML) surveillance, spinal cord, and orbits.

SUMMARY

- » A brain MRI with gadolinium is recommended for the diagnosis of MS
- » A spinal cord MRI is recommended if the brain MRI is non-diagnostic or if the presenting symptoms are at the level of the spinal cord
- » Recommendations for a follow-up evaluation include brain MRI to demonstrate dissemination in time and ongoing clinically silent disease activity while on treatment, to evaluate unexpected clinical worsening, for reassessment of the original diagnosis, and for use as a new baseline MRI before starting or modifying therapy.
- » A routine brain MRI should be considered every 6 months to 2 years for patients with relapsing MS.
- » Gadolinium-based contrast agents do accumulate in the brain and, to a much lesser degree with macrocyclic agents. While there is no known CNS toxicity, these agents should be used judiciously, recognizing that gadolinium continues to play an invaluable role in specific circumstances related to the diagnosis and follow-up of individuals with MS.
- » The clinical question being addressed should be included in the requisition for the MRI.

BRAIN MRI RECOMMENDATIONS

Baseline studies for patients with a clinically isolated syndrome (CIS) and/or suspected MS:

- » Brain MRI protocol with gadolinium at baseline, and to establish dissemination in time
- » Spinal cord MRI if transverse myelitis, insufficient features on brain MRI to support diagnosis, or age>40 with non-specific brain MRI findings
- » A cervical cord MRI performed simultaneously with the brain MRI would be advantageous in the evaluation of patients with or without transverse myelitis and would reduce the number of patients requiring a subsequent MRI appointment
- » Orbital MRI if severe optic neuritis with poor recovery

Timing of a follow-up brain MRI protocol for patients with a CIS and/or suspected MS to look for evidence of dissemination in time:

- » 6-12 months for high risk CIS (e.g. >2 ovoid lesions on first MRI)
- » 12-24 months for low risk CIS (i.e. normal brain MRI) and/or uncertain clinical syndrome with suspicious brain MRI features (e.g. radiologic isolated syndrome [RIS])

Timing of brain MRI protocol for patients with an established diagnosis of MS:

- » No recent prior imaging available (e.g. patient with established diagnosis of MS and new to your clinical practice)
- » Postpartum to establish a new baseline
- » Prior to starting or switching disease-modifying therapy
- » Approximately 6 months after switching disease-modifying therapy to establish a new baseline on the new therapy
- » Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity (i.e. new T2 lesions or gadolinium enhancing lesions)

- » Unexpected clinical deterioration or reassessment of original diagnosis (gadolinium-based contrast may be helpful)
- » The use of gadolinium-based contrast agents is helpful but not essential for detecting subclinical disease activity because new T2 MS lesions can be identified on well-performed standardized MR imaging.

SPINAL CORD MRI RECOMMENDATIONS

- » Symptoms presenting in the spinal cord (transverse myelitis, progressive myelopathy)
- » Older age of onset
- » Recurrent transverse myelitis
- » No role for establishing dissemination in time

PML SURVEILLANCE BRAIN MRI PROTOCOL

Timing of PML surveillance brain MRI protocol:

- » Every 12 months for serum JC virus antibody negative patients
- » Every 3-6 months for serum JC virus antibody positive patients and > 18 months on natalizumab

NOTE: the brain MRI protocol for monitoring patients on disease-modifying therapies includes the same sequences as the PML surveillance protocol.

PROTOCOL 1: STANDARDIZED BRAIN MRI PROTOCOL (DIAGNOSIS AND ROUTINE FOLLOW-UP OF MS)

Field Strength	Scans should be of good quality, with adequate signal-noise ratio (SNR) and spatial resolution (in slice pixel resolution of < 1mm x 1mm)
Scan Prescription Coverage Slice thickness and gap	Use the subcallosal plane to prescribe or reformat axial oblique slices Whole brain coverage < 3mm, no gap (for 2D acquisition or 3D reconstruction)
Core sequences	2D/3D Sagittal & Axial FLAIR ^{1,#} 2D/3D Axial T2 [#] Axial 2D DWI ² 3D IR-prep GE ³ T1
Gadolinium (as required)	Post Gad 2D/3D Axial T1
Additional sequences	Susceptibility weighted (SWI) Pre Gad 2D/3D Axial T1 Axial PD

¹ FLAIR (Fluid Attenuated Inversion Recovery)

² DWI (Diffusion Weighted)

³ IR-prep GE (Inversion-recovery prepared Gradient Echo; Magnetization Prepared Rapid Gradient Echo or MP-RAGE; Turbo Field Echo or TFE)

FLAIR or T2 may be performed during the 5 minute minimum delay after gadolinium injection before acquiring the post-gadolinium T1

PROTOCOL 2: PML SURVEILLANCE BRAIN MRI PROTOCOL

Field Strength	Scans should be of good quality, with adequate signal-noise ratio (SNR) and resolution (in slice pixel resolution of $\leq 1\text{mm} \times 1\text{mm}$)
Scan Prescription	Use the subcallosal plane to prescribe or reformat axial oblique slices
Coverage	Whole brain coverage
Core Sequences	2D/3D Sagittal & Axial FLAIR ¹ Axial 2D DWI ²
Gadolinium (as required)	Post Gad 2D/3D Axial T1
Additional Sequences	SWI 2D/3D Axial T2 3D IR-prep GE ³ T1 Pre Gad 2D/3D Axial T1 Axial Proton Density
Slice thickness and gap	$\leq 3\text{mm}$, no gap (for 2D acquisition or 3D reconstruction)

¹ FLAIR (Fluid Attenuated Inversion Recovery)

² DWI (Diffusion Weighted)

³ IR-prep GE (Inversion-recovery prepared Gradient Echo; Magnetization Prepared Rapid Gradient Echo or MP-RAGE; Turbo Field Echo or TFE)

PROTOCOL 3: SPINAL CORD MRI PROTOCOL

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Field Strength	Scans should be of good quality, with adequate signal-noise ratio (SNR) and resolution (in slice pixel resolution of $\leq 1\text{mm} \times 1\text{mm}$) Closed magnets (large bore for claustrophobic patients) preferred.
Coverage	Cervical cord coverage ¹
Core Sequences	Two of the following: Sagittal T2 Or Proton Density Or STIR ² Or T1-PSIR ³ Axial T2/T2* through lesions
Slice thickness and gap	Sagittal: $\leq 3\text{mm}$, no gap Axial: $\leq 5\text{ mm}$, no gap
Additional sequences	Sagittal T1 Post Gad T1 [#] (sag, axial) Axial T2/T2* entire cervical cord 3D IR-prep GE ⁴ T1

¹Thoracic and conus coverage recommended if symptoms localize to this region to rule out an alternate diagnosis

²STIR (Short Tau Inversion Recovery)

³PSIR (Phase Sensitive T1 Inversion Recovery)

⁴IR-prep GE (Inversion-recovery prepared Gradient Echo; Magnetization Prepared Rapid Gradient Echo or MP-RAGE; Turbo Field Echo or TFE)

[#]No additional gadolinium necessary if cord examination immediately follows gadolinium enhanced brain MRI

PROTOCOL 4: ORBIT MRI PROTOCOL

- » May be clinically indicated to confirm optic neuritis and rule out compressive lesions
- » Recommended sequences include coronal STIR or fat-suppressed T2 and a post-gadolinium fat-suppressed T1 with a section thickness of ≤ 2 mm, with coverage to include the optic chiasm
- » Optional sequences may include axial/coronal pre-gadolinium Fat-Sat T1, axial Fat-Sat T2 or STIR, Axial Post-Gad Fat-Sat T1

RECOMMENDATIONS FOR COMMUNICATION

MRI REQUISITION:

- » The clinician should provide on the request for the standardized MRI brain and/or spinal cord protocol
- » Clinical questions to be addressed
 - * Diagnosis
 - * Management decision
- » Relevant clinical history and physical examination findings
- » History of MS medication
- » If known, date and place of previous examinations

MRI REPORT:

Standardized nomenclature/terminology should be used and include:

1. Description of findings
 - * Lesion type, location, size, shape, character, number
 - * Whether meets MRI DIS or DIT criteria
 - * Qualitative assessment of T2, T1 (black hole) and brain volume/atrophy
2. Comparison with previous studies (lesions, atrophy)
3. Interpretation (typical for MS, atypical for MS, not MS) and differential diagnosis, if appropriate

NOTE: Structured reports are extremely helpful.

RECOMMENDATIONS:

- » Studies should be stored in a standard readable format
- » Copies of MRI studies should be retained permanently and be available
- » It may be beneficial for patients to keep their own studies on portable digital media

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