Revised Recommendations of the CMSC Task Force for a Standardized MRI Protocol and Clinical Guidelines for the Diagnosis and Follow-up of Multiple Sclerosis

Summary of MRI Protocol and Guidelines Prepared By:

THE CONSORTIUM OF MULTIPLE SCLEROSIS CENTERS

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Summary: Revised Recommendations of the CMSC Task Force for a Standardized MRI Protocol and Clinical Guidelines for the Diagnosis and Follow-up of Multiple Sclerosis

An international group of neurologists and radiologists developed revised guidelines for standardized brain and spinal cord magnetic resonance imaging (MRI) for the diagnosis and follow-up of multiple sclerosis (MS). A brain MRI protocol 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. A follow-up brain MRI with gadolinium is recommended to demonstrate dissemination in time, ongoing clinically silent disease activity while on treatment, to evaluate unexpected clinical worsening, to re-assess the original diagnosis, and as a new baseline prior to starting or modifying therapy. A routine brain MRI should be considered every 6 months to 2 years for all patients with relapsing MS. The brain MRI protocol includes 3D T1-weighted, 3D T2-FLAIR (fluid attenuated inversion recovery), 3D T2-weighted, post single-dose gadolinium-enhanced T1-weighted, and a diffusion-weighted imaging (DWI) sequence. If 3D acquisitions are not

possible, 2D acquisitions are acceptable. In either case, the subcallosal plane should be used to prescribe (2D) or reformat (3D) axial slices (≤ 3mm, no gap). The progressive multifocal leukoencephalopathy (PML) surveillance protocol includes FLAIR and DWI sequences only. The spinal cord MRI protocol includes sagittal T1-weighted and proton density, short tau inversion recovery (STIR) or phase sensitive inversion recovery (PSIR), axial T2- or T2*-weighted through suspicious lesions, and, in some cases, post-contrast gadolinium-enhanced T1-weighted imaging. The clinical question being addressed should be provided in the requisition for the MRI. The radiology report should be descriptive with results referenced to previous studies. MRI studies should be permanently retained and available. The current revision incorporates new clinical information and imaging techniques that have become more available.

KEY TABLES:

Table 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 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	Anatomic 3D inversion-recovery prepared T1 gradient echo (e.g.1.0 -1.5mm thickness) Gadolinium single dose 0.1 mmol/kg given over 30 seconds[1] 3D sagittal T2-weighted FLAIR[2] (e.g. 1.0 to 1.5 mm thickness) 3D T2-weighted[2] (e.g.1.0 to 1.5 mm thickness) 2D axial DWI (≤5mm slices, no gap) 3D FLASH (non IR[3] prep) post gadolinium[2] (e.g.1.0 to 1.5 mm thickness) 3D series would be typically reconstructed to 3mm thickness for display and subsequent comparison for lesion counts
Optional sequences	Axial proton density (PD) Pre- or post-gadolinium axial T1 spin-echo (for chronic black holes) Susceptibility weighted imaging (SWI) for identification of central vein within T2 lesions

[1]Minimum 5-minute delay before obtaining post gadolinium T1. The 3D Sagittal FLAIR may be acquired immediately after contrast injection before the 3D FLASH series.

[2] If unable to do 3D acquisition, then 2D axial and sagittal FLAIR, axial fast spin-echo proton density/T2, and axial post-gadolinium T1–weighted spin echo at ≤3mm slice thickness.

[3] Inversion Recovery

Table 2

PML[1] Surveillance Brain MRI PROTOCOL

Field Strength	Scans should be of good quality, with adequate SNR and resolution (in slice pixel resolution of ≤ 1mm x 1mm)
Scan Prescription Coverage	Use the subcallosal plane to prescribe or reformat axial oblique slices Whole brain coverage
Sequences[1]	3D sagittal T2-weighted FLuid Attenuated Inversion Recovery (FLAIR)[2] 2D axial diffusion weighted imaging; DWI (5mm thick, no gap)
Slice thickness and gap	≤ 3mm, no gap (for 2D acquisition or 3D reconstruction)

[1] Progressive Multifocal Leukoencephalopathy

[2] If unable to do 3D acquisition, then 2D axial FLAIR at ≤3mm slice thickness

Table 3

Spinal Cord MRI PROTOCOL

Field Strength	Scans should be of good quality, with adequate SNR and resolution (in slice pixel resolution of ≤ 1mm x 1mm) Closed magnets (large bore for claustrophobic patients) preferred.
Coverage	Cervical cord coverage[1]
Core Sequences	Sagittal T2 Sagittal Proton Density, STIR or PST1-IR[2] Axial T2 through lesions
Slice thickness and gap	Sagittal: ≤3mm, no gap Axial: 5 mm, no gap
Optional sequences	Axial T2 through complete cervical cord Gadolinium[3] and post gadolinium sagittal T1 Sagittal T1

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

[2]Phase Sensitive T1 Inversion Recovery

[3]Minimum 5-minute delay before obtaining post gadolinium T1. Additional gadolinium does not need to be given for a spinal cord MRI if it follows a contrast brain MRI study.

Table 4

Clinical guidelines for brain and spinal cord MRI in MS

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

- Brain MRI protocol with gadolinium at baseline, and
- 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 with gadolinium for patients with an established diagnosis of MS:

- No recent prior imaging available (e.g. patient with MS transferring to a new clinic)
- 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
- Unexpected clinical deterioration or reassessment of original diagnosis

NOTE: routine spinal cord follow-up not required unless syndrome is predominately recurrent transverse myelitis.

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 PML surveillance protocol sequences.

Table 5

Recommendations for communication

The clinical requisition for brain MRI should include the following:

- Request the CMSC (Consortium of Multiple Sclerosis Centers) or standardized brain MRI protocol
- Indicate purpose of study:
  - Diagnostic study for CIS or MS (indicate date of symptom onset)
  - Treatment monitoring study (indicate if on disease-modifying therapy)
  - PML surveillance study (indicate if high or low risk)
  - Unexpected clinical decline or reassessment of diagnosis
- Date and location of most recent MRI study (encourage patient to bring a copy of outside images on portable media at time of MRI appointment)

The radiology report should include the following:
For a diagnostic MS study:

- Number of gadolinium-enhancing T1 lesion number (e.g. 0, 1, 2, 3, 4, ≥5)
- Comparison with previous studies for the number of new T2 lesion number (e.g. 0, 1, 2, 3, 4, ≥5)
- The presence of juxtacortical (touching the cortex), periventricular (touching the ventricles), infratentorial or spinal cord lesions
- The report should avoid a summary statement like "McDonald diagnostic criteria met"
- The interpretation should indicate if findings are typical, atypical, or not consistent with MS, and should provide a differential diagnosis if appropriate

For a follow-up MS study:

- Number of gadolinium-enhancing T1 lesion number (e.g. 0, 1, 2, 3, 4, ≥5)
- Comparison with previous studies for the number of new T2 lesion number (e.g. 0, 1, 2, 3, 4, ≥5)
- Qualitative assessment of:
  - Overall T2 lesion burden severity (e.g. mild, moderate, severe)
  - Comparison with previous studies for overall worsening of T2 lesion burden and atrophy

For a PML surveillance study:

- Comparison with previous studies for new T2 lesions, hyperintense lesions on DWI
- Presence of PML suspicious features

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The world's leading association of multidisciplinary MS healthcare professionals dedicated specifically to MS. Where every doctor, nurse, researcher, therapist, social worker and technician is connected by a common bond: moving closer to a cure for MS.

CMSC

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We are building the future of MS care.

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