

An International Standardized Magnetic Resonance Imaging Protocol for Diagnosis and Follow-up of Patients with Multiple Sclerosis

Advocacy, Dissemination, and Implementation Strategies

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Standardized magnetic resonance imaging (MRI) protocols are important for the diagnosis and monitoring of patients with multiple sclerosis (MS). The Consortium of Multiple Sclerosis Centers (CMSC) convened an international panel of MRI experts to review and update the current guidelines. The objective was to update the standardized MRI protocol and clinical guidelines for diagnosis and follow-up of MS and develop strategies for advocacy, dissemination, and implementation. Conference attendees included neurologists, radiologists, technologists, and imaging scientists with expertise in MS. Representatives from the CMSC, Magnetic Resonance Imaging in MS (MAGNIMS), North American Imaging in Multiple Sclerosis Cooperative, US Department of Veteran Affairs, National Multiple Sclerosis Society, Multiple Sclerosis Association of America, MRI manufacturers, and commercial image analysis companies were present. Before the meeting, CMSC members were surveyed about standardized MRI protocols, gadolinium use, need for diffusion-weighted imaging, and the central vein sign. The panel worked to make the CMSC and MAGNIMS MRI protocols similar so that the updated guidelines could ultimately be accepted by international consensus. Advocacy efforts will promote the importance of standardized MS MRI protocols. Dissemination will include publications, meeting abstracts, educational programming, webinars, “meet the expert” teleconferences, and examination cards. Implementation will require comprehensive and coordinated efforts to make the protocol easy to access and use. The ultimate vision, and goal, is for the guidelines to be universally useful, usable, and used as the standard of care for patients with MS. *Int J MS Care*. 2020;22:226-232.

The consensus conference organized by the Consortium of Multiple Sclerosis Centers (CMSC) in October 2019 was a landmark event in the

advancement of a standardized magnetic resonance imaging (MRI) protocol for the diagnosis and follow-up of patients with multiple sclerosis (MS). The CMSC hosted this conference, bringing together the CMSC MRI Guidelines Working Group (CMSC Working Group), a panel of international experts charged with updating the guidelines for a standardized MRI protocol in MS. Until recently, there were two most commonly

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recommended protocols: 1) revised recommendations for a standardized MRI protocol and clinical guidelines for diagnosis and follow-up of MS from the CMSC in North America and 2) consensus guidelines on the use of MRI in MS from the Magnetic Resonance Imaging in MS (MAGNIMS) Study Group in Europe.¹⁻⁵ Although these protocols are well recognized and frequently cited,⁶⁻¹⁰ disappointingly, they are not used widely.^{11,12}

During the 2019 MRI Consensus Guidelines Conference, the goal was to collaborate with multiple stakeholders in MS patient care and neuroimaging to begin developing globally aligned recommendations and to promote more widespread use of a standardized MRI protocol for MS. The first objective is within reach now as the CMSC Working Group, using the updated recommendation from this meeting, has partnered with the MAGNIMS Study Group and the North American Imaging in Multiple Sclerosis Cooperative (NAIMS) to produce the International 2020 MAGNIMS-CMSC-NAIMS Consensus Guidelines on the Use of MRI in Multiple Sclerosis (International 2020 Guidelines [manuscript submitted for publication]). The present paper reports on the second objective of promoting more widespread use of a standardized MS MRI protocol with discussions and proposals for advocacy, dissemination, and implementation.

Consensus Conference

The October 2019 consensus conference attendees consisted of neurologists, radiologists, MRI technologists, and imaging scientists with expertise in MS from the United States, Canada, and Europe, including representatives from the CMSC, MAGNIMS, NAIMS,

National Multiple Sclerosis Society (NMSS), Multiple Sclerosis Association of America (MSAA), and leading MRI manufacturers (GE Healthcare, Philips Healthcare, and Siemens Medical Solutions) and commercial image analysis companies (Cortech Labs and icometrix). The purpose of this meeting was to update the CMSC guidelines for a standardized MRI protocol for the diagnosis and monitoring of MS, with a major focus on discussion and development of plans to promote its use. Before the meeting, the CMSC general membership was surveyed about the current use of MRI with a consistent standardized protocol, as well as the use of gadolinium and diffusion-weighted imaging sequences and the utility of cortical lesions, brain atrophy, and the central vein sign, which helped in updating the technical and protocol-specific details for a standardized MRI examination. In the process of updating the protocol, in recognition of the value and importance of being able to have an international consensus protocol, there was a consistent effort to make the CMSC and MAGNIMS MRI protocols and guidelines similar. Working collaboratively with MAGNIMS and NAIMS, the updated CMSC recommendations were incorporated into the International 2020 Guidelines.

Recognizing the critical importance of promoting more widespread use of the standardized MS MRI examination, the CMSC Working Group developed several action plans to advocate, disseminate, and implement the updated recommendations worldwide. Advocacy involves promoting the protocol to become universally useful, usable, accepted, and adopted. Dissemination includes distributing the information internationally. Implementation involves putting all of these recommendations into effect.

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Outcomes and Plans

MRI Survey

Ninety-five of the CMSC members responded to the question, “Do most of your patients get an MRI done with a standardized protocol?” Only 34% were definite that the CMSC protocol was used, 14% had to specifically request the CMSC or a standardized MRI protocol, 48% responded that either a local protocol was used or that they were uncertain whether the CMSC protocol was used, 3% indicated that studies “looked different each time,” and 1% did not know.

Advocacy

Magnetic resonance imaging is invaluable in the diagnosis and ongoing monitoring of MS. Identifying new lesions and/or enhancement on MRI can lead to an earlier diagnosis of MS and help determine whether there is a need to initiate or change treatment. A well-performed standardized MRI examination is key. Using standardized T2-weighted/fluid-attenuated inversion recovery (FLAIR) sequences can accurately detect new MS lesions compared with previous standardized MRI studies, often without the need for gadolinium (reduces extra cost and can minimize concerns about gadolinium deposition with frequent administration).^{1,5,13} In nonstandardized MRI, inconsistent slice thickness (often with slice gaps), incomplete brain coverage, and not using a reproducible acquisition plane (subcallosal plane is recommended) all contribute¹⁴ to images that are different from one examination to the next, making them difficult to compare for accurate and confident identification of new lesion activity.

Raising awareness about the critical importance of standardized MS MRI protocols by advocating for their use with radiologists and neurologists will be required. Receiving endorsements from national and international neurologic and radiologic associations as well as patient advocacy groups, including the NMSS, Multiple Sclerosis Society of Canada, and MSAA, will be helpful to achieve this goal.

Educating patients with MS about the value of standardized MRI protocols is also important. As part of the MS health care team, patients are already active participants in their own care, and they often maintain digital copies of their own MRI records and images. It should, therefore, not be surprising if an informed and empowered patient specifically requests MRI following the International 2020 Guidelines. Having patients advocate for the use of the standardized MRI examination will

make a difference with providers and payers. Patient education will help in the effort to encourage international acceptance and use of the guidelines.

Educating payers and insurance companies will also be key. If they understand that nonstandardized images that cannot be easily compared with previous studies are a waste of time and money, they will soon be requesting that all MRI facilities use the international guidelines. Payers want to keep costs low while providing high-quality care for their clients.¹⁵ Standardized images that provide optimal data and reduce the need for repeated imaging may be one way for the government and insurers to control health care spending. Of perhaps greater concern is that a suboptimal image could lead to the wrong management decision, which will be even more costly, especially if treatment decisions lead to prescribing more costly medications with potentially more adverse effects. Insurers and payers also need to advocate for their patients with MS by having them referred only to facilities that have adopted the standardized MRI protocol.

Dissemination

The CMSC has outlined a broad strategy for dissemination of the International 2020 Guidelines. To communicate with neurologists, radiologists, and others on the MS health care team, there have been multiple submitted abstracts to national and international neurologic, MRI, and MS-related meetings. Information about the updated guidelines is also available now through multiple resources, including posters presented at international meetings, published news articles, and video programming (Appendix S1, which is published in the online version of this article at ijmsc.org). Much more will be done with the soon-to-be-published consensus International 2020 Guidelines.

The CMSC will also work in conjunction with organizations such as the NMSS to disseminate the Guidelines by way of educational programming, webinars, distance learning, social media, and postings on their websites. The CMSC plans to have an FAQ (Frequently Asked Questions) on its website concerning the new International 2020 Guidelines, when these become available, to assist neurologists, radiologists, and MRI technologists as they incorporate the protocol into their everyday practice. Education on an international level will be critical to promoting use of the guidelines.

Examination cards that succinctly describe the full International 2020 Guidelines will be available to any-

one visiting the CMSC, NMSS, and Multiple Sclerosis Association of America websites, and vendor-specific versions will be available for uploading onto MRI machines. Hard-copy laminated versions of the examination cards will also be available on request and widely distributed to MS clinics, MRI centers, and other health care facilities.

The US Department of Veteran Affairs was instrumental in early dissemination of the MRI protocol after the 2006 publication of the CMSC consensus guidelines,¹⁶ and they are already working on dissemination and implementation strategies for the International 2020 Guidelines with their MRI facilities throughout the United States (Appendix S2). There are plans for the CMSC to have similar discussions with national MRI services and managed care providers to inform them of the details of the standardized MRI examination and to strongly encourage them and their members to adopt and use the standardized MRI protocol for their patients and clients with MS.

Implementation

Probably one of the biggest barriers for MRI centers that have been performing studies that do not meet the updated recommendations is the inertia of “we’ve been doing this a long time, we’re familiar with what we’re doing, and we don’t want a change as change will be hard.” The radiologist and staff will need to be convinced that the standardized MRI examination is useful and usable so that the changes can be made and the protocol will be used.

The radiologist and staff at the MRI center will need to understand that the standardized MRI examination will be useful as it will be helpful and beneficial to the patient with MS and referring physician by identifying new lesions and lesion activity, which aids diagnosis and informs management decisions. It will also be useful (helpful and beneficial) to the radiologist because it will be much easier to compare images that are consistent and reproducible, including when patients transfer care (eg, after a move). Having the neurologist (and other referring physicians) specifically request a standardized MRI examination according to International 2020 Guidelines will be important. Even better will be specific requests from patients with MS, and the payers, that they will only be imaged at MRI centers that do so.

For the standardized MRI examination to be usable, the radiologist and MRI center staff will need to recognize and understand that the examination is reason-

able and practical, which most commonly means that the examination should be completed in a reasonable amount of time. There is also a mistaken perception of its complexity. The standardized MRI brain study, which includes core sequences (<3-mm slices, contiguous), three-dimensional (3D) (or two-dimensional [2D] if 3D not available) axial and sagittal FLAIR, and 3D (or 2D) T2-weighted and 2D diffusion-weighted images, can be easily acquired in less than 20 minutes, and for sites wanting the additional options for brain volume (3D high-resolution T1-weighted gradient echo) and central vein (susceptibility-weighted) assessment, the entire study can be accomplished in 25 to 30 minutes.³ The use of gadolinium-based contrast agents is essential in the diagnostic work-up and can also be helpful in monitoring some patients with MS, particularly when there is highly active disease, unexplained or unexpected clinical worsening, or concern regarding an alternative diagnosis to MS. It is not necessary for most routine follow-up studies to identify new lesion activity when imaging is well performed in a standardized manner. Acquiring the 3D FLAIR sequences during the 5-minute delay required after injection is an additional useful time-saving strategy.

Our understanding of MRI best practices continues to evolve and advance. A major improvement in MRI technology in the past few years is the ability to acquire high-resolution 3D images. In a time that is just slightly longer than that required to acquire a 2D sequence in only one plane, a 3D isometric acquisition can be reformatted in any imaging plane, replacing images in two different planes (axial and sagittal) and thereby reducing overall imaging time. The high-resolution images (typically 1×1×1 mm) are particularly helpful for lesion identification with the FLAIR sequence.

To make the standardized MRI protocol even easier to adopt, MRI equipment manufacturers are working to have the International 2020 Guidelines protocol sequences available on the MRI machine itself without requiring any changes to existing equipment. Having the sequences already preloaded into the imaging software and/or easily updated (online or with downloadable MRI protocol cards) will make the protocol efficient, easy to use, and more likely to be selected as the protocol of choice for diagnosis and monitoring of patients with MS.

Ideally, it would be best to use the same standardized MRI protocol, the same facility, and the same

MRI equipment for yearly examinations. This is especially important when using follow-up MRIs to monitor subtle, technically challenging changes such as brain atrophy. Using the same facility and equipment may not be possible for all patients (eg, the patient may move or insurance providers may change, requiring a change in MRI facility). However, using the same standard protocol with full brain coverage, consistent image acquisition along the subcallosal plane, and slices that are contiguous and of similar thickness will allow for easy comparison and accurate assessment for new lesions and other changes on subsequent studies, even when there are differences between MRI machine type and/or location. There are ongoing challenges in MRI of the spinal cord, and the guidelines recognize that individual centers should focus on acquisitions that are best suited and most familiar for their local MRI, emphasizing the value of getting at least two (of the four) recommended complementary acquisitions (FLAIR, T2-weighted, proton density-weighted, or T1-weighted [phase-sensitive inversion recovery or 3D inversion-prepared gradient echo]) to identify MS lesions.

Discussion

Magnetic resonance imaging plays an important role in the diagnosis and follow-up of patients with MS. The key is having standardized MRI examinations that enable easy comparison with previous studies and accurate lesion activity identification.^{1-5,16-18} Recommendations and guidelines for the use of a standardized MRI examination by the CMSC were first proposed in 2001 under the visionary leadership of the late Professor Donald Paty and have since been updated and revised five times,^{1,2,16} reflecting our understanding of MS and the evolution of MRI technology. Although widely referenced and known, surprisingly the guidelines are still not widely used. Although centers may use a locally defined MRI protocol for MS consistently, if they do not fully conform with the 2018 CMSC protocol, this would not allow studies to be easily compared for patients who move to a new area or have MRI performed in a different center. The survey of CMSC members performed in preparation for the consensus conference indicated that only 34% of respondents were definite that the MRIs performed were according to the 2018 CMSC guidelines. According to a poster presented at the 2020 Virtual Annual Meeting of the CMSC, of 1233 examinations from a real-world MRI data set, only 8% met the criteria for the T1-weighted sequence of the

2018 CMSC guidelines and only 7% satisfied the criteria for the T2-weighted sequence.¹¹

It has been the vision of the CMSC Working Group from the start that the Guidelines would be “4U”: universal, useful, usable, and used. With the collaborative efforts of the CMSC, MAGNIMS, and NAIMS, the soon-to-be published International 2020 MAGNIMS-CMSC-NAIMS Consensus Guidelines on the Use of MRI in Multiple Sclerosis will make the guidelines (almost) universal. Having the status of “international” guidelines will lead to wider acceptance and, more importantly, wider adoption and use. A multipronged approach educating radiologists, neurologists, and other health care providers, as well as payers, insurers, and patients, will then be needed to promote the wider use of the standardized MRI protocol. Using the same facility whenever possible would be best for longitudinal surveillance imaging that relies on sensitive quantitative tools to detect subtle changes such as brain volume measures.

Advocacy and dissemination strategies will help raise awareness that the standardized MRI examinations are useful, being helpful and beneficial to radiologists and neurologists in providing care to patients with MS, and usable, being practical and reasonable to acquire. Radiologists who have overcome the inertia of not wanting change and have used the protocol are typically enthusiastic and extremely satisfied, and many find that they use the protocol even for other neurologic indications in addition to MS because of the protocol’s sensitivity and versatility. Having MRI equipment manufacturers provide the recommended sequences on the machine, easily accessible as a one-step process, will help improve the standard of care for MRI in MS.

PRACTICE POINTS

- Quality MS care includes magnetic resonance imaging (MRI) performed using a standardized protocol with images that can be acquired in 20 minutes or less.
- Standardized MRI reduces the need for and expense of repeated studies by avoiding suboptimal images.
- Advocacy efforts and strategies for dissemination and implementation will be key for the wider clinical use of standardized MRI examinations for patients with MS.

Neurologists and other MS health care providers are also key in the effort toward advocating for the universal use of a standardized MRI protocol for patients with MS. Educating them about the International 2020 Guidelines is essential so that referring physicians will specifically request a standardized MRI examination for their patients.

Educating patients about the International 2020 Guidelines is another key. Today, more and more patients are engaged in their own health care. When patients understand the importance of standardization, they will expect and insist that MRI facilities use International 2020 Guidelines knowing that they will benefit from it. Patients will advocate for access to “the right images,” which should have the support of the payers and insurers, because this will be much more cost-effective and minimize the need for repeated examinations for inadequate images. Viewing standardized MRIs through the lens of the COVID-19 pandemic, the focus of care at the present time is to minimize time in doctors’ offices and health care facilities. Standardized MRIs can improve diagnostic accuracy, reduce the need for additional imaging, and reduce unnecessary community infection exposure for patients.

In conclusion, the CMSC Working Group has collaborated with MAGNIMS and NAIMS to publish the International 2020 Guidelines on the use of MRI for diagnosis and monitoring of MS patients. We very much look forward to sharing the newly updated International 2020 Guidelines for MRI in MS through various advocacy, dissemination, and implementation strategies. Ultimately, our vision, and goal, is for the updated protocol to be universally useful, usable, and used as the high-quality standard of care for MS patients, and we hope that a future follow-up survey will demonstrate improved acceptance, adoption, and use of this standardized MRI examination. □

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