Effective Utilization of MRI in the Diagnosis and Management of Multiple Sclerosis

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KEYWORDS

• MRI • Multiple sclerosis • Disease-modifying treatment • Diagnosis • Management • Lesions • Atrophy • Standardized MRI protocol

KEY POINTS

- MRI is the most important tool for diagnosis and management of patients with multiple sclerosis (MS).
- MRI is able to detect white matter (WM) lesions in the central nervous system and their dissemination in space and time.
- MRI is used for tracking disease activity and for prognostic evaluation, as well for monitoring treatment efficacy and safety.
- Nonconventional and quantitative MRI measures can capture features of MS histopathologic findings beyond WM lesions but, for various reasons, are not currently implemented in clinical practice.
- Consensus guidelines on standardized MRI acquisition protocol have been recently published.

INTRODUCTION

Multiple sclerosis (MS) is an autoimmune, inflammatory, demyelinating and degenerative disease of the central nervous system (CNS), leading to a wide range of disability. The diagnosis of MS relies on the McDonald criteria, revised in 2010,[1] which is based on the evaluation of clinical symptoms (at presentation with clinically isolated syndrome [CIS] and/or in the history) and MRI of the CNS. The relevance of MRI as a noninvasive tool for the initial investigation of suspected MS and for disease monitoring over time has constantly grown due to the widespread availability of magnetic resonance (MR) scanners, advances in computational technology, and a plethora of scientific studies.

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In recent years, several disease-modifying treatments (DMTs), acting with different mechanisms, have become available for MS. In particular, DMTs can decrease the focal inflammatory activity; the rate of brain atrophy; and, ultimately, the accrual of disability. It is important to choose for each patient the most adequate DMT and to monitor its efficacy and possible adverse effects over time.

USE OF MRI IN THE DIAGNOSIS OF MULTIPLE SCLEROSIS

Over the past 20 years, the neurologic community has adopted for MS various diagnostic criteria, which have been regularly modified as new lines of evidence and expert recommendations have emerged. The latest criteria were established in 2010 by an international panel and consist of a revision of the classic McDonald criteria.[1] The diagnostic criteria for MS have shown their validity and reliability when applied to patients younger than age 50 years with a typical clinical syndrome consistent with demyelination of the CNS (ie, CIS), such as optic neuritis, transverse myelitis, and brainstem syndromes, and after exclusion of alternative conditions mimicking MS.

MRI is currently the most relevant tool for MS diagnosis and is formally included in the diagnostic workup of patients with CIS suggestive of MS. Indeed, it shows high sensitivity for detection of focal white matter (WM) lesions in the CNS and specificity for lesion dissemination in space (DIS) and dissemination in time (DIT). In particular, DIS is fulfilled by the presence of 1 or more lesions in 2 of 4 characteristic anatomic locations (periventricular, juxtacortical, infratentorial, or spinal cord). DIT is demonstrated by simultaneous presence of gadolinium (Gd)-enhancing and Gd-nonenhancing lesions, thus indicating at least 2 demyelinating events, or by new T2 and/or Gd-enhancing lesion at follow-up MR examination. For the first time, the latest criteria allow an MS diagnosis based on a single MRI scan showing both DIS and DIT.

Sizes, shapes, and locations of MS lesions are variable. However, typically, they have an ovoid shape, a diameter greater than or equal to 3 mm, and cluster close to the ventricles and in the corpus callosum, although juxtacortical and infratentorial regions are other common sites of involvement. On sagittal images, lesions can appear as “fingers” stemming from the ventricular borders and reaching the corona radiata. A well-defined nodular enhancement usually occurs in acute small lesions, whereas a ring-like appearance may be present in subacute large lesions, which have a higher level of tissue destruction and, therefore, tend to resolve more slowly.

Importantly, the diagnostic work-up may be inconclusive in early MS, thus clinical and MRI follow-up may be needed to confirm the diagnosis. A 3 to 6 month interval between the baseline and follow-up MR examination has been recommended and, in the case in which no DIT occurs at that time, a further scan is recommended 6 to 12 months later.[2] If the brain MRI is normal over time, the diagnosis of MS appears less likely.

MRI is also able to detect incidental lesions suggestive of MS histopathologic findings in the brain and spinal cord of subjects without past or current neurologic symptoms. This condition has been termed radiologically isolated syndrome.[3] A new consensus article by the Magnetic Resonance Imaging in Multiple Sclerosis (MAGNIMS) network provides recommendations useful for a proper stratification and management of these patients, which distinguishes between those at high risk for developing MS and those who have a low risk and thus are improperly exposed to unnecessary medical testing and treatment.[4]

The 2010 revisions of the McDonald criteria have received some criticism regarding their leniency, possibly leading to false-positive diagnosis, and the lack of consideration of MS pathologic findings beyond WM lesions. Against this background, there