

MRI in MS – state of the art

Frederik Barkhof, VU Medical Centre, Amsterdam, NL (f.barkhof@vumc.nl)

Neuroimaging, and especially magnetic resonance imaging (MRI), is often being used to demonstrate dissemination of lesions in the CNS in patients with multiple sclerosis (MS). MRI can be used to show the delicate features of MS, such as perivenular distribution of lesions, involvement of cortical gray matter and U-fibers, and involvement of brainstem, cerebellum and spinal cord.

In the recently adopted diagnostic criteria for MS as proposed by an international panel (the so-called McDonald criteria), strong emphasis is placed on the use of information derived from MRI. In this setting, where one relies more heavily on MRI than previously, a high specificity is warranted.

MRI in the McDonald criteria

The dissemination in space (DIS) criteria include:

- at least 1 juxtacortical lesion
- at least 1 enhancing lesion (or 9T2 lesions)
- at least 1 infratentorial lesion
- at least 3 periventricular lesions

To demonstrate DIS, a cut-off of 3 positive criteria is needed.

For the demonstration of dissemination in time (DIT), one needs:

- a gadolinium-enhanced lesion at 3 months or later suffices
- or a new T2 lesion on a further follow-up scan (also at month 3)

The McDonald criteria have good predictive value for the development of clinically definite MS (CDMS) according to the older (mostly clinical) Poser

criteria. In the 2005 revision of the McDonald criteria [Polman et al.], slight modifications have been introduced, e.g. replacement of missing infratentorial lesions or 9T2 lesions with spinal cord lesions. Most work has been done using 1.5T scanners, but preliminary evidence suggests that 3T scanners, despite showing around 20% more lesions, do not significantly impact performance of these diagnostic criteria [Wattjes].

Spinal cord MRI is often useful

In cases where there is doubt about the applicability of the brain MRI criteria (older patients, cerebrovascular risk-factors), the performance a spinal cord scan can be extremely helpful, since incidental cord lesions are extremely uncommon in ageing and cerebrovascular disease, and very frequent in MS (even in patients without cord symptoms or signs). Other indications for a spinal cord scan include: primary progressive MS, cord presentation, and rarely, a negative brain scan with strong clinical suspicion of MS [Lycklama].

Monitoring treatment using MRI

Serial MRI shows a vast amount of disease activity that goes undetected clinically. Typically this is done using frequent (e.g. monthly or quarterly) gadolinium-enhanced MRI, but similar results can be obtained using registration and subtraction of 3D images with isotropic resolution. To some extent, the significance of such subclinical activity remains undetermined. The number of active (gadolinium-enhancing) lesions is closely linked to (concurrent) relapse-activity, but its predictive value wears off over time. On a trial level, the effect of drugs on mean MRI lesion activity is closely correlated with the mean effect on relapses, validating MRI as a surrogate outcome in randomized clinical trials [Sormani]. Measures of cerebral atrophy form (serial MRI) reflect the neurodegenerative aspect of the disease, and are probably

more relevant to predict long-term disability. It can also be used to determine neuroprotective treatment strategies [Barkhof].

While MRI plays a major role in evaluating the effect of new therapies in randomized clinical trials, its importance in monitoring individual patients remains uncertain. The usefulness of MRI may be to rule out subclinical relapses in patients, when there is doubt about the institution or modification of anti-inflammatory treatment [Rio].

References

Polman CH, et al. *Ann Neurol* 2005;58:840-6

Lycklama G, et al. *Lancet Neurol*. 2003;2:555-62

Barkhof F, et al. *Nat Rev Neurol*. 2009 May;5(5):256-66

Sormani et al. *Ann Neurol* 2009;65:268-75

Río J, et al. *Nat Rev Neurol*. 2009;5:553-60