MRI pitfalls in Multiple Sclerosis and differential diagnosis

Philippe Maeder
Neuroradiologie
C.H.U.V. Lausanne
Because sometimes things are not as they appear...

Alice in wonderland
MS variants & MS like diseases
- Marburg
- Baló’s concentric sclerosis
- Schilder’s myelinoclastic diffuse sclerosis
- Neuromyelitis optica (NMO) Devic syndrome

Monophasic post-infectious demyelination: ADEM, SSPE

Vasculitis
- Susac’s disease
- Primary CNS vasculitis
- Behçet, PAN, lupus, Sjögren, Wegener...
- Toxic: amphetamin, cocaine...

Other diseases of white mater mimicking MS
- Lyme, Viral encephalitis, AIDS, PML, Sarcoïdose, CADASIL, primary CNS lymphoma, PRESS...
Marburg

- In 1906 Otto Marburg described three cases of a withering demyelinating disorder in young adults
- Macroscopy: large tumor like plaques in the hemispheric white matter
- Microscopy: Hypercellular demyelinating plaques, with oedema, faint astroglial reaction, and presence of hypertrophic and giant astrocytes
- CSF: increase in proteins, slightly increased or normal cellularity, oligoclonal bands less frequent than in MS
- MRS: increase of the peak of choline and a decrease of \( N\)-acetyl-aspartate (NAA)
- Pathogenesis: chemical modifications of the MBP may cause a structural instability of the central myelin sheath
Marburg MS variant & MS like disease
Tumefactive plaque as the first manifestation of MS

One year later
In 1928 József Baló described the case of a young student who died rapidly after the onset of a progressive neurological illness thought to be caused by a brain tumour located in the left cerebral hemisphere

- Macroscopy: concentric target-like lesions
- Microscopy: alternating bands of partial preservation of myelin and myelin loss, with preserved axons, lipid-containing macrophages, giant astrocytes with multiple nuclei and perivascular cuffs of lymphocytes
- Young adults and results in death within a period of weeks or months but some cases have a milder course
- Baló’s type lesions are only a stage of the disease and evolve with time in a diffuse demyelinated plaque
Baló
MS variants & MS like diseases

Baló
Neuromyelitis optica (NMO)  
Devic syndrome

- In 1894, Eugène Devic reported the clinical course and autopsy findings of a 45-year old woman who developed bilateral optic neuropathy and transverse myelopathy within 2 weeks and died later.
- Pathological examination of the case showed severe demyelination and necrotic changes in the optic nerves and spinal cord, but no brain lesion.
- Microscopy: extensive loss of immunoreactivities to AQP4 and glial fibrillary acidic protein (GFAP) with relative preservation of the staining of myelin basic protein in acute NMO lesions.
- Female preponderance.
- Autoantibodies to aquaporin-4 (AQP4): dominant water channel in the central nervous system densely expressed on foot processes of astrocytes.
- Predominant polymorphonuclear pleocytosis, and absence of oligoclonal IgG bands.
- Limited variants (either recurrent myelitis or optic neuritis), Asian opticospinal MS, and "atypical" forms with brain involvement.

MS variants & MS like diseases
Acute Disseminated Encephalo-myelitis (ADEM) and Acute Hemorrhagic Leucoencephalitis (AHLE) (Hurst)

- Immunomediated monophasic demyelination disease of the central nervous system.
- Follows an unspecific respiratory infection. Crossreactivity between human myelin antigens and viral or bacterial antigens is thought to initiate an autoimmune process causing demyelination usually sparing the subcortical U fibers.
- Typically affects children and young adults.
- AHLE: most severe variant with perivascular demyelination and hemorrhage with predominantly neutrophilic and macrophagic inflammatory infiltrates and fibrinoid necrosis of the vessels.
- ADEM can relapse and some patients may ultimately convert to multiple sclerosis.
Monophasic post-infectious demyelination

ADEM
Monophasic post-infectious demyelination

ADEM
Monophasic post-infectious demyelination

AHLE

Hemorrhage-lactate
Subacute sclerosing panencephalitis (SSPE)

Rare chronic, progressive encephalitis caused by a persistent infection of measles virus. T2 hyperintensities in deep white matter and progressive cerebral atrophy.
In 1979 Drs. Susac, Hardman and Selhorst reported two patients with the triad of encephalopathy, branch retinal artery occlusion (BRAO), and hearing loss (HL)

- Autoimmune endotheliopathy affecting the pre-capillary arterioles of the brain, retina, and inner ear (cochlea and semicircular canals)
- Encephalopathy, with psychiatric features, confusion, memory loss and other cognitive changes
- Typically affects young women (20-40)
- Central corpus callosum, leptomeningeal involvement
Susac’s disease
Primary CNS angiitis

Inflammation of CNS vessels without evidence of systemic vasculitis. Irregularities of vessels (MRA DSA), multiple infarcts, hemorrhages, and patchy or confluent white matter T2 abnormalities, leptomeningeal enhancement.
Lupus

Systemic auto-immune connective tissue disease with frequent autoantibody-mediated CNS vasculitis. White matter hyperintensities in frontal and parietal lobes, infarcts, atrophy, hemorrhage, meningeal enhancement.
Behçet

Lyme

Neuroborreliosis is a tick-borne infection which affects the peripheral and central nervous system. MRI shows non specific white matter hyperintensities and cranial nerve enhancement.

Optic neuritis
Infectious encephalitis

Involvement of white and gray matter (diffusion) necrosis and hemorrhage if untreated. Subacute and chronic variants.

Other diseases of white matter mimicking MS

Herpes simplex (HSV1)

Herpes Zoster (VZV)
Progressive Multifocal Leucoencephalopathy (PML)

Demyelinating disease of the brain caused by the reactivation of JC virus (JCV) infection when the immunity is compromised (AIDS.) T2 hyperintensity and T1 hypointensity of subcortical white matter, without mass effect and contrast enhancement.
Other diseases of white matter mimicking MS

PML and immune reconstitution inflammatory syndrome (IRIS)

Mass effect and contrast enhancement may be seen.
Neurosarcoidosis

Granulomatous disease of unknown origin affecting the CNS in 5-10% Periventricular T2 hyperintensities, thickening and enhancement of the meninges particularly at the skull base. Common optic nerve involvement.

Other diseases of white mater mimicking MS
Primary CNS lymphoma

Mostly diffuse B-cell lymphoma often appearing in white matter and basal ganglia. Contrast enhancement, except in AIDS.

Other diseases of white matter mimicking MS
CADASIL

Cerebral Autosomal Dominant Arteriopathy with Subcortical Infarcts and Leukoencephalopathy

A dominantly inherited small artery disease that leads to dementia and disability.

Widespread areas of increased signal in the white matter associated with focal hyperintensities in basal ganglia, thalamus, and brainstem.

Other diseases of white matter mimicking MS
Other diseases of white matter mimicking MS

Posterior reversible encephalopathy syndrome (PRES)

Reversible vasogenic (cytotoxic) edema in the subcortical white matter of the parietal and occipital lobes. Common causes: eclampsia, hypertension, acute renal failure, cytotoxic drugs...

Many atypical variants.

hypertension

2 weeks later
Other diseases of white mater mimicking MS

PRES induced by cytotoxic treatment

Asparaginase and cytarabine for acute lymphoblastic leukemia