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Ultra-high field (7T and above) MRI is now necessary to make the next step forward in understanding MS pathophysiology

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Commentary: Ultra-high field (7T and above) MRI is now necessary to make the next step forward in understanding MS pathophysiology

The mechanisms underlying the pathophysiological processes that lead to disease progression and disability in MS remain incompletely understood and there remains a critical need for technologies that may facilitate exploration of CNS tissue damage in people with the disease. In this controversies in MS, Bagnato and Gore advocate that ultra-high field MRI is necessary to facilitate understanding of these mechanisms, while Jonkman counters that there is limited practical utility in this approach and our time and resources should be directed elsewhere.

A strong case is made by Bagnato and Gore for the advantages of ultra-high field MRI in improving our ability to accurately detect cortical lesion development early in the disease and overall burden as the disease progresses. While this capacity is not equivalent to what is seen at post-mortem it certainly exceeds what can be discerned at 3T or lower magnetic fields and therefore allows a more detailed assessment of the extent, and importantly the temporal dynamics, of cortical lesion development. Since cortical lesion burden is associated with white matter lesion burden it may be argued that measuring white matter lesion burden is a reasonable surrogate for disease activity. However, the mechanisms underlying lesion evolution and their relationship to clinical symptoms and disease progression, especially of subpial cortical surface lesions, appear to be different and need to be studied independently. Similarly, detection and serial assessment of lesions in the subcortical grey matter nuclei such as the thalamus, which has been shown to atrophy in a linear fashion from onset of disease, will be an essential part of determining whether this process occurs as a derivative of local pathology or rather as a sequelae of distant lesions mediating degeneration in connected tracts. In addition, interrogation of grey matter structures in the spinal cord, highlighted by recent studies showing focal atrophy and motor neuron pathology in MS, will be essential for understanding the association between these processes.

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Perhaps more importantly than just elucidating the benefits of ultra-high field MR on early detection and quantification of grey matter lesions, is the recent demonstration that this approach can be used to characterize tissue pathology, and perhaps someday allow MS pathological lesion subtype assessments in vivo. Indeed, studies are showing utility of 7T MR in detection of central veins, a hallmark of the MS plaque, and also now with iron deposition at the lesion edge, which will facilitate specification of MS lesions. This latter development offers the unique potential to discern chronic active lesions that may have the capacity to evolve and damage neighbouring tissue over time from those that have the capacity to resolve inflammation and promote a tissue microenvironment conducive to endogenous remyelination. The implications of resolving lesional tissue subtypes in MS is enormous, both for deep phenotyping of patients to facilitate understanding of the associated genetic, immunological and metabolic factors that may mediate these processes, as well as for monitoring the success of putative therapeutic interventions designed to impact lesion evolution or repair.

Nonetheless, Jonkman properly highlights several shortcomings of ultra-high field imaging that must be considered, including the cost, safety and availability of this technology, which do not support its widespread use amongst multiple centers engaged in drug trials or for clinical management. However, it is often the case that expensive and impractical tools allow cutting edge advances that are ultimately refined to become more widely available and applicable to general practice. In the end, there is a necessity of discovery to make progress in MS disease understanding and management and we must embrace the judicial use of ultra-high field MRI in expert MS research centers, just as we do with advanced microscopic techniques in the laboratory, knowing the information gained will be the nidus for the development of more practical and clinical tools to help our patients.