

Letter

Portable ultra-low-field MRI: scanning new horizons in dementia detection

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Keywords

Dementias/neurodegenerative diseases; neuroimaging; diagnostic medicine; medical technology; systematic review.

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Ultra-low-field magnetic resonance imaging (ULF-MRI) neuroimaging is an emerging technology that has the potential to streamline dementia assessment pathways by providing community-based, point-of-care brain scans. Almost a million people in the UK are living with dementia, with many of us likely to be affected by this condition. Timely diagnosis of dementia allows people to access appropriate care and support; indeed, the vast majority of people living with dementia report that they see clear benefits of getting a diagnosis. There are marked regional variations in both rates of and time to dementia diagnosis across the UK; these were highlighted in a 2023 All Party Parliamentary Group report.¹ This report also noted variation in access to and waiting times for a brain scan. There is emphasis nationally on improving rates and timeliness of diagnosis with appropriate clarification of different dementia subtypes; all of these priorities are dependent on accessibility of investigative tools.

Structural neuroimaging using computed tomography or MRI brain scans is widely used to inform the diagnosis of dementia and is a frequent cause of bottlenecks in the assessment pathway. Furthermore, it usually necessitates travel to a general hospital, which almost certainly contributes to the lower dementia diagnosis rates associated with rurality and distance from healthcare services.¹

ULF-MRI operates at significantly lower field strengths than conventional MRI scanners (typically <0.1 T *v.* 1.5–3.0 T), making it much cheaper and easier to operate. Although development of ULF-MRI has been ongoing since the 1980s, modern advances in both hardware and software have dramatically enhanced the quality of the images, to the point that one system is licenced by the USA Food and Drug Administration for clinical use, primarily in situations where neuroimaging is otherwise not feasible, for example, in neurocritical care.²

To explore the potential of ULF-MRI in the diagnosis of dementia, we systematically reviewed the relevant literature.³ The review was registered on PROSPERO and followed PRISMA 2020 guidelines. We included studies comparing conventional neuroimaging with ULF-MRI in adults, excluding studies of acute brain injury and stroke.

The ten papers selected for inclusion comprised single-centre and multicentre studies from five different countries. The mean participant age ranged from 31 to 63 years, and nine in ten studies used the Hyperfine Swoop ULF-MRI imaging system. Most studies were based on hospital samples, and a total of 297 participants were included (range: 1–70). Five key themes were identified: morphology, white matter lesions, machine learning, volumetric changes, and operator and/or participant experiences.

Three studies focusing on morphology reported the ability of ULF-MRI to identify specific pathology using routine image processing techniques. This included encephalomalacia in the left cerebellar hemisphere, a right frontal low-grade glioma, leukoencephalopathy ($n = 3$ patients) and brain tumours ($n = 4$ patients).

Two studies evaluated white matter lesions. One reported a moderate correlation between ULF and conventional MRI for detection of moderate-severe white matter hyperintensities in patients at risk of stroke (Fazekas score ≥ 2 , $n = 33$), using visual inspection and grading by neuroradiologists. A study of patients with multiple sclerosis reported that automated measures of total white matter lesion volume using ULF and conventional MRI were highly correlated; visual inspection of ULF-MRI images by neuroradiologists detected white matter lesions in 31 of the 33 patients, but conventional MRI was able to identify smaller lesions. This suggests that although ULF-MRI can currently visualise some white matter changes, conventional imaging is able to detect more subtle alterations.

Advances in machine learning and super-resolution protocols have demonstrated the potential of ULF-MRI to create images of diagnostic quality.⁴ Four studies in the review used super-resolution protocols based on machine learning ('training' a computer using paired high- and low-resolution scans) to map low-resolution inputs to high-resolution outputs, in essence making a blurry photograph much crisper based on what can be accurately predicted. These studies reported high correlations between ULF-MRI and conventional MRI for many brain volumetric measurements, including hippocampus, ventricles, thalamus and whole cerebrum, although finer measurements (e.g. cortical thickness) remained more challenging.

Nine studies provided information regarding clinician or participant experience of using ULF-MRI. The advantages of ULF-MRI compared with conventional MRI were identified as (a) portability, (b) point of care imaging and (c) significantly reduced infrastructure requirements; for example, ULF has much lower energy demands and does not require advanced cooling or shielding systems. In addition, the effect of the magnet in conventional MRI scanners (and the precautionary distance for ferromagnetic objects) extends over 4 m, whereas for ULF-MRI this effect only extends to the perimeter of the device. This allows carers to stay at the bedside, which improves the participant experience. The lower field strength also means that ULF-MRI may be accessible for some patients with implants where conventional MRI is unsafe.²

Potentially, therefore, a ULF-MRI scanner could be located within a community memory clinic or other local healthcare centre, or even within a van as a mobile scanner.⁵ However, ULF-MRI is not without practical limitations. For example, it may not be suitable for patients with large body habitus or with some metal implants or implanted devices.

Although ULF-MRI is not a replacement for conventional MRI scanning, the quality of anatomical imaging may be sufficient to inform diagnosis of dementia in many cases, alongside a holistic assessment. With this in mind, the evidence reviewed suggests that ULF-MRI has the potential to transform our approach to neuroimaging in dementia assessment and to reduce regional variation in access to neuroimaging. It may be possible to offer community-based imaging as part of a 'one-stop clinic', combining ULF-MRI (when

appropriate) with clinical assessment and the use of other innovations such as computerised cognitive testing, blood-based biomarkers and data from wearable devices. Studies of ULF-MRI in memory clinic populations will determine whether it will become a much-needed disruptor of our current dementia assessment pathways. The advances in this technology are timely in the context of the increase in demand for dementia assessment and developments in disease-modifying treatments for patients with Alzheimer's disease. The potential of ULF-MRI for monitoring amyloid-related imaging abnormalities related to these treatments is another critical question.

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First received 4 Jul 2024, accepted 9 Jul 2024

Declaration of interest

Joanne Rodda and Sukhi Shergill are members of the Editorial Board of the British Journal of Psychiatry; neither took any part in the review or decision-making process related to this

paper; and a version of this review has been presented as a poster at the International Congress of the Royal College of Psychiatrists in June 2024.

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Psychiatry in history

Dyce Sombre

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Dyce Sombre (1808–1851) lost his kingdom in north India that he had inherited from his adoptive mother when the British East India Company confiscated it but left him wealthy earning him the sobriquet 'half-caste Croesus'; a reference to his Eurasian ethnicity. He travelled to England and got elected as a member of parliament representing Sudbury in 1841 making him the first Asian and India-born to have served in parliament, albeit briefly, as he lost his seat for alleged corruption after a few months.

He married Mary Anne Jervis, the daughter of the second Viscount St Vincent. He soon began to allege that his wife was in an incestuous relationship with her father and had many other lovers. He even challenged the famous war hero the Duke of Wellington, his wife's putative paramour, to a duel. We will never know who, if anyone, played Iago to Sombre's Othello.

His wife's family had him declared as a 'chancery lunatic' based on examination by psychiatrists, although not everyone who examined him agreed that he was a lunatic. Dr James Warwick was assigned to travel with Dyce Sombre as his medical attendant. Writing in the *Lancet* in 1849, Warwick alleged that those who disagreed with the diagnosis believed that in the East 'treachery is habitual and incest common' and that 'this gentleman had special grounds of irritation and the most intense dislike of the parties against whom he entertains suspicions'.

Sombre escaped to France and then travelled to other European countries including Russia, seeking opinions from psychiatrists. Unlike their counterparts in England most European psychiatrists did not agree with the diagnosis of 'lunacy'. Warwick once again responded to Russian dissent accusing them of being 'ever envious and jealous of our Indian supremacy, and obtained for Mr. Dyce Sombre much attention and sympathy'.

Dyce Sombre wrote a 500-page tome 'refuting the charge of lunacy brought against him in the court of chancery' in 1849. He makes a cogent comment about the manner in which he was deemed a lunatic: 'The mere word of a physician, supported no doubt by petitions and affidavits, was sufficient to restrain me from the exercise of my liberty, me, who had committed no crime nor illegality, without so much as a question being addressed to me by any responsible person in office, while a thief, a pick-pocket or a burglar cannot be kept in custody, even when caught in the act, without being examined by a magistrate'. The tome ends with his plaintive plea: '... in a country which prides itself upon being the only one in the world where personal liberty is fairly understood, where a pickpocket or a murderer will meet with all the tenderness of the law, but where, alas, there is no law for the presumed lunatic, where there are interested parties, whose wishes are that he remain so'.

He died after several unsuccessful attempts to rescind his status as a chancery lunatic, regain his freedom and access to his wealth.

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The British Journal of Psychiatry (2024)
225, 507. doi: 10.1192/bjp.2024.148