

Bridging the Neuroimaging Access Gap: Clinical Integration of Mobile 64 mT MRI for Paediatric Care at a Low-Resource Referral Hospital in Malawi

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Title page

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Bridging the Neuroimaging Access Gap: Clinical Integration of Mobile 64 mT MRI for Paediatric Care at a Low-Resource Referral Hospital in Malawi

Running Title: Clinical Integration of Mobile 64 mT MRI

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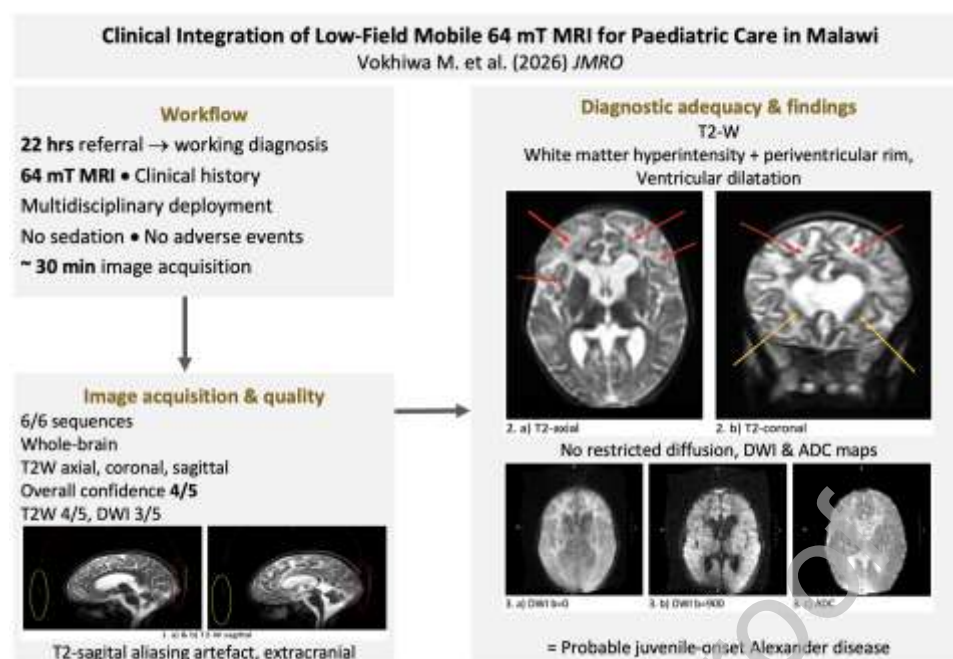
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Graphical Abstract



Bridging the Neuroimaging Access Gap: Clinical Integration of Mobile 64 mT MRI for Paediatric Care at a Low-Resource Referral Hospital in Malawi

Abstract

Inequitable access to neuroimaging limits paediatric neurological care across sub-Saharan Africa, where fewer than one MRI scanner exists per million people. Low-field magnetic resonance imaging (MRI) may expand access, but evidence supporting its integration into paediatric clinical workflows in low-resource hospitals remains scarce. We evaluated the feasibility, diagnostic adequacy, and proof-of-concept clinical utility of mobile 64 mT MRI system at a referral hospital in southern Malawi without on-site conventional brain imaging.

In this pilot single-case observational study, a 9-year-old female with progressive neurological decline and suspected white matter disease underwent triplanar T2-weighted and diffusion-weighted imaging using a Hyperfine Swoop 64 mT system. Workflow, image quality, artefacts, diagnostic adequacy, and radiologist diagnostic confidence were assessed, with cloud-enabled remote radiological review.

The workflow from referral to consensus working diagnosis was completed within 22 hours without sedation or adverse events. All six planned sequences were acquired with whole-brain coverage with diagnostically adequate image quality (overall confidence: 4/5, T2: 4/5; DWI: 3/5). T2-weighted imaging demonstrated bilateral frontal and parietal white matter

hyperintensity, a periventricular rim, and supratentorial ventricular dilatation; diffusion-weighted imaging and ADC maps showed no restricted diffusion. Integrated with the clinical history, findings supported a working diagnosis of probable juvenile-onset Alexander disease and informed discontinuation of a planned tertiary referral and transition to palliative and rehabilitation services.

Mobile 64 mT MRI with remote radiological review was feasible within this resource-constrained paediatric clinical workflow and provided clinically useful neuroimaging where conventional imaging was unavailable. Larger studies are needed to establish reproducibility and inform equitable scale-up across similar settings.

Key words:

low-field MRI; neuroimaging access; paediatric neuroimaging; clinical implementation; sub-Saharan Africa

Highlights:

- Mobile 64 mT MRI was integrated into paediatric care at a hospital without conventional brain imaging
- The complete workflow from clinical referral to consensus working diagnosis was achieved within 22 hours
- All planned sequences were acquired without sedation or adverse events
- Diagnostically adequate imaging supported a working diagnosis of probable juvenile-onset Alexander disease
- Cloud-enabled remote radiological review supported multidisciplinary clinical decision-making

Introduction

For millions of children across sub-Saharan Africa (SSA), access to brain imaging remains out of reach – a critical inequity that leaves serious neurological conditions undiagnosed, mismanaged, or diagnosed too late to alter outcomes [1-3]. A cross-sectional survey in the West African sub-region reported fewer than one MRI scanner per million people, despite a population exceeding 400 million [4]. Some African countries, including the Democratic Republic of Congo and Mali, lack MRI scanners altogether [5]. As a consequence, diagnoses are often based on clinical assessment alone or on less sensitive modalities such as CT or EEG, contributing to delayed and missed diagnosis of paediatric neurological disorders [6-8].

Low- and ultra-low-field MRI systems have emerged as a promising approach to expanding neuroimaging access in resource-constrained settings. Field-strength terminology is not yet standardised; although some classifications define ultra-low-field MRI (ULF-MRI) as ≤ 10 mT and classify 64 mT within the broader low-field range, 64 mT systems are also described as ultra-low-field in the contemporary literature [9,10]. Mobile systems operating at 64 mT can function within existing clinical infrastructure with substantially reduced siting and power requirements compared with conventional MRI, reducing barriers to deployment closer to patients [11-13]. Early studies in Malawi and Uganda have demonstrated that such systems can be successfully deployed in African hospitals, achieving feasible neuroimaging and rapid on-site setup [14,15]. Nonetheless, evidence on the integration of these systems into real-world paediatric clinical pathways in resource-constrained SSA hospitals remains sparse.

The current study is conducted within the UNITY (Ultra-low-field Neuroimaging in The Young) initiative, which deploys the Hyperfine Swoop mobile 64 mT MRI system (Hyperfine Inc., Guilford, CT, USA) across sub-Saharan Africa and South Asia using standardised protocols, cloud-based workflows, and shared quality control procedures [11]. Prior work within this platform has validated image quality across multi-site deployments [10] and demonstrated practical, quality-assured brain imaging in Malawian infants [16], establishing the technical foundation on which this clinical application builds.

The diagnostic consequences of this access gap fall hardest on children with complex neurological conditions who require brain imaging to guide clinical management [6]. Among these, white matter disorders - including leukodystrophies - represent a particularly vulnerable group: MRI is central to their diagnosis, enabling differentiation of subtypes and informing clinical decision-making [17], yet the absence of conventional scanners in many low-resource hospitals creates a diagnostic void that leaves affected children without access to appropriate neuroimaging [1,2]. Portable, point-of-care MRI systems have shown promise in delivering rapid bedside neuroimaging for conditions such as stroke and haemorrhage in settings where intra-hospital transfer delays compromise timely care [6]; if clinically feasible for a broader range of presentations, low- and ultra-low-field MRI systems, such as the mobile 64 mT MRI, could bridge this void by enabling timely brain imaging within referral hospitals across the region [12].

The aim of this pilot study was to evaluate the clinical implementation and utility of mobile 64 mT MRI in supporting the diagnosis and management of a paediatric patient presenting with suspected white matter disease at Zomba Central Hospital, Malawi. Specifically, we

sought to (1) demonstrate the operational feasibility of mobile 64 mT MRI by documenting the workflow from referral to consensus working diagnosis, (2) evaluate image quality and diagnostic adequacy of acquired sequences in addressing the clinical question, and (3) assess the clinical utility of the imaging findings in guiding multidisciplinary decision-making. By documenting technical performance alongside clinical workflow and diagnostic utility, the study also sought to generate implementation evidence that may inform further optimisation of low-field MRI technologies and their application in resource-constrained clinical settings.

2. Materials and methods

2.1 Ethical approval

This study received ethical approval from the College of Medicine Research and Ethics Committee (COMREC; Protocol #P.11/22/3879). Written informed consent was obtained from the patient's caregiver for clinical MRI and for publication of the patient's case details, MRI images, and clinical photographs. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

2.2 Study design

This was a single-case observational pilot study, nested within a broader collaborative initiative examining the clinical accessibility of mobile 64 mT MRI in low-resource healthcare settings. A single-case design was selected to prospectively document workflow integration, image quality, and diagnostic utility in a real-world clinical scenario, providing proof-of-concept evidence prior to broader implementation.

2.3 Setting

The study was conducted at Zomba Central Hospital, a tertiary referral hospital serving approximately five million people in the South-Eastern region of Malawi. At the time of the study, no conventional cross-sectional brain imaging (CT or high-field MRI) was available on site; patients requiring such investigations required referral to Queen Elizabeth Central Hospital in Blantyre, approximately 70 km away, often resulting in significant delays and financial barriers. The hospital hosts one of two Hyperfine Swoop 64 mT systems in Malawi, deployed as part of the UNITY initiative's study and a local clinical trial on neurodevelopment in children exposed to maternal iron deficiency – providing a unique infrastructure opportunity to pilot a clinical application in this setting.

2.4 MRI infrastructure

Imaging was performed using a mobile 64 mT MRI system (Swoop Mk1.7, Hyperfine, Inc., Guilford, CT, USA). The system incorporates a biplanar, whole-body unshielded gradient system and a solenoidal, linearly polarised volume radiofrequency (RF) coil with single-channel transmit and eight-channel receive architecture. The detachable head RF coil functions as a transmit/receive head coil with an eight-channel receive array. Maximum

gradient amplitudes are 24.9 mT/m (X), 24.4 mT/m (Y), and 25.7 mT/m (Z), with corresponding maximum slew rates of 23, 22, and 67 T/m/s, respectively.

The scanner is a compact, wheel-mounted unit weighing approximately 640 kg, with dimensions of approximately 150 cm (59 inches) in height and 84 cm (33 inches) in width, and operates using standard electrical power. It was installed in a dedicated imaging room within the Training and Research Unit of Excellence (TRUE) at Zomba Central Hospital. The room was not a conventional RF-shielded MRI suite, and no purpose-built RF shielding or specialised conventional MRI infrastructure was required. Implementation of the 64 mT system within a resource-constrained hospital environment in Malawi has previously been described [14,16].

2.5 Patient and clinical presentation

The case involved a 9-year-old female who presented with progressive neurological and systemic symptoms in August 2023. Her mother reported that the child was previously well, except for a history of febrile seizures that ceased at age four which were considered self-limiting and benign. In March 2023, she experienced two seizures, after which she developed progressive difficulty walking, weakness in the upper limbs, and impaired speech and swallowing. Over the subsequent five months, her speech became increasingly difficult, though her vision, hearing, bladder, and bowel function remained intact.

On examination, the patient appeared severely wasted with an enlarged head circumference. Neurological assessment revealed generalised weakness, though formal power testing could not be performed due to severe malnutrition. Right-sided upper motor neuron signs were present, including hyperreflexia, clonus, and an extensor plantar response. Cranial nerve examination demonstrated slurred speech and impaired swallowing. The patient was otherwise haemodynamically stable at presentation.

Given these findings, the paediatric team requested brain MRI to investigate suspected white matter disease, space-occupying lesion, or other structural parenchymal abnormality.

2.6 Procedures and workflow

A multidisciplinary team — comprising a paediatrician, nursing staff, radiology technicians, a consultant radiologist, a neuroscientist, and an MRI analysis expert — coordinated the clinical imaging process. The workflow was prospectively documented across eight stages:

1. Imaging request: The paediatrician (JC) initiated the request based on the child's neurological presentation and communicated this to the neuroscientist (MV).
2. Protocol recommendation: The consultant radiologist (KC) recommended the most appropriate sequences for the clinical question and remained available for subsequent review and interpretation.
3. Patient preparation: The paediatric team stabilised the patient, coordinated safe transport to the scanning room, and provided continuous clinical monitoring. Nursing staff supported the guardian and child during positioning to minimise anxiety.

4. Image acquisition: The neuroscientist (MV) supervised scanning, working with radiology technicians who operated the 64 mT MRI system. The overall MRI session lasted approximately 90 minutes, including provision of study information to the mother and consent, patient preparation and positioning, sequence setup, and approximately 30 minutes of image acquisition.
5. Processing and visualisation: Initial image processing and visualisation were performed on-site by the neuroscientist (MV); subsequent technical quality assurance was provided by the MRI analysis expert (FL).
6. Remote radiologist review: Images were securely uploaded to the Hyperfine, Inc. Image Viewer, remotely accessed, and reviewed by the consultant radiologist (KC), who provided expert interpretation.
7. Multidisciplinary discussion: Findings were discussed collaboratively by the paediatric team, radiologist, neuroscientist, and nursing staff, integrating clinical and imaging perspectives.
8. Working diagnosis: A consensus working diagnosis was reached, guiding subsequent clinical management.

2.7 MRI protocol

Imaging was performed using the Hyperfine Swoop mobile 64 mT MRI system (Hyperfine Inc., Guilford, CT, USA), a point-of-care device designed for low-resource and bedside environments [18,19]. The device supports T1- and T2-weighted imaging, diffusion-weighted imaging (DWI), and apparent diffusion coefficient (ADC) mapping, optimised for rapid brain imaging [20-22]. The clinical imaging protocol was selected in consultation with the consultant radiologist based on the patient's presentation and the clinical question of suspected white matter disease. Following acquisition, DICOM images were uploaded from the Swoop system to the Hyperfine, Inc. Image Viewer, a secure cloud-based environment that enabled remote access for radiological review [23]. This was a particularly valuable feature in a setting with limited on-site specialist availability.

The consultant radiologist was available to review and discuss the resulting images in real time. The patient was positioned supine on the scanner bed with head immobilisation to minimise motion. Head elevation and midline centring were verified to ensure all posterior anatomy remained within the prescribed FOV prior to each sequence. She remained asleep without sedation, and scanning was performed following the validated paediatric imaging protocols described by Dean et al. (2014) [24]. The child's guardian was present throughout the procedure to provide reassurance.

The protocol comprised six sequences. A coronal localiser scan was acquired first to confirm positioning and ensure whole-brain coverage prior to diagnostic sequences. Triplanar T2-weighted imaging (axial, coronal, sagittal) was selected for sensitivity to white matter abnormalities, ventricular dilatation, and structural changes. Two DWI sequences ($b=0$ and $b=900 \text{ s/mm}^2$) were included to detect restricted diffusion indicative of acute ischaemia, infection, or evolving injury. ADC maps were derived from DWI data to differentiate true restricted diffusion from T2 shine-through effects.

Individual sequence durations ranged from approximately 1 to 8.6 minutes, with a total image acquisition time of approximately 30 minutes.

2.8 Image acquisition and quality assessment

We prospectively defined image acquisition and quality variables to evaluate feasibility at 64 mT field strength and to enable replication. For each sequence, acquisition parameters were recorded – including sequence name, TR/TE (ms), voxel size (mm³), slice thickness (mm), voxel spacing (mm), matrix size, b-value (s/mm²), and scan time (min) – as determinants of resolution, coverage, contrast, and efficiency. Clinical usability was assessed through prospective recording of patient motion, artefacts, image quality, diagnostic adequacy, and diagnostic confidence. Motion and image quality were assessed by three members of the multidisciplinary imaging team: a consultant radiologist (KC), a neuroscientist (MV), and an MRI analysis expert (FL). Diagnostic confidence was assessed by the consultant radiologist (KC). Motion and artefact severity were scored on 5-point Likert scales (1 = none, 5 = severe), with artefact type noted. Image quality was rated 1 – 5 (non-diagnostic to excellent), adequacy coded as adequate/limited/inadequate, and diagnostic confidence rated 1 – 5 (very low to high). This framework ensures consistent, transparent evaluation of whether mobile 64 mT MRI produces clinically useful images with acceptable quality and minimal artefacts in a real-world paediatric setting.

3. Results

3.1 Workflow

The complete workflow was accomplished within 22 hours, from the initial imaging request at 14:00 on Day 1 to a consensus working diagnosis at 12:00 on Day 2 (Table 1). The paediatrician initiated the request, the radiologist recommended the protocol, and the patient was prepared overnight and immediately before scanning. The overall MRI session took place between 08:00 and 09:30 on Day 2 under supervision of the neuroscientist and radiology staff, including provision of study information and consent, patient preparation and positioning, sequence setup, and approximately 30 minutes of image acquisition. On-site image processing completed the same morning. Images were uploaded for remote radiologist review, and a multidisciplinary discussion established the consensus working diagnosis – demonstrating rapid, coordinated deployment of mobile 64 mT MRI within a resource-constrained clinical setting.

There were no adverse events during scanning. Both the patient and guardian remained comfortable throughout, and all planned sequences were completed without interruption, repetition, or the need for sedation.

3.2 Image acquisition and quality

The 64 mT MRI protocol achieved whole-brain coverage across all six sequences. Among the diagnostic sequences evaluated in Table 2, acquisition times ranged from approximately 1.8 minutes for the b=0 s/mm² diffusion-weighted acquisition to 8.6 minutes for the b=900 s/mm² acquisition (Table 2). The three T2-weighted planes (axial, coronal, sagittal) yielded

diagnostically adequate images with minimal motion artefacts, receiving image quality ratings of 4/5 and diagnostic confidence ratings of 4/5. Diffusion-weighted imaging was acquired in approximately 1.8 minutes at $b=0$ s/mm² and 8.6 minutes at $b=900$ s/mm²; images were diagnostically usable despite mild motion, and derived ADC maps preserved diagnostic information. Overall, image quality and adequacy ratings confirmed the protocol was clinically sufficient to guide diagnostic decision-making in this low-resource paediatric setting.

A wrap-around (aliasing) artefact was observed on the sagittal T2-weighted images, with posterior scalp and skull signal folded onto the anterior field (Figure 1). The artefact was confined to extracranial tissues and did not impair diagnostic interpretation of intracranial structures.

3.3 Diagnostic adequacy and radiological findings

The 64 mT MRI protocol was diagnostically adequate, successfully addressing the clinical question with an overall radiologist confidence rating of 4/5. T2-weighted images demonstrated symmetric white matter hyperintensity in the frontal and parietal lobes without mass effect, a characteristic periventricular rim, supratentorial ventricular dilatation, and reduced brain volume for age (Figure 2). Grey matter and posterior fossa structures appeared normal.

Diffusion-weighted imaging and derived ADC maps showed no areas of restricted diffusion (Figure 3). Regions of white matter hyperintensity on T2-weighted imaging corresponded to areas of elevated ADC, confirming a chronic rather than acute process and excluding acute ischaemia or active infection as primary diagnoses. The inclusion of triplanar T2-weighted acquisitions was considered valuable during interpretation, as orthogonal views improved delineation of ventricular dilatation and periventricular changes while reducing uncertainty from motion or partial volume effects.

Integrating the imaging findings with the clinical history, the multidisciplinary team reached a consensus working diagnosis of probable juvenile-onset Alexander disease – a leukodystrophy characterized by white matter degeneration – with associated obstructive ventricular dilatation potentially reflecting periaqueductal parenchymal involvement.

Following the MRI findings and multidisciplinary review, the planned referral to a tertiary referral hospital was discontinued, as no additional therapeutic intervention was considered likely to be offered at that facility. The patient and her mother were subsequently enrolled in palliative care services for counselling and psychosocial support and referred to rehabilitation services, where the mother received training in physiotherapy techniques and safe feeding practices to reduce risks associated with the child's unsafe swallow and support nutritional intake. Once the mother was able to provide the required care at home, the patient was discharged on 24 August 2023 with referral for continued community-based follow-up in her home village. Longer-term clinical outcome could not be established because the mother did not have a telephone number through which she could be contacted for follow-up.

4. Discussion

This pilot study demonstrates the feasibility and clinical utility of integrating mobile 64 mT MRI into a paediatric care pathway at a resource-constrained referral hospital without on-site conventional brain imaging. The complete pathway from clinical referral to consensus working diagnosis was achieved within 22 hours, with diagnostically adequate imaging acquired without sedation or adverse events and supported by cloud-enabled remote radiological review. Importantly, the imaging findings addressed the clinical question, supported a working diagnosis of probable juvenile-onset Alexander disease, and directly informed subsequent management, including discontinuation of a planned tertiary referral and transition to palliative and rehabilitation care. Together, these findings extend previous evidence of the technical feasibility of such low-field MRI deployment in resource-constrained settings by demonstrating its integration into real-world paediatric clinical decision-making, while also identifying practical considerations relevant to further technological optimisation and broader clinical implementation.

4.1 Clinical accessibility and diagnostic utility

This case demonstrates the feasibility of using mobile 64 mT MRI to expand neuroimaging access in a low-resource referral hospital – delivering timely, radiation-free brain imaging within a paediatric workflow and producing findings that directly informed clinical management. For a child presenting with progressive neurological decline at a hospital with no conventional imaging on site, the 22-hour referral-to-diagnosis pathway represents not merely a technical achievement but a meaningful expansion of diagnostic access. This finding is particularly significant in the sub-Saharan African context, where the consequences of absent neuroimaging fall hardest on children with conditions – such as white matter disorders – that are invisible to clinical examination alone.

Our findings build on prior deployments of low- and ultra-low-field MRI in research and pilot clinical contexts across sub-Saharan Africa [14,15] and are among the first documented applications in a paediatric clinical scenario, extending the evidence base for point-of-care neuroimaging where high-field MRI is unavailable [6,25]. In settings where CT is the only available cross-sectional imaging modality, low-field MRI offers important advantages [26]. CT exposes children to ionising radiation – a particular concern given the radiosensitivity of developing tissues and the long latency for radiation-induced malignancy [27,28] – and provides limited sensitivity for parenchymal white matter pathology, where subtle changes in myelination or gliosis often appear only as nonspecific hypodensities [29,30]. Even at 64 mT, the system produces tissue-specific contrasts – T2 hyperintensity and diffusion characteristics – that enable more detailed assessment of white matter structure and integrity [13,31]. Direct validation studies comparing such low-field MRI, high-field MRI, and CT in low-resource settings remain limited, and such comparisons will be essential to define the clinical niche of low-field MRI within existing diagnostic pathways [26].

The diagnostic features identified – symmetric frontal and parietal white matter hyperintensity with a periventricular rim and supratentorial ventricular dilatation, without restricted diffusion – are consistent with leukodystrophy patterns described in the higher-field MRI literature [32,33]. Although image resolution at 64 mT is lower than conventional

1.5T or 3T systems, the ability to identify hallmark diagnostic features of Alexander disease was clinically decisive – enabling a working diagnosis that would otherwise have required referral to a facility 70 km away or remained inaccessible entirely. Importantly, the imaging findings also directly informed the subsequent care pathway. Following multidisciplinary review, the planned tertiary referral was discontinued because no additional therapeutic intervention was considered likely to be offered at that facility, and care transitioned to palliative and rehabilitation services, including counselling, psychosocial support, physiotherapy, and safe-feeding support. The patient was subsequently discharged for continued community-based follow-up. This illustrates clinical utility beyond diagnostic adequacy, whereby locally accessible neuroimaging can inform management and potentially avoid referrals unlikely to provide additional therapeutic benefit. The broader implication is that such low-field MRI may support diagnosis across a range of paediatric neurological conditions common in sub-Saharan Africa – including epilepsy syndromes, post-infectious sequelae, paediatric stroke, and acute infectious pathologies – where limited imaging access contributes to late or missed diagnosis [34]. Mobile low-field systems integrated into tertiary paediatric wards could substantially reduce referral delays and extend diagnostic reach across the region.

4.2 Clinical implementation and technology development

Adoption of low-field MRI at scale depends not only on image acquisition capability but on achieving consistent diagnostic quality, managing artefacts, and addressing cost and infrastructure implications [10,31,35]. This case provides a structured framework for evaluating these factors prospectively, ensuring scanning is both technically feasible and diagnostically useful in low-resource settings. Such real-world implementation can also provide feedback relevant to technology development: experience with image quality, artefacts, sequence performance, clinically visualised features, infrastructure, and workflow can identify priorities for further optimisation of acquisition, reconstruction and analysis approaches. Clinical implementation and technological development should therefore be viewed as complementary processes, with experience from use informing subsequent technical and methodological refinement. Further validation across larger patient cohorts will be essential to confirm reproducibility, refine quality benchmarks, and determine how low-field MRI can be integrated into routine clinical use.

The implementation challenges are also informative for continued technology development. Clinical deployment in resource-constrained settings provides context-specific evidence on acquisition performance, motion and artefact susceptibility, sequence requirements, image-review pathways, infrastructure, and user needs that may not be fully captured during technology development or controlled validation. Systematically communicating these experiences to MRI physicists, engineers, image-analysis researchers, and other developers can support iterative optimisation while helping ensure that future low-field technologies remain responsive to the clinical environments in which expanded access is most needed.

4.3 Implementation considerations and broader scale-up

Cost considerations are central to this agenda. Conventional 1.5T or 3T MRI systems frequently exceed \$1.5 – 2.5 million including installation and infrastructure [35], whereas

commercial ULF systems are priced at approximately \$250,000 – \$682,000 and research prototypes have been developed for under \$20,000 [31,35] – savings that arise from reduced requirements for radiofrequency shielding, cryogen cooling, and high-power electrical infrastructure [1,36,37]. Running and maintenance costs are similarly reduced, as ULF systems require neither cryogen refills nor the specialised service contracts associated with high-field MRI. Nonetheless, even at substantially reduced capital costs, procurement, training, and maintenance expenses remain significant in low-resource contexts, underscoring the need for cost-effectiveness analyses, pooled procurement strategies, and integration into sustainable diagnostic pathways [1,31,35].

This case illustrates that mobile 64 mT MRI can function as a genuine neuroimaging access solution – not merely a research tool – in a hospital serving five million people with no on-site conventional brain imaging. The system enabled radiation-free brain imaging without sedation in a child with progressive neurological decline, producing clinically actionable findings within 22 hours of referral. The integration of cloud-based remote radiologist review further demonstrated a replicable model for overcoming on-site specialist shortages – a critical feature for hospitals across sub-Saharan Africa where radiological expertise is concentrated in a small number of urban centres.

Nevertheless, several operational challenges will need to be addressed for broader implementation. These include dependence on stable power supply, motion management in paediatric patients, and the limited imaging sequence repertoire available at 64 mT compared with higher-field systems [6,14,31]. Ensuring adequate training of local staff and sustainable technical support is equally critical. More broadly, integration of low-field MRI into health systems will require investment in patient referral workflows, image review pathways, and follow-up management, alongside cost-effectiveness analyses to inform policy decisions.

Together, these lessons underscore that while mobile 64 mT MRI offers a viable and accessible entry point to neuroimaging in resource-constrained hospitals, its long-term equitable impact will depend on addressing infrastructural, technical, and system-level challenges through continued clinical validation – including systematic evaluation across a broader case series.

4.4 Limitations

This study has several limitations inherent to its single-case design. Generalisability is limited – findings reflect one clinical presentation, one institutional context, and one multidisciplinary team configuration, and may not be representative of performance across different patients, settings, or operational conditions. Diagnostic certainty is further constrained by the absence of genetic testing, histopathological confirmation, or higher-field MRI comparator imaging; the diagnosis of probable Alexander disease remains a working clinical impression. Longer-term clinical outcome could not be established because the patient's mother did not have a telephone number through which she could be contacted for follow-up after discharge.

The multidisciplinary team composition – including a neuroscientist supervising acquisition and a remote specialist radiologist – may not be replicable in all low-resource contexts, and the generalisability of this workflow model to settings with less expert support requires prospective evaluation. Logistical dependencies – including stable power supply and the need for trained local personnel – will require systematic evaluation in larger implementation studies.

4.5 Conclusions

Across sub-Saharan Africa, millions of children with serious neurological conditions have no access to brain imaging, leaving diagnoses delayed, missed, or based on clinical assessment alone. This case demonstrates that mobile 64 mT MRI can provide clinically useful neuroimaging where conventional imaging is unavailable – providing rapid, radiation-free neuroimaging within a paediatric clinical workflow at a referral hospital with no conventional imaging on site. Critically, it produced clinically actionable findings: a working diagnosis of probable juvenile-onset Alexander disease in a child for whom no conventional brain imaging was available on site at the point of care.

Beyond the individual case, these findings carry broader implications for neuroimaging equity in low-resource settings. The successful integration of cloud-based remote radiologist review into a multidisciplinary workflow demonstrates a model, with potential for replication, that does not depend on on-site specialist availability – a critical feature for hospitals across the region. The 22-hour referral-to-diagnosis timeline further illustrates that mobile 64 mT MRI can function not merely as a research tool but as a clinically responsive diagnostic resource.

This proof-of-concept evidence lays the foundation for systematic evaluation of such low-field MRI across a broader case series, examining diagnostic yield, workflow reproducibility, and clinical impact across a range of neurological presentations. Larger-scale studies, cost-effectiveness analyses, and implementation research will be essential to translate this promise into equitable, sustainable neuroimaging access for children across sub-Saharan Africa and similar low-resource contexts worldwide.

Disclosure / Conflict of interest

No conflict of interest reported

Ethics declaration**Informed consent and patient details**

Written informed consent to take part in the study and to publish the article has been obtained from all participants or their legal representatives. The privacy rights of participants have been observed.

Studies in Human

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place.

This study was approved by the College of Medicine Research and Ethics Committee.

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Case Reports

This research follows the CARE guidelines and the CARE checklist.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Tables

Table 1: Operational workflow and feasibility metrics for clinical deployment of mobile 64 mT MRI.

Timeline of the imaging pathway from referral request to multidisciplinary consensus working diagnosis, including workflow stages, timing intervals, and operational observations used to evaluate feasibility within a paediatric clinical setting.

Stage	Timestamp	Interval (min/hr)	Notes
Request by paediatrician	Day 1, 14:00	—	<i>Suspected white matter disease, space-occupying lesion, or structural parenchymal abnormality</i>
Protocol recommendation	Day 1, Evening	—	Radiologist advised sequences
Patient preparation	Day 1, Evening	—	Paediatrician + nurses, no sedation used
MRI session start	Day 2, 08:00	~18 hrs later	Neuroscientist supervised, guardian present
MRI session end	Day 2, 09:30	1.5 hrs	All planned sequences acquired
Image processing/visualisation	Day 2, Morning	—	On-site by MV, QA by FL followed later
Remote radiologist review	Day 2, by 11:00	—	Images uploaded and reviewed
Multidisciplinary discussion	Day 2, ~11:30	—	Findings discussed collaboratively
Working diagnosis	Day 2, 12:00	~22 hrs total	Consensus working diagnosis: probable juvenile-onset Alexander disease

All six planned sequences were acquired without sedation; total image acquisition time ~30 min; overall MRI session ~90 min; no repeats; no power interruption; request-to-diagnosis 22 hrs.

Table 2: MRI acquisition parameters, image quality assessment, and diagnostic adequacy across imaging sequences.

Sequence-specific acquisition parameters and prospective evaluation of motion, artefacts, image quality, diagnostic adequacy, and diagnostic confidence used to assess clinical usability of the 64 mT MRI protocol.

Sequence	TR/TE (ms)	Voxel size (mm ³)	Matrix size	b-value (s/mm ²)	Time (min)	Motion (1–5)	Artefacts (type /score)	Quality (1–5)	Adequate for question (Y/N)	Diagnostic confidence (1–5)
T2 Axial	2000.00/208.40	1.5x1.5 x5.0	120x146x40	—	~6.5	1	1	4	Y	4
T2 Coronal	2000.00/233.20	1.5 x5.0x1.5	120x40x134	—	~5.2	1	1	4	Y	4
T2 Sagittal	2000.00/236.00	5.0x1.6 x1.5	36x146x146	—	~5.3	1	*2	4	Y	4
DWI (Axial)	1000.00/76.04	2.4x2.4 x5.88	76x92x34	0	~1.8			3	Y	4
DWI (Axial)	1000.00/76.04	2.4x2.4 x5.88	76x92x34	900	~8.6			3	Y	3
ADC Map**	Derived	2.4x2.4x5.88	76x92x34	—	Derived			3	Y	3

Notes:

Abbreviations: TR/TE = repetition time/echo time, values are reported in milliseconds; DWI = diffusion-weighted imaging; ADC = apparent diffusion coefficient.

Likert scale definitions: Motion/Artefacts (1 = none, 5 = severe); Image quality (1 = non-diagnostic, 5 = excellent); Diagnostic confidence (1 = very low, 5 = high).

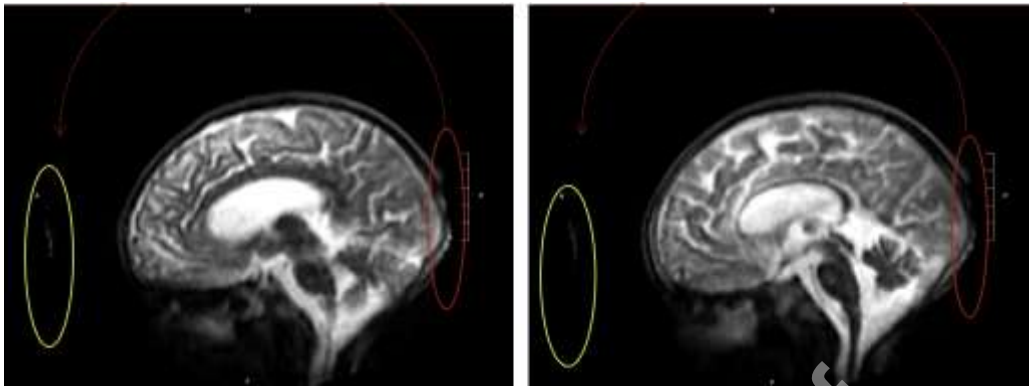
Image quality summary: T2-weighted sequences achieved image quality ratings of 4/5; diffusion-weighted imaging remained diagnostically adequate despite mild motion.

Diagnostic adequacy (Yes/No): The imaging protocol addressed the clinical question and contributed to multidisciplinary consensus working diagnosis.

*Artefact type: Wrap-around (aliasing), posterior → anterior (severity score: 2/5).

Figure 1: Sagittal T2-weighted images demonstrating wrap-around (aliasing) artefact.

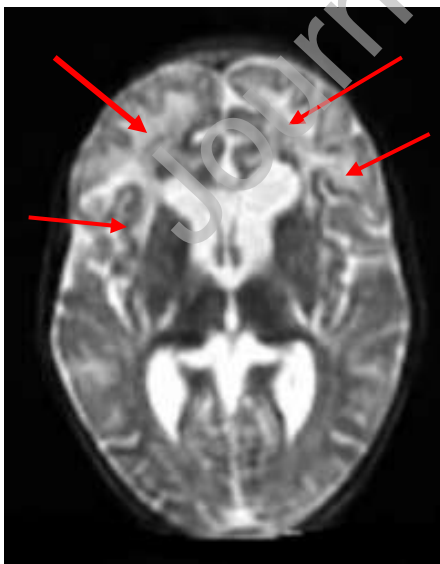
Posterior extracranial signal from the scalp and skull is folded into the anterior field due to suboptimal head centring during acquisition. The artefact remained confined to extracranial tissues and did not affect diagnostic interpretation of intracranial structures.



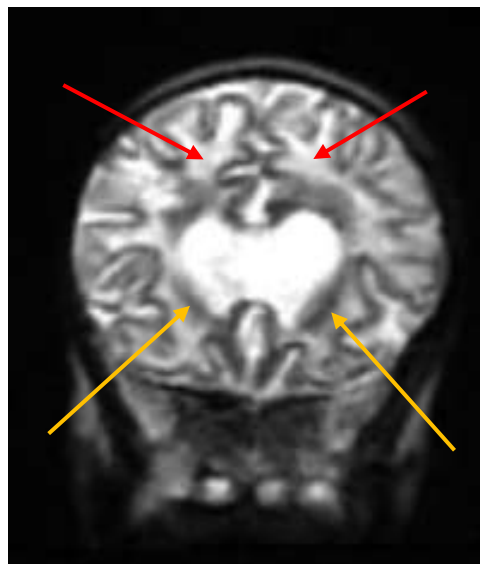
1. a) & b) T2-W sagittal

Figure 2: T2-weighted imaging demonstrating diagnostic adequacy and radiological findings.

(a) Axial and (b) coronal T2-weighted images demonstrating symmetric hyperintensity of the frontal and parietal subcortical and deep white matter (Red arrows), associated with a characteristic periventricular rim (yellow arrows), supratentorial ventricular dilatation, and reduced brain volume for age.



2. a) T2-axial



2. b) T2-coronal

Figure 3: Diffusion-weighted imaging and derived apparent diffusion coefficient (ADC) maps.

(a) Diffusion-weighted image ($b = 0 \text{ s/mm}^2$), (b) diffusion-weighted image ($b = 900 \text{ s/mm}^2$), and (c) derived apparent diffusion coefficient (ADC) map. No focal areas of restricted diffusion were identified. Regions corresponding to T2-weighted white matter hyperintensity demonstrated elevated ADC signal, consistent with increased diffusivity and supporting a chronic rather than acute pathological process.

