EDITORIAL

In-unit neonatal magnetic resonance imaging—new possibilities offered by low-field technology

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Magnetic resonance (MR) imaging and spectroscopy has been used for clinical diagnostics and research in neonatal medicine since the 1980s [1, 2], and the first specialised neonatal MR scanner installed within a neonatal unit was reported in 1997 [3]. At this time typical field strengths for MR scanners were 0.5–1.0 Tesla (T), but it was immediately recognised that increased field strength allowed shorter scan times, enhanced image resolution, better signal to noise ratio, and advanced clinical and research techniques such as functional MR Imaging and tractography. Consequent technical progress means that most MR imaging is currently carried out at 1.5 or 3 T, while 7 T scanners are becoming more common [4].

However, many issues including high technical and economic costs have meant that in the ensuing quarter of a century only a very small number of institutions world-wide have been able to install MR scanners within their neonatal units, although these facilities have generated a substantial literature on the appropriate sequences, methods and results of dedicated neonatal imaging [1, 3, 5–8]. The sickest new-born infants at highest risk of cerebral abnormalities thus still have limited access to this technology.

Advances in magnet technology and image processing techniques are now overcoming some of the disadvantages of weaker magnetic field strengths and raising the possibility of more accessible MR scanning for vulnerable infants in neonatal intensive care. A signal advance in modern low-field MR scanners is the use of a permanent magnet design which reduces cost, energy consumption and infrastructure requirements, increasing accessibility and allowing closer proximity [9].

The Embrace neonatal MR scanner (Aspect Imaging, Nashville, TN, USA) is one such specialised lower-field system, which has been studied by Thiim et al., and reported in this edition of the Journal of Perinatology [10]. Utilising a 1 T permanent magnet, the scanner's 5 G magnetic safety radius is confined within the system's cover across a relatively compact footprint—facilitating installation within ward areas in a permanent stationary position. The preliminary evidence they present suggests that images produced by this 1 T system are similar in quality to the 1 T neonatal images produced 25 years ago using conventional super-cooled magnet technology [3, 5–7], and in a small cohort of 32 infants Radiologists' reports of the Embrace 1 T images where almost always similar to a 3 T reference scan [10]. Significantly, although perhaps not surprisingly, this lower-field MR system detected a number of abnormalities which were not visualised on cranial ultrasonography, including a case of profound hypoxic injury where the diagnosis is clinically important.

The authors are highly experienced in the use of MR in neonatology, and they now report that following their experiences with the in-NICU Embrace system they plan to use it for all primary neonatal MR imaging [10]. This raises the questions: is 1 T MR technology now sufficiently mature that tertiary neonatal units should consider installing scanners? Further, should routine lower-field MR imaging replace cranial ultrasonography as the primary imaging method in neonatal intensive care?

Since the earliest days of neonatal MR it has been recognised that immediate access to an MR scanner directly on the neonatal intensive care floor has clear logistical and patient-safety advantages. The return of lower-field MR systems may herald a reconsideration of the use of neuroimaging in neonatal intensive care. It is hopeful that in-NICU MR imaging can improve the care of neurological conditions like stroke and hypoxia-ischaemia, and even improve the currently modest prognostic performance of routine MR for predicting neurodevelopmental outcomes in preterm infants [11]. However, there will be limitations. In the data presented most of the findings detected in preterm infants and not seen on ultrasound were probably of only minor prognostic importance [10–12]. Lower field strengths makes it more difficult to perform advanced imaging sequences and spectroscopy, valuable in the evaluation of suspected hypoxic-ischaemic encephalopathy [13]. Formal assessments of the prognostic value of low-field high-access MR imaging in large studies will be needed to define which patients, if any, would benefit from this change in practice.

If the case for these systems is made, MR physicists and engineers will undoubtedly return to study lower-field imaging physics and further technical advances will follow. Indeed, the engineers are already going further than 1 T in their exploration of low-field imaging. Near ultra-low-field MR scanners, such as those scanning at field strengths of 0.065 T, are in development [9]. These offer the possibility of truly portable MR machines which may be taken directly to the patient's cotside. Early results of these ultra-low-field scanners within adult and neonatal critical care centres have been encouraging [14–16].

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ADDITIONAL INFORMATION

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