Looking under the bonnet of bronchopulmonary dysplasia with MRI

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Worldwide, 1 in 10 babies are born preterm. Bronchopulmonary dysplasia (BPD, also termed chronic lung disease of prematurity) is the major respiratory complication of preterm birth. The classic Northway description of BPD of airway injury with subsequent inflammation and fibrosis has given way to 'new BPD', with less fibrosis, and fewer, larger alveoli. Advances in care (including antenatal steroids and postnatal surfactant administration) are postulated to have led to this change. However, BPD incidence has remained static at 35%–45% of extremely preterm births,[1] and remains a significant burden of care, requiring ambulatory and home oxygen, with increased healthcare visits and respiratory hospitalisations of affected infants. The sequelae of BPD persist into adulthood, where up to 25% of adult survivors of prematurity have ongoing respiratory symptoms.[2] Treatment of BPD is primarily provision of ambulatory oxygen, awaiting lung growth to reduce the tachypnoea and hypoxia.

The widely used 2001 National Institutes of Health (NIH) definition of BPD defines BPD based on oxygen requirement at specific timepoints, and stratified infants into mild, moderate or severe depending on amount of respiratory support. This approach intentionally did not include radiographic findings. There is however some value in imaging, and in Japan, chest radiographs have been used in the routine diagnosis and classification of BPD for several decades.[3] Notably, chest radiographs to confirm lung parenchymal involvement have returned to the NIH guidelines, although with discussion.[4]

Chest radiographs are frequently used in BPD research, can be scored to give numerical endpoints and are complemented by CT scans which provide excellent structural information. However, both are at a cost of radiation exposure. Reliable non-ionising radiation approaches, such as MRI, would be useful. However, in its simplest form, proton MRI of the lung yields little information due to the low proton density of the lung and artefacts caused by high magnetic susceptibility and respiratory motion. Various techniques can be employed to improve MRI of the lung, including new sequences like ultrashort echo time[5] and the use of inhaled gas contrast agents.[6] However, many of these techniques are as yet unvalidated as clinical tools, especially in infants.

In this issue, Forster and colleagues posit that T1 and T2 relaxation times are altered in the presence of emphysematous and fibrotic interstitial remodelling, respectively.[7] They present data from a multicentre MRI study in which T1 and T2 mapping was used to evaluate lung tissue properties, and demonstrated that changes in the T1 and T2 relaxation times are associated with a diagnosis of BPD, and with BPD severity. Furthermore, they used the inherent spatial data that MRI provides to show that the distribution of these abnormalities varies between lung regions, suggesting that BPD lung disease is not heterogeneous. The authors replicated the result in a second, smaller cohort.

One of the biggest challenges in treating BPD is the lack of objective biomarkers to determine lung disease severity and predict prognosis. Novel uses of MRI such as that presented by Forster and colleagues are a promising start to addressing this critical need. It is particularly attractive, as unlike traditional use of radiological data, it is not reliant on human observers (objective) and provides an easily-interpreted numerical result (quantitative). As such, techniques such as these are as well suited as research outcomes as well as clinical tools. MRI could help clinical management of infants with BPD, by providing a non-ionising method of differentiating BPD from alternate diagnosis such as interstitial lung disease, and providing prognostic information. Additionally, quantified index of BPD severity could be useful in providing a robust methodology for measuring outcomes of strategies to reduce BPD.

Where next for pulmonary MRI of the neonate? Ultimately, preventing prematurity would prevent BPD. While preterm delivery remains common, our goal should be to reduce the pulmonary impact of prematurity. What remains for this and other MRI techniques is further validation of the technique in larger longitudinal cohorts, to understand their utility in predicting long-term outcomes and ruling out differentials. As these techniques evolve, it is likely that no single technique will be used in all circumstances, but rather that different modalities will be used depending on the question being asked.

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