1-1-2012

Chest MRI in children: Why bother?

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Official Journal of the Asian Pacific Society of Respirology
Respirology

EDITORIAL

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Key words: high resolution CT, image quality, MRI, pediatric imaging, visual assessment.

In this issue of *Respirology*, Montella and colleagues[1] ask this question: How does high-field chest MRI compare with CT of children with non-cystic fibrosis (CF) lung disease? In an important extension of the first description of this study[2] where they compared MRI and CT with pulmonary function measurements, the authors evaluated how widely-used chest CT and almost never-utilized lung MRI compare for diagnostic imaging of chronic lung disease. Here they show that high-field (3Tesla as compared with the 1.5Tesla clinical standard) thoracic MRI has high reliability and good-to-excellent agreement with CT, definitively answering the important question at hand; their results support more widespread and routine use of MRI in longitudinal monitoring of chronic lung disease, especially in children as well as further optimization and improvement of lung MRI methods. Importantly, non-CF lung disease accounts for the majority of paediatric pulmonary abnormalities[3] and the increasing prevalence and economic burden[4] related to chronic respiratory disease should motivate the research and development of novel MRI methods for serial and longitudinal imaging.[5]

X-ray-based high resolution CT (HRCT) still provides the tool of choice for chest imaging of adults and children with respiratory disease mainly because of its short acquisition times, high spatial resolution and rich information content based on the differential attenuation of x-rays in the lung tissue and airspaces. Although HRCT provides a way to display and qualitatively/quantitatively interpret lung abnormalities, all x-ray based methods including HRCT deliver a small but potentially significant radiation dose to the patient. This limits repeated or longitudinal imaging, a particular problem for children with chronic respiratory disorders. To directly address this limitation, one approach has involved the development of low-dose HRCT techniques[6] and these have become a routine part of screening for, and examination of, lung disease,[7] although the radiation risks are not eliminated. Another approach involves the development of thoracic MRI—mainly overlooked as a clinical application, although its diagnostic potential was recognized nearly two decades ago.[8]

Conventional proton MRI (^{1}H MRI) is readily available in most clinical care centres and radiology departments, however, until now, a number of fundamental challenges have limited its use as a clinical tool for lung imaging. MRI provides exquisite soft tissue contrast of the brain, abdomen and musculoskeletal system by virtue of its detection of water-bound protons in slightly different chemical environments. Proton MRI therefore is understandably dependent on the proton density of the tissues involved but the lung has relatively low tissue density (and high gas density) and is mainly devoid of water. Therefore the lung has very low proton density—and this is one reason why thoracic MRI, even when optimized for the lung, results in an image that resembles a black hole,[9,10] apparently devoid of tissue and morphological information. Compounding this, the lung consists of millions of air-tissue interfaces (on the micrometre scale) designed to aid in gas exchange and because of this, the different magnetic environments in the air and tissue result in so-called magnetic 'susceptibility artefacts'. High-field lung MRI susceptibility artefacts result in transverse relaxation times (T2*) that are shortened ($T2^* = 740\ \mu s$ at 3T), and the practical implication for imaging is that signal decay is accelerated and pulse sequences must be optimized for faster echo times (on the order of 10–100 μs). Taken together, low proton density and susceptibility artefacts mean that lung MRI must incorporate both short echo time/acquisition and long acquisition times for signal averaging and improved signal-to-noise ratios.

Recently there has been a renewed interest in the clinical potential of thoracic proton MRI stimulated by cardiac MRI developments[11] as well as novel pulmonary functional MRI using noble gas contrast agents[12] and Fourier-decomposition proton MRI.[13,14] Pertinent to the current evaluation is the development of the use of ultra-short echo times for lung structure imaging pioneered by Mayo and Muller[8] with recent applications to CF[15] and non-CF lung diseases.[16]

Here, Montella *et al*[1] utilize a straightforward MRI protocol, available on most hospital scanners without the need for additional programming, enabling a practical comparison between two clinically available methods; this is a definite strength of their approach and speaks to the relevance of their results. Although future work will likely incorporate optimized pulse sequences and methods with decreased echo times (e.g. echo time here was 92 ms and with UTE, echo time of 12 μs is possible), the current results are very promising and urge us to continue to develop and test improved lung structural and functional MRI for routine clinical use.

Up until recently, the imaging modality of choice for clinical diagnosis and monitoring of respiratory disease has unquestionably been x-ray-based HRCT. Although good agreement between MRI and CT was observed and reported here, it is clear that lung

doi: 10.1111/j.1440-1843.2011.02079.x

imaging using MRI currently cannot surpass HRCT in terms of speed, image contrast and content as well as spatial resolution. In fact, because of the inherent limitations based on the physics of MRI itself, pulmonary MRI may never replace HRCT for lung disease diagnoses. However, in recognition of the fact that the lung is the most radiosensitive organ in the chest[17,18] and longitudinal monitoring will increase the risk of cumulative radiation doses,[19] especially in children, MRI, even without optimization, should be considered. As shown here, the information derived is certainly complementary to HRCT and in some longitudinal applications in chronic disease, is superior to CT because of its relatively low risk and high information content. Certainly, the current study highlights the practical diagnostic information available now using thoracic MRI acquired on conventional clinical scanners.

Yes, we think chest MRI is definitely worth the bother, now, and in the future.

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