Rapid non-invasive ventilation and perfusion imaging accelerated by neural networks: a two-minute functional MR examination for CF lung disease assessment

Continuous monitoring of cystic fibrosis (CF) lung disease plays a pivotal role in patient management since prompt specialist-care can help to reduce the occurrence of disease-related complications.

For monitoring the lung, pulmonary function tests (PFTs) such as spirometry and multiple-breath washout have recently shown promise in providing clinical information. While reasonably inexpensive and practical, PFTs cannot provide spatial information on the functional impairments. This is, however, possible with magnetic resonance imaging (MRI), which can provide valuable complementary information about lung structure and functions. MRI does not involve exposure to ionizing radiation and is perfectly suited for follow-ups and frequent examinations.

In recent years, an effort has been made to develop a highly specialized but clinically applicable method for non-invasive lung function visualization, such as ventilation and blood perfusion (Figure 1). Functional imaging of the lung is performed during simple free-breathing; thus, it is feasible even in the preschool pediatric populating and subjects that cannot perform PFTs, such as toddlers. MR-based lung function assessment has shown compelling results in clinical studies at several imaging centers.

Functional imaging of the lung requires almost ten minutes of measurements. Our project aims to reduce the measurement time to only two minutes by employing artificial intelligence-based algorithms for quantification of pulmonary ventilation and blood perfusion. Our project's secondary aim is to increase the sensitivity of our technique to lung disease for an improved diagnosis. Faster measurements would improve patient comfort and increase imaging feasibility with preschool or uncooperative children.

Moreover, the examination costs can be reduced, which in turn may allow to increase the imaging frequency and improve disease surveillance or may enable access to pulmonary functional MRI to more patients. The proposed rapid pulmonary functional MRI protocol might become attractive compared to other routine techniques, change clinical approaches, and improve CF patient care.

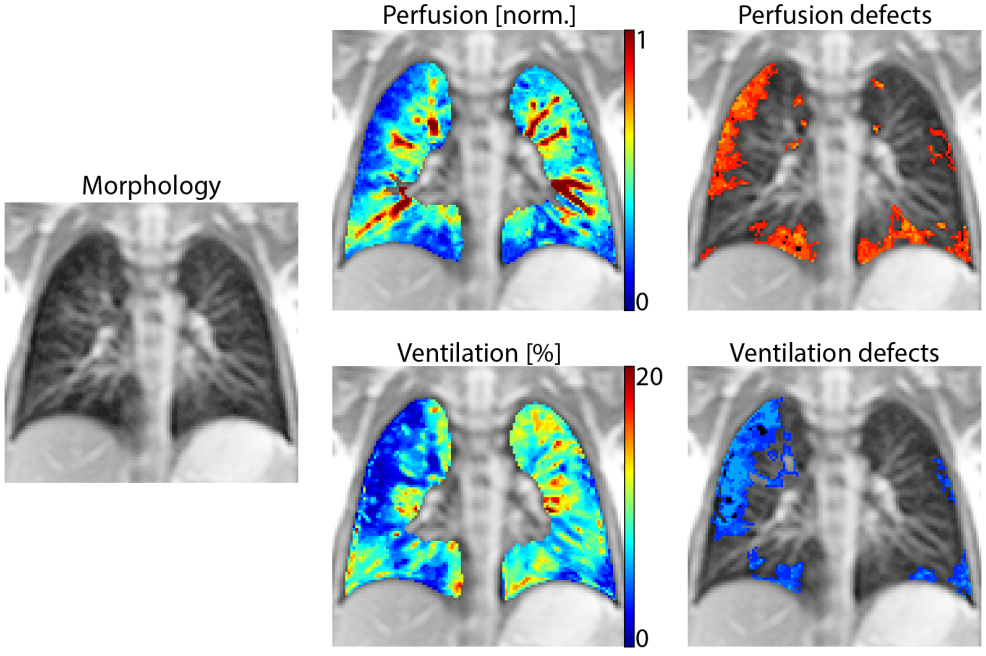

Figure 1. *Exemplary functional lung MRI obtained in a 6-year-old girl with CF. On the left, morphology, in the middle blood perfusion and ventilation, on the right masks of defects.*