Functional imaging of the lung with dynamic MR
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Recent development of fast MR imaging techniques opened a new window for functional assessment of the lung. The lung is a specialized organ for gas exchange, which was formed through evolution. The lung is comprised of three-dimensional alveolar structure, which maximizes the contacting surface area between pulmonary capillary bed and air. The geometric characteristics of lung are inseparable from its function: ventilation and perfusion. Quantification of pulmonary perfusion can be achieved by first-pass contrast agent technique or arterial spin labeling technique. The first-pass contrast agent method is easy to be applied, and provide pixel-by-pixel mapping of perfusion parameters. However, there are issues to be solved theoretically including deconvolution, leakage of contrast agent, and definition of output function. Arterial spin labeling technique is non-invasive and can be repeated. However, implementation and application are difficult. Imaging of ventilation can be performed using hyperpolarized noble gas technique or oxygen-enhanced MR imaging. Both methods are relatively new and novel. Hyperpolarized noble gas technique demonstrate the flow of gas itself, while oxygen-enhanced MR imaging shows transfer of molecular oxygen indirectly through enhancement of protons in lungs by paramagnetic effect of molecular oxygen. The real premises of these methods are dynamic imaging of ventilation and physics-based approaches for analyses of dynamic imaging data. The registration of quantified ventilation/perfusion images is crucial. However, the fact that ventilation requires motion of lung indeed proposes a fundamental challenge for registration of ventilation/perfusion images. At the same time, physics-based approach of registration of lung imaging provides a unique mathematical description of lung mechanics. Ventilation, perfusion, and biomechanics are three major components of lung function. Dynamic MR imaging provides a powerful tool for 21st century functional imaging of the lung.