Functional MR imaging using hyperpolarized contrast agents

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Both hyperpolarized carbon and helium MRI provide unique functional information. However, it is important to depict functional images within the context of the concurrent structural information. For example, in hyperpolarized helium lung imaging, it is important to acquire a proton lung image in order to better visualize the lung structure or to incorporate structural information from other modalities such as CT when MRI is inadequate. In hyperpolarized carbon metabolic imaging, it is vital to acquire proton images with soft tissue contrast of the region of interest in order to localize the metabolic information provided by the ^{13}C MR images. Furthermore, special methodological considerations of hyperpolarized imaging, including limitations due to rapid T_1 decay and additional demands for spectral resolution, make it important to optimize data acquisition efficiency.

Despite the emphasis on function in hyperpolarized imaging, in certain applications it can be used to acquire structural information, such as tumor or airway size. Likewise, conventional proton MR images can also provide functional information regarding perfusion, vascular volume or physiologic motion. By combining such functional and structural information, more advanced analyses are enabled. This work presents methods for incorporating structural information from conventional MRI and CT with hyperpolarized helium MR images of ventilation in the lungs. In addition, several innovations to improve hyperpolarized carbon data acquisition efficiency and structure-function information from a proton MRI acquired simultaneous to a hyperpolarized carbon MRI are demonstrated.