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Noninvasive Magnetic Resonance Imaging for Quantitative Brain Assessment

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Magnetic Resonance Imaging (MRI) for the assessment of cerebral blood perfusion has been routinely used for an increasing number of clinical indications, including cerebrovascular diseases, neoplasms, degenerative and psychiatric disorders. Noninvasive and quantitative MRI techniques include the Arterial Spin Labeling (ASL) and Intravoxel Incoherent Motion (IVIM). ASL uses hydrogen present in arterial blood as an endogenous contrast agent. Briefly, the method consists of magnetically labeling arterial blood by applying radiofrequency pulses. After the labeled blood reaches the region of interest, the images are acquired and then subtracted from control images (without labeling), resulting in a perfusion-weighted map proportional to the cerebral blood flow (CBF). Then, image processing and signal modeling enable CBF quantification. In addition to CBF maps, ASL provides information about perfusion territories of main cerebral arteries, vascular reactivity to hypercapnia challenge, and functional response of the brain during a task or at rest. Moreover, IVIM is a diffusion-weighted MRI method, which can separate the intravoxel signal into classical diffusion and perfusion-related contributions. Its combination with ASL enables quantitative assessment of the blood-brain barrier permeability without using an exogenous contrast agent, as the gadolinium. Therefore, I will discuss the basic principles, main applications, methodological difficulties and limitations of both ASL and IVIM for the assessment of neurological disorders.

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