ASL versus DSC Perfusion MRI: Do We Need Gadolinium in Clinical Practice?
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Clinical perfusion techniques fall into 2 basic categories: those using diffusible vs nondiffusible tracers. Diffusible tracer techniques include H$_2^{15}$O PET, stable xenon CT, and arterial spin labeled (ASL) MRI. Diffusible tracers are not confined to the vessels and enter the tissue. The major nondiffusible tracer techniques in use are bolus contrast CT and MR perfusion methods, where the tracer remains within the vasculature as long as the blood brain barrier is intact. Clinical experience in MRI is greatest for bolus contrast or dynamic susceptibility contrast (DSC) perfusion MRI[1].

There are many implementations of ASL, which in general fall into 2 basic categories: pulsed and continuous. In both cases, arterial blood water is labeled and allowed to flow into the imaging plane(s), during which time there is T1 decay of the label. Subtraction of labeled images from unlabeled control images yields a difference image, in which measured signal change is proportional to cerebral blood flow (CBF). Multiple labeled/control image pairs are typically acquired and averaged. A brain perfusion study thus takes about 5-8 minutes to acquire. ASL studies require no IV contrast and no delay between acquisitions[2].

There are several advantages to using ASL techniques. The noninvasive nature of ASL methods is attractive for patients with poor IV access and also infants and children. Absolute quantitation is possible with relative insensitivity to permeability effects. ASL methods are less affected by large vessel signal. Multiple (and unlimited) repeated measurements can be obtained. While DSC perfusion MRI acquisitions can be repeated (e.g., after a challenge as with acetazolomide), total gadolinium dose limits multiple repeated acquisitions. Also, CBF measurements can be repeated immediately with ASL, and successive CBF maps can be obtained with temporal resolution as fast as 3-8 seconds for perfusion-based functional MRI (as opposed to relying on the BOLD effect)[3-5]. Finally, it is possible to selectively label vascular territories or even individual vessels noninvasively, impossible to accomplish with DSC perfusion MRI[6-8].

Disadvantages to ASL perfusion MRI include transit delays, which may cause artifacts like persistent label in large vessels. Another disadvantage is relatively low SNR compared to DSC perfusion MRI, at least in original implementations, though SNR increases on the order of 10-fold have become available with combinations of higher field strength scanners and improvements in arterial spin labeling efficiency, background suppression, parallel imaging, and coil technology. Susceptibility effects may cause difficulties near paranasal sinuses and skull base or near hemorrhagic foci, but this can also be a problem for DSC perfusion MRI. Relatively straightforward calculation of perfusion metrics like cerebral blood volume and time-to-peak is available with DSC perfusion MRI as compared to ASL methods, though there are potential solutions[9, 10].
Practical utility of ASL methodology has been demonstrated for several potential applications, including acute and chronic cerebrovascular disease, CNS neoplasms, epilepsy, aging and development, neurodegenerative and neuropsychiatric disorders[1, 11-13]. This case-based presentation will focus on these applications, using selected examples to illustrate strengths, weaknesses, or complementary roles of ASL versus DSC perfusion MRI approaches. Selected references are provided below, including several review articles, but this list is by no means comprehensive.

References